

CROSS-LINGUISTIC ARTICULATION RATE AMONG NEAR-BALANCED BILINGUALS AND IMPLICATIONS FOR SECOND LANGUAGE FLUENCY MEASUREMENT

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ABSTRACT

The present study examines cross-linguistic articulation rates in read speech among 28 native speakers (14 English and 14 Japanese) and 14 Japanese-English near-balanced bilinguals. The results show that: (1) articulation rates are comparable between the native speakers and the bilinguals; (2) there was a significant difference of articulation rates in Japanese and English among the bilinguals; (3) there is a strong positive correlation between English and Japanese articulation rates among bilinguals. Implications for development of L2 fluency measurement using the L1 fluency as a baseline are discussed.

Keywords: speech rate, articulation rate, second language, fluency, balanced bilingual

1. INTRODUCTION

The present study aims at development of second language fluency measurement using first language fluency as a baseline. In other words, it is seeking a way to tell learners, “Your speaking fluency in the second language has improved and has already reached x% of your mother-tongue fluency”. To achieve this aim, the present study investigates a way to compare articulation rates between two different languages directly.

Second language fluency measurement has been developed since the 1950s [1, 2], and widely used in SLA research. However, recent studies have found that there is a correlation between L1 fluency and L2 fluency [3, 4]. Therefore, some researchers suggest that L1 fluency should be considered in L2 fluency measurement, which means that L1 fluency should be used as a baseline in second language fluency measurement [5]. Fluency measures are of two principle kinds: temporal variables, such as speech rate, and hesitation phenomena, such as the number of silent pauses [2]. The problem is that comparison of temporal variables between two languages is much more difficult than that of hesitation

phenomena. This is because temporal variables involve the number of syllables and direct comparison is affected by the difference of syllable structures in each language, especially languages like English, a stress-timed language, and Japanese, a syllable-timed language. Therefore, we cannot yet tell L2 learners, “Your L2 fluency has improved and has now reached your L1 fluency level.” The aim of the present study is to find a way to tell this to L2 learners.

Within the phonetics research area, the following question concerning cross-linguistic speech rate has been discussed: Speakers of some languages seem to speak faster, “like machine-guns”, than other language speakers, but are those languages really spoken more rapidly than other languages? [6] There are some empirical studies which investigate cross-linguistic speech rate using native speakers’ speech samples. In a study comparing speech rates in continuous speech between 6 English and 6 Japanese native speakers, the results did not show a significant difference between the two languages in phonemes/minute [7]. In a study with a bigger sample size, which examined syllables/second in 45 English and 45 Spanish native speakers, the results showed that both speech rate (including pauses) and articulation rate (not including pauses) in the two languages were significantly different [8]. Speech rate and articulation rate in English were both lower than in Spanish: speech rate 3.66 (English), 4.24 (Spanish); articulation rate 5.00 (English), 6.08 (Spanish). Thus, the results are different depending on which unit is counted, either phonemes or syllables. In a more recent study, which investigated syllable reduction, it was reported that the results are different when phonological (canonical) syllables are counted or when phonetic (actually produced) syllables are counted [9]. The researchers examined articulation rates in 10 Danish and 9 Swedish native speakers in two speaking style samples. One was a sentence read aloud and the other was a recording from radio news. The results show that when phonological syllables are counted, articulation rates (syllable/sec) were significantly different between

the two languages both in read speech, Danish (4.72), Swedish (3.38), and in the radio news recording, Danish (6.21) and Swedish (5.35). However, when phonetic syllables were counted, the difference between the two languages disappeared for both speaking style samples, because of syllable reduction. Thus, it is important to clarify the unit, such as phonemes or syllables, and phonological or phonetic measures in cross-linguistic speech rate studies. The present study focuses on phonological syllables, following the methodology of fluency measurement in SLA research.

The present study tries a new methodology using near-balanced bilinguals' speech samples. Most of the previous studies of cross-linguistic speech rate and articulation rate use native speakers' speech samples. However, this method requires abundant data because of individual differences. Therefore, the present study examines articulation rates in speech performances in both languages, produced by bilingual speakers, who have native-like speaking ability in both languages. In short, the purpose of the present study is to compare the articulation rates (phonological syllables/second) in English and Japanese among near-balanced bilinguals to develop an L2 fluency measurement using L1 fluency as a baseline.

2. METHODOLOGY

The present study firstly examines whether the bilingual group's articulation rate is comparable to that of native-speakers. Then it examines if there is a correlation between English and Japanese articulation rates among the bilingual speakers. Finally, it examines if articulation rate in Japanese can predict articulation rate in English and discusses the way to compare articulation rates between two languages directly.

2.1. Speakers

There are three groups of participants in the present study: Japanese-English near-balanced bilinguals, English native speakers, and Japanese native speakers. Only for the English native-speaker group's performances, a corpus, "The Wildcat Corpus of Native- and Foreign-Accented English" was used. 14 English native speakers (M2, F12) in the corpus are all university students in the USA (aged 18 to 33). This corpus was chosen to use in the present study, because the same text is used as in the bilingual group experiment, and the speaking style in read speech was natural rather than clear recitation, which is also similar to performances in the bilingual group. The Japanese native-speaker group also consists of 14 university students (M2,

F12; aged 18 to 23) who live in Tokyo. The number of male speakers is lower than female speakers, because the balance was adjusted to the bilingual group that has a lack of male participants. Participants in the bilingual group (aged 18 to 23) were recruited at Sophia University in Tokyo which is famous for bilingual education. All the bilingual participants satisfied two conditions: (1) Japanese-English bilingual speakers who have lived for at least 5 consecutive years in both Japan and English-speaking countries; (2) the age of acquisition for both languages should be younger than the age of six. Totally 25 bilingual speakers joined the experiment. Among them, 14 participants were selected after the second screening with self-reported L1 and L2 language proficiency balance. Only the participants who evaluated their speaking proficiency balance between L1 and L2 as 50:50 or 60:40 were selected. (The choices were 50:50, 60:40, 70:30, 80:20, and 90:10. Most of the bilingual participants answered their listening proficiency balance is 50:50. Reading proficiency balance was much higher in English for most of them). Among the selected 14 bilingual speakers, 6 of them chose Japanese as a dominant language and 6 of them chose English as a dominant language. 2 of them could not decide a dominant language.

2.2. Materials

An Aesop story, "The North Wind and the Sun" [10] is used for the present study, because it is translated into many languages and is commonly used in phonetics research.

2.3. Recording

The bilingual group were recorded in the Sophia University recording studio at a sampling rate of 22kHz. They were told to read aloud the passage at their habitual speech rate. The instructions which were given to the participants were followed by Tsao (1997). They were, "Read the passages at your comfortable rate, or your conversational rate as usual". The passages written in English and written in Japanese are regarded as one set. The order of reading English and Japanese passages was alternated to provide counter balance. The bilingual participants were given some time to read both the passages silently, after that they were told to practice reading out a set of the passages once. Then each speaking set was repeated 5 times. When they made a mistake, they read the sentence again. For the participants in the Japanese native-speaker group, the same procedure was followed, but they needed to read only the Japanese passage. After one time of practice, they repeated it only once.

2.4. Analysis

All the recordings were analyzed using Praat software. Phonological syllables were counted in each run between two pauses. The onsets and offsets of each run were determined using standard criteria. The pause duration was set at 200 milliseconds or more. The articulation rate was calculated by dividing the number of syllables by the duration of the run (syllables per second).

3. RESULTS

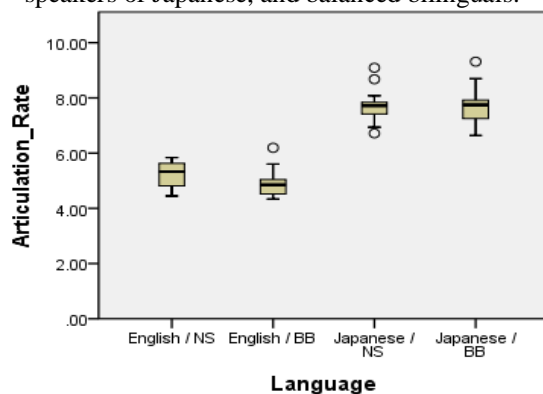
Table 1 is a summary of the mean articulation rates and standard deviation among the three groups.

Table 1: The means and standard deviation of articulation rates among native speakers of English (NS(E)), native speakers of Japanese (NS(J)), and balanced bilinguals (BB)

Group	Articulation rate in English (syll/sec)	Articulation rate in Japanese (syll/sec)
NS(E) (n=14)	5.210 (.473)	
NS(J) (n=14)		7.730 (.616)
BB (n=14)	4.929 (.495)	7.72 (.704)

Before analysing the group differences, normality of distribution was tested by Kolmogorov-Smirnov normality tests. The test results show that the data is all normally distributed. Then native speaker groups and the bilingual group were compared by t-tests. The results show that there was no significant difference in articulation rates between native-speaker groups and the bilingual group either in English and Japanese.

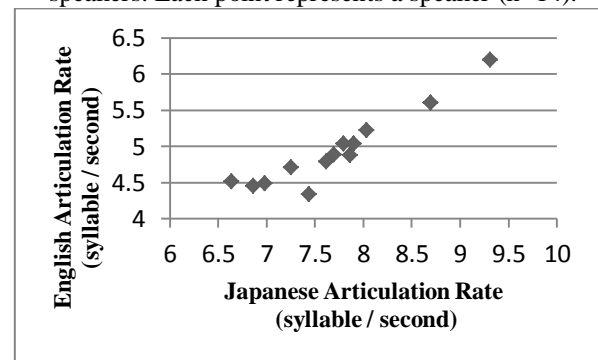
Figure 1: The articulation rates of English and Japanese among native speakers of English, native speakers of Japanese, and balanced bilinguals.



The difference between English and Japanese articulation rates among the bilingual group was also tested. A significant difference was found between

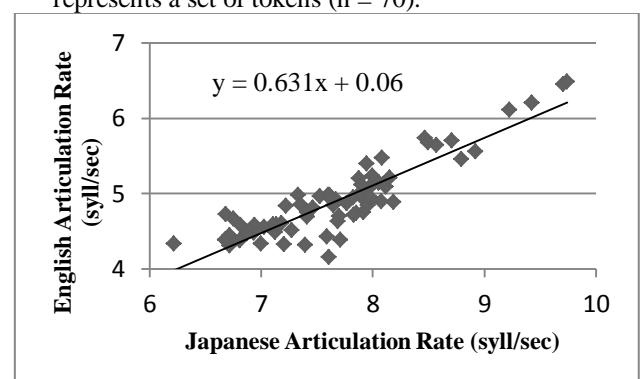
them ($t(27) = -34.620, p < .001; d = 1.62$) (Figure 1). Next, the correlation between English articulation and Japanese articulation among bilingual speakers was analyzed. As shown in Figure 2, strong positive correlations were observed between them ($n=14, r=.942$).

Figure 2: The correlation between English and Japanese articulation rates among bilingual speakers. Each point represents a speaker ($n=14$).



Finally, linear regression function was calculated to evaluate how much Japanese articulation rate can predict English articulation rate among the bilingual group. Articulation rates in 140 tokens were computed (14 participants \times 5 sets \times 2 languages = 140 tokens). The results show that the regression equation can account for approximately 80% of the variance ($R^2 = .799, p < .001$). As shown in Figure 3, regression equation is $y = 0.631x + 0.06$.

Figure 3: Linear regression function between English articulation rate and Japanese articulation rate among the bilingual group. Each point represents a set of tokens ($n = 70$).



4. DISCUSSION

The present study examined native speakers' and near-balanced bilinguals' articulation rates in English and Japanese read speech. There are two findings in the present study.

Firstly, the results show that the average articulation rates in English and Japanese in read speech are clearly different. As for English

articulation rate, the rate was around 5 syllables per second both in the native speaker group and the balanced bilingual group (NS: 5.2, BB: 4.93). These results are consistent with previous studies (5.0 [8], 4.54 (slow talkers), 5.82 (fast talkers) [11], 4.43 [12]). Although the materials are different in each study, English articulation rate in read speech seems to be around 4 to 5 syllables per second. On the other hand, there seems to be no empirical data of Japanese articulation rate calculated in syllables/second. Average Japanese articulation rates in the present study were around 7.7 syll/sec for both groups (NS: 7.73, BB: 7.72). Because Osser & Peng (1964) found there is no significant difference between English and Japanese articulation rates when phonemes/min are measured, further investigation is needed for cross-linguistic articulation rate in both phoneme count and syllable count under the same conditions.

The second finding of the present study is that near balanced bilinguals' articulation rates between the two languages have a strong positive correlation ($n=14$, $r=.942$). This can be explained by the neuromuscular hypothesis, which insists that habitual speech rate is determined by the talker's neurological characteristics, rather than social and linguistic conditions [11]. Because balanced bilingual speakers talk in two languages using the same neurological functions, their habitual speech rates in both the languages should be equally affected by their neurological functions. That might be why there was a strong correlation between the two languages among the near-balanced bilinguals in the present study.

Finally, implications for development of second language fluency measurement using L1 fluency as a baseline are discussed. Figure 3 shows the regression equation between English and Japanese articulation rate as $y = 0.631x + 0.06$. This means that when a balanced bilingual's articulation rate in one language is provided, the articulation rate in the other language can be predicted. For example, when a balanced bilingual's Japanese articulation is 10 syll/sec, his or her English articulation is calculated as 6.37 syll/sec ($= 0.631 \times 10 + 0.06$). The present study suggests that using this equation, it might be possible to provide learners a personal goal for second language fluency. For example, if a learner's Japanese (L1) articulation is 10 syll/sec, the fluency goal would be an articulation rate of 6.36 syll/sec in English (her L2). If her actual English articulation rate is 4.0 syll/sec, her L2 articulation rate has reached 63% ($4.0 / 6.36$) of her goal. Thus, the present study suggests that there is a way to develop L2 fluency measurement based on L1 fluency.

Some studies show the possibility of automatic fluency measurement in read speech and in spontaneous speech [13]. In the future, it might be possible to develop speaking-practice software with automatic fluency measurement functions. Then L2 learners will be encouraged to practice by knowing their score each time, like people enjoy practicing singing with a karaoke scoring system. Further study of cross-linguistic articulation rate in many speaking styles is necessary, and this issue needs more discussion among phonetics and second language testing researchers.

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