ABSTRACT

PHONOLOGICAL PROCESSES IN SENTENCES PRODUCED BY ADULT JAPANESE ENGLISH LANGUAGE LEARNERS

by Lana Renee Schrock

This paper examined the speech sound errors in the sentences of five adult Japanese English Langue Learners (ELLs) and classified the errors as phonological processes. The processes observed were compared to the established developmental processes exhibited by monolingual English speaking children to provide insight into the similarities between L1 phonological acquisition and L2 phonological learning. The results revealed that a majority of the incorrect phonemes are also phonemes that are mastered late in the development of English speaking children. A great deal of variation in rate of occurrence of different phonological processes existed across speakers. Rounding, tensing, decentralization, vowelization, final devoicing, and cluster reduction were the most frequently occurring vowel and consonant processes. The results of this study are interpreted in relation to markedness and a contrastive analysis between Japanese and English phonetic inventories. Clinical implications with respect to pronunciation instruction for ELLs are also addressed.

PHONOLOGICAL PROCESSES IN SENTENCES PRODUCED BY ADULT JAPANESE ENGLISH LANGUAGE LEARNERS

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Introduction

A number of variables have been shown to affect the production accuracy of speech sounds in second language learners. Among these are the similarities and differences between the phonetic inventories of the first language (L1) and second language (L2), the age of learning, and the frequency of L2 use (Flege, 1981). Most people who learn a second language after adolescence speak with a noticeable foreign accent. Nevertheless, some theories suggest that the same mechanisms that underlie first language acquisition are applied to second language learning (Flege, 1981). If this is true, one might expect some similarities between the phonemes most difficult for a monolingual child to master during development and the phonemes that an adult learner of that child's language finds difficult to produce correctly. This prediction is not meant to suggest that adults learning a second language are starting from the same place as children acquiring their first language. After all, the adult language learner already has an established phonological system. However, adults invariably encounter new phonemes when learning a new language. It is possible then, that we may find some parallel between the relative difficulty adults experience learning new phonemes and the age at which those phonemes are mastered in development.

First language speech acquisition has been described according to developmental norms for speech sound mastery (Sander, 1972) as well as age ranges for the suppression of phonological processes. Developmental processes are observed in the speech of very young children whose phonological systems do not yet match the complexity of an adult's. As a result, children simplify the adult phonology by applying patterned errors, or processes to target words. To the extent that phonological processes are defined as orderly sound changes in which an entire class of sounds is impacted (Edwards & Shriberg, 1983), and to the extent that these processes simplify a target language's phonology to match the learner's existing phonological system, processes may also be observed in the speech of adult English Language Learners (ELLs).

Typically, the pronunciation of ELLs is described according to changes in individual phonemes, such as the substitution of /v/ with /b/, causing the word *very* to be pronounced as *berry*, or the substitution of /ð/ with /d/, causing the word *then* to be pronounced as *den*. However, these speech patterns could be described according to phonological processes. In this

instance, /v/ becoming /b/ and /ð/ becoming /d/ are both examples of stopping. In this paper, we examine sound errors in the sentences of five adult Japanese English Language Learners and classify the sound errors according to phonological processes. In the remainder of the introduction we present a contrastive analysis of the English and Japanese sound inventories and a description of Japanese phonotactic constraints. This is followed by a summary of the sound errors expected in Japanese ELLs and a review of the consonant and vowel processes observed in monolingual US English speaking children.

Japanese Phonetic Inventory

Table 1 illustrates the similarities and differences between the Japanese and English consonant inventories. *Shared* phonemes are sounds that are phonetically similar between the two languages. *Unshared* phonemes are sounds that are phonetically dissimilar and language specific.

Stops. In Japanese, some consonants are produced in much the same way as English sounds but may differ in manner and place of articulation. For example, Japanese stops include /p, b, t, d, k, g/, the same stops that are present in English (Tsujimura, 1996). The difference is the production of voiceless stops in Japanese, which are unaspirated. The placement of the tongue differs slightly in Japanese as well, as stops are produced with the tongue blade rather than the tip (Tsujimura, 1996).

Fricatives. Although English consists of both labio-dental and interdental fricatives, Japanese does not contain fricatives in either category. Japanese contains the voiced and voiceless alveolar fricatives /s/ and /z/. The Japanese /s/ is produced differently from the English /s/: the lips are not rounded in Japanese but slightly rounded in the English pronunciation (Tsujimura, 1996). The frequency of occurrence of the Japanese /z/ is lower than the /z/ in English. Japanese consists of fricatives not found in English, including the voiceless bilabial fricative /ɸ/ and the voiceless palatal fricative /ç/ (Tsujimura, 1996).

Affricates. The affricates of English and Japanese vary considerably. The Japanese phonetic inventory includes voiced and voiceless alveo-palatal affricates in addition to voiced and voiceless alveolar affricates (Tsujimura, 1996). The alveo-palatal affricates /tʃ, dʒ/ in Japanese tend to be less rounded than the English equivalents. The Japanese voiceless alveolar

affricate /tˢ/ is produced in typical affricate fashion, but the voiced alveolar affricate /dᶻ/ is produced similarly to the voiced alveolar fricative /z/ (Tsujimura, 1996).

Approximants. Japanese contains three approximants: one liquid, /r/; and, two glides, /w/ and /j/ (Tsujimura, 1996). In Japanese, the alveolar liquid sounds much like the English /d/, which is usually transcribed as a flap in Japanese. The velar glide /w/ is unrounded and does not typically involve much lip movement, unlike the English /w/, which mandates lip movement. Some cases of production of the Japanese /w/ have included lip movement, indicating possible dialectal differences (Tsujimura, 1996; Vance, 1987).

Nasals. The Japanese /m/ and /n/ do not differ from the English counterparts. The third nasal sound, /ŋ/, is used by some Japanese speakers but not all. In addition to the three nasals common to English, Japanese has a uvular nasal /ɴ/, which is used before a pause (Vance, 1987).

Japanese Vowel Inventory

Table 2 illustrates a contrastive analysis between the Japanese and English vowel inventories. Japanese consists of five vowels, a smaller number than English (Ladefoged, 2001). The five vowels of Japanese include high front /i/, mid front /e/, mid back /a/, low central /o/, and high back /ɯ/ (Tsujimura, 1996). The Japanese high front vowel differs from the English vowel in the word *leap* in that the lips are not parted in the Japanese production (Tsujimura, 1996). Standard US English contains two mid front vowels, but Japanese consists of only one mid front vowel that is produced moderately higher in the oral cavity than the English counterpart in the word *bet* (Tsujimura, 1996). Standard US English consists of two mid back vowels, whereas Japanese consists of only one, /o/, that is produced moderately higher than the English vowel in the word *caught* (Tsujimura, 1996). The low central Japanese /a/ is produced in a more front-focused manner compared to the low back Standard US English /ɑ/. The Japanese high back vowel differs from the Standard US English counterpart by lip rounding (Tsujimura, 1996). In Standard US English, the vowel /u/ is produced with rounded lips. However, the Japanese vowel /ɯ/ is produced without rounding (Tsujimura, 1996). The five vowels of Japanese are considered monophthongs and are contrasted as long or short, also referred to as bi-moraic or mono-moraic, respectively (Ingram & Park, 1997; Keating & Huffman, 1984).

Phonotactic Constraints

Phonotactic constraints are language-specific restrictions for combining phonemes into words. Japanese words end mostly with open-syllables. Standard US English words may end with open or closed syllables. Japanese does not consist of any consonant clusters in word-initial or word-final position, so Japanese ELLs may experience difficulty producing Standard US English words that contain consonant clusters or closed syllables (Avery & Ehrlich, 1992). In addition, Japanese ELLs may have difficulty producing word-initial /w/ and /j/ when these phonemes are followed by high vowels, resulting in omission of initial glides (i.e., *year* may be produced as *ear*) (Avery & Ehrlich, 1992).

To simplify consonant clusters, Japanese speakers may insert a vowel between the two consonants. Japanese ELLs often add vowels to the end of English words, a process called epenthesis. Examples of this are found in Japanese words that have been borrowed from English, such as *lamp*, *bus*, and *hot*, which are produced as /rampu/, /basu/, and /hot:o/, respectively (Avery & Ehrlich, 1992; Tsujimura, 1996).

Observed Substitutions in Japanese English Language Learners

Consonants. Since some Standard US English sounds are not present in Japanese, Japanese ELLs may substitute those sounds with sounds that are present in their native language. For example, the English /f/ may be substituted with Japanese /ɸ/, /v/ with /b/, /θ/ with /s/, and /ð/ with /z/. Japanese speakers are not likely to make a distinction in pronunciation of English words beginning with the above pairs (Tsujimura, 1996). For example, the words *vase* and *base* would likely be produced as *base*.

The English liquid /r/ presents some challenges for Japanese speakers. In words with final /r/ some Japanese speakers of English omit the /r/ and lengthen the preceding vowel. When the Standard US English /r/ is in word initial position, it is often substituted with the flap /ɾ/ (Tsujimura, 1996). This is likely due in part to the pronunciation of the Japanese alveolar liquid /r/, which sounds much like the Standard US English flapped /d/ or /t/. Although the Japanese /ɾ/ and the Standard US English liquids /r/ and /l/ differ in place and manner of articulation, Japanese speakers of English perceptually collapse the English liquids /l/ and /r/ into the same

category as the Japanese /r/, leading to sound substitutions (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004).

Vowels. When producing Standard US English vowels, Japanese speakers often alter the duration or spectral quality of the vowels. Japanese ELLs commonly produce English vowels with more overlap than do native English speakers by conflating different vowels into the same categories. For example, the Standard US English /ɑ/ and /ʌ/ may be produced in the same manner as Japanese /a/, and the vowels /ʊ/ and /u/ may be conflated with the Japanese /ɯ/ (Oh et al., 2011; Tsukada et al., 2005). The phonetic similarity between L1 and L2 vowels may prevent learners from forming a new vowel category in L2, which results in vowel transfer of L1 phonemes to L2 (Flege, 1987).

Developmental processes in Monolingual English Children

Consonants. Mastery of consonant production occurs over a wide age range in typically developing monolingual US English children. For example, phonemes such as /m/ and /b/ are mastered as early as 3 years, while phonemes such as /ð/ and /r/ are mastered as late as 8 years of age (Sander, 1972). While children learn to master all sounds in all word positions developmental processes are applied to target words. The phonological processes observed in typically developing monolingual English-speaking children are categorized as syllable-structure processes, substitution processes, and assimilation processes (Ingram, 1976; Lowe, 1994; Stoel-Gammon & Dunn, 1985). Common syllable structure processes include: weak syllable deletion, final consonant deletion, cluster reduction, and epenthesis. Examples of substitution processes include: gliding, vocalization, stopping, and fronting. Assimilation processes include: labial assimilation, velar assimilation, nasal assimilation, prevocalic voicing, and final devoicing (Hodson & Paden, 1981; Lowe, 1994; Stoel-Gammon & Dunn, 1985).

Some processes, such as weak syllable deletion, final consonant deletion, and fronting, are usually suppressed by the time children are three years old. Other processes, such as cluster reduction, gliding, and stopping, may persist well past three years of age (Stoel-Gammon & Dunn, 1985). The most common processes in children younger than three years of age appear to be weak syllable deletion, final consonant deletion, gliding, and cluster reduction (Stoel-Gammon & Dunn, 1985).

Vowels. Unlike consonants, vowels are typically mastered by 3 years. However, when vowels are incorrectly produced, they can also be categorized according to processes. Much the same as consonant error patterns, vowel error patterns typically change an entire class of vowels and are grouped according to alterations in features, complexity, and vowel harmony (Pollock, 1991). An example of a feature change is backing, which occurs when front vowels are produced further back in the mouth. Other possible vowel feature changes are fronting, lowering, raising, centralization, tensing, laxing, rounding, and unrounding. An example of a complexity change is diphthong reduction, in which a diphthong is reduced to a monophthong. A vowel harmony change occurs when a vowel in a word is changed as a result of another vowel within the word, such as when a low or mid vowel changes to a high vowel as a result of another high vowel in the word (Pollock, 1991). Vowel harmony changes include complete vowel harmony, frontness vowel harmony, height vowel harmony, tenseness vowel harmony, and rounding vowel harmony.

Purpose of Study

This research study identifies the speech errors observed in the sentences of five adult, Japanese, ELLs and analyzes the errors according to the framework of phonological processes. The knowledge gained from this study will provide some insight into the similarities between L1 acquisition and L2 learning and may provide the basis for further investigations to determine whether current approaches to phonological process training for children can be applied to pronunciation instruction for adult ELLs. Following are the research questions addressed: (1) What are the phonological processes observed in the sentences of five adult Japanese ELLs?; (2) What is the relationship between the number of years a Japanese ELL has been speaking English and the rate of occurrence of phonological processes?; and, (3) What are the similarities and differences between the phonological processes observed in Japanese ELLs and the developmental processes established for monolingual English children?

With respect to these research questions, we have formed the following hypotheses: (1) The phonological processes observed in the sentences of Japanese ELLs will correspond with developmental phonological processes established for monolingual US English speaking children; (2) There will be an inverse relationship between the length of time a Japanese ELL has been speaking English and the rate of occurrence of phonological processes; and, (3) Those

processes that are among the last to be suppressed in monolingual US English speaking children will have the highest rate of occurrence in the sentences of Japanese ELLs.

Methods

Participants

The five participants in this study, two males and three females, were native speakers of Japanese who resided in the state of Washington. Inclusion criteria for participation were as follows: (1) typically-developed speech, language and hearing by self-report; (2) began learning and using spoken English after the age of twelve years; (3) older than 18 years of age; and, (4) moderate command of Standard US English as judged by the researcher based on the reading of the Grandfather Passage. Potential participants were excluded if they reported fluency in any language other than Japanese and English. Table 3 presents the demographic information for all the speakers.

The participants ranged in age from 22 to 46 years old and each began learning English at age 12 to 13 years. At the time the sentences were recorded, the participants had been speaking English for a range of 3 months to 21 years.

Recording Procedures

All recordings took place in a sound-attenuated room in the Speech and Hearing Clinic at the University of Washington. The recordings were made through a mono channel using an Audio-technica ATM75 condenser headset microphone that was placed approximately 3 inches in front and to the right of the participant's mouth. The microphone was connected to an Apogee Electronics Mini-Me Digital-to-Analog Converter for sound digitization at the following settings: a sampling rate of 44.1 KHz, 16 bit resolution, and a curve setting of 2. The soft-limiting setting was activated to prevent peak-clipping during the recording. Recordings were made directly onto a Sony laptop with Praat 4.1.27 through a mono channel with buffer size of 50 megabytes and a sampling rate of 44.1 KHz (Boersma & Weenink, 2005; Wood, 2005).

Sentence Recording. Before recording each sentence, speakers were given time to review each sentence and ask questions regarding unfamiliar words. Every participant was recorded as he/she read 22 sentences. The sentences were generated using the Sentence Intelligibility portion of the Speech Intelligibility Test (SIT) computer software, which randomly creates lists of semantically unpredictable, phonetically balanced sentences that range in length from 5 to 15 words (Yorkston, Beukelman, & Hakel, 1996). Four different sentence sets were

generated. Each set consisted of 22 sentences. The four sets were randomly assigned to the five participants (See Figure 1).

Data Analysis

Identification of Phoneme Accuracy

Each set of 22 sentences from the SIT was phonetically transcribed according to Standard US English pronunciation of connected speech. For example, the phrase *the black cat* would be transcribed to account for the gemmination of the final /k/ in *black* with the initial /k/ in *cat*. Therefore, the target would be transcribed as /blækæt/. The principal researcher and three graduate students listened to the sentences produced by the Japanese speakers and individually coded each sentence for phoneme accuracy. Phonemes that were perceived as being produced differently than the Standard US English target were marked as inaccurate phonemes. Phonemes produced differently due to coarticulation were not coded as being inaccurate. For example, most native speakers of US English partially devoice phrase final /z/. Therefore, devoiced consonants were identified as being inaccurate only when the Japanese speaker fully devoiced a consonant to its voiceless cognate. Graduate students were trained to independently identify inaccurate productions. The principal researcher and the graduate students met to compare results and reach group consensus regarding the accuracy of each phoneme.

Identification of Phonological Processes

The consonant processes included in this study were final consonant deletion, cluster reduction, gliding, stopping, vowelization, velar fronting, prevocalic voicing and final consonant devoicing. The vowel processes included were backing, raising, tensing, laxing, rounding, decentralization, and diphthong reduction. These vowel processes were identified based on Chomsky and Halle's distinctive features binary system (1968). Refer to Table 4 for examples of each vowel process.

For each target sentence, the number of opportunities for various consonant and vowel processes to occur was identified on a word-by-word basis, remaining aware of coarticulation effects. For example, the consonant processes possible in the word *patrons* /petrənz/ are prevocalic voicing, cluster reduction, gliding, and final consonant devoicing. The vowel processes possible are tensing, laxing, and lowering.

Once the total number of opportunities for each process was identified, a graduate student determined the number of occurrences of phonological processes per speaker. The specific

phoneme errors in each sentence were identified and characterized according to the aforementioned phonological processes. For example, if the target word /petrənz/ was produced as /pɛtrəns/, it would be noted as laxing /e/ → /ɛ/ and final consonant devoicing /z/ → /s/. For each process, the total number of occurrences was divided by the total number of opportunities. This number was multiplied by 100, and thus the percentage of occurrence was calculated (i.e., % occurrence = (# of occurrences / # of opportunities) x100).

The number of opportunities for specific processes varied within a sentence set. For instance, the number of opportunities for final consonant deletion was 117, whereas the number for vowelization was 30. The sentence sets were phonetically balanced; therefore, the number of opportunities for processes was similar across speakers. For example, the number of opportunities for final consonant deletion varied from 111 to 118 and for vowelization from 30 to 35 across the five speakers. Only consonant processes that had the opportunity to occur at least 30 times in each sentence set were included in this study.

Results

Reliability

Point-to-point reliability for sound changes observed in inaccurate phonemes was calculated based on 18% of the sentences in the sample; four sentences were randomly selected from each speaker's set of 22 sentences. Inter-judge reliability was performed by two graduate students. Reliability reached 90.43% for intra-judge reliability and 74.19% for inter-judge reliability.

Phonological Processes Affecting Consonants

The result of the process analysis revealed a great deal of variation in rate of occurrence across speakers (See Figure 2 and Table 5). The three most commonly occurring phonological processes are vowelization, final consonant devoicing, and cluster reduction.

Vowelization was the most frequently occurring process for all speakers except Speaker 4 for whom the most frequently occurring process was final consonant devoicing. The rate of occurrence for vowelization was between 31.43% and 56.67%. Vowelization affected the mid-central rhotic vowel in words such as *mother* and *flowers* and the post-vocalic alveolar liquid in words such as *special* and *natural*. The phoneme /ɚ/ was more frequently affected (See Table 6).

Final consonant devoicing was the most frequently occurring process for Speaker 4 and the second most frequently occurring process for Speaker 5. The rate of occurrence for final

consonant devoicing was between 10.71% and 33.33%. Final consonant devoicing affected alveolar voiced plosives and fricatives in words such as *dozens* and *decades.* The phoneme /z/ was most frequently affected.

Cluster reduction was the second most frequently occurring process for Speakers 1 and 3 and the third most frequently occurring process for Speakers 2 and 5. The rate of occurrence for cluster reduction was between 13.04% and 18.07%. Cluster reduction affected alveolar plosive and fricative consonant clusters in word final positions in words such as *its* and *interest*. Some of the phoneme clusters affected included /nd, nz, dz, ts, st, rt/.

Additional frequently occurring processes included final consonant deletion and stopping. Final consonant deletion was the second most frequently occurring process for Speaker 2 and the third most frequently occurring process for Speaker 3. The rate of occurrence was between 3.39% and 19.66%. Final consonant deletion affected the alveolar nasal and liquid phonemes, the palatal liquid, and the voiced labiodental fricative in words such as *cane* and *car*. The phonemes /n/ and /r/ were most frequently affected.

Stopping was the third most frequently occurring process for Speaker 4. The rate of occurrence was between 2.17% and 23.6%. Stopping affected the voiced interdental fricative and voiced labiodental plosive in words such as *that* and *five.* The phoneme /ð/ was most frequently affected.

Phonological Processes Affecting Vowels

The result of the vowel phonological process analysis also revealed much variation in the rate of occurrence across the speakers (See Figure 3 and Table 7). However, the three most frequently occurring vowel processes were rounding, tensing, and decentralization.

Rounding was the most frequently occurring process for all the speakers except Speakers 3 and 5 for whom the most frequently occurring processes were backing and diphthong reduction, respectively. The rate of occurrence for rounding was between 7.14% and 50%. Tensing was the second most frequently process for Speakers 1, 2, and 4. The rate of occurrence for tensing was between 6.17% and 26.32%. Decentralization was the third most frequently occurring process for Speakers 2, 3, 4, and 5 but was not observed at all for Speaker 1. For the speakers for which decentralization was observed, the rate of occurrence was between 7.35% and 17.2%.

Additional vowel processes observed included laxing, raising, backing, and diphthong reduction. The rate of occurrence for laxing was between 1.61% and 6.67%. The rate of

occurrence for raising was between 2% and 4.55%. The rate of occurrence for backing was 16% for Speaker 3; backing was not observed in the other four speakers. Two speakers, Speakers 3 and 5, were the only speakers for whom diphthong reduction was observed with a rate of occurrence of 11.1% and 42.9%.

Years Speaking English and Rate of Occurrence of Processes

No clear relationship was found between the rate of occurrence of processes and the number of years the speakers had been speaking English. For example, among the five speakers, Speaker 2 had been speaking English for the greatest amount of time, 21 years, and Speakers 4 and 5 had been speaking English for the least amount of time, 3 months. However, it is not the case that Speaker 2 had a smaller rate of occurrence for all phonological processes compared to Speakers 4 and 5. Of the eight consonant processes, Speaker 2 exhibited the highest rate of occurrence of vowelization (56.7%). Of the eight vowel processes, Speaker 2 exhibited the highest rate of occurrence for only two, raising (4.55%) and laxing (6.67%). By contrast, Speaker 4 exhibited the lowest rate of occurrence of raising (2.0%) and cluster reduction (13.04%) among the five speakers.

Of the five speakers, Speakers 4 and 5, who had been speaking English the least amount of time, exhibited the highest rate of occurrence of some phonological processes. For example, Speaker 5 exhibited the highest rate of occurrence of two vowel processes, diphthong reduction (42.9%) and decentralization (17.2%). Speaker 4 presented the highest percentage of occurrence of two consonant processes, final consonant devoicing (33.33%) and stopping (23.6%).

As stated earlier, four different sentence sets were randomly assigned to the five speakers. As a result, the productions of Speakers 1 and 5 were based on the same sentence set. These two speakers had been speaking English for 21 years and 3 months, respectively. When the results of Speaker 1 were compared with those of Speaker 5, we found that; overall, Speaker 5 exhibited a higher rate of occurrence of consonant and vowel processes than did Speaker 1. Of the eight consonant processes, there were two exceptions to this observation. Both speakers exhibited the same rate of occurrence for cluster reduction (15.48%), and Speaker 1 exhibited velar fronting at 2.33%, while this process was not present in any of the sentences produced by Speaker 5. Of the eight vowel processes, Speaker 1 exhibited a lower rate of occurrence for all except the following: raising, in which both speakers exhibited the same rate of occurrence

(2.33%), and tensing, in which Speaker 1 exhibited a higher rate (11.11%) than did Speaker 5 (6.94%). The possible implications of these observations will be addressed in the discussion.

Discussion

This study examined speech sound errors in the sentences of five adult, Japanese ELLs. Multiple sound errors were observed in the sentences produced by the speakers. The observed errors affected more than one phoneme or combination of phonemes within a class of sounds; therefore, these errors were categorized according to phonological processes. The following research questions were addressed: (1) What are the phonological processes observed in the sentences of five adult Japanese ELLs?; (2) What is the relationship between the number of years a Japanese ELL has been speaking English and the rate of occurrence of phonological processes?; and, (3) What are the similarities and differences between the phonological processes observed in Japanese ELLs and the developmental processes established for monolingual English children?

With respect to these research questions, we formed the following hypotheses: (1) The phonological processes observed in the sentences of Japanese ELLs will correspond with developmental phonological processes established for monolingual US English speaking children; (2) There will be an inverse relationship between the length of time a Japanese ELL has been speaking English and the rate of occurrence of phonological processes; and, (3) Those processes that are among the last to be suppressed in monolingual English children will have the highest rate of occurrence in the sentences of Japanese ELLs.

Observed Phonological Processes

The first research question addressed was (1) What are the phonological processes observed in the sentences of five adult Japanese ELLs? The results indicate that the processes observed in the Japanese ELLs corresponded with the developmental processes established for monolingual US English speaking children. This observation supported our first hypothesis. The consonant processes observed included final consonant deletion, cluster reduction, prevocalic voicing, final devoicing, gliding, velar fronting, stopping, and vowelization. Each of the aforementioned processes affected more than one phoneme or combination of phonemes within a class of sounds. For example, stopping affected /θ, ð, v/, final consonant deletion affected /n, t, r, l, v, d/, and cluster reduction affected /nt, rd, mz, ts, gr, tr/. Prevocalic voicing and velar fronting were the only processes that did not affect more than one speech sound. The vowel processes

observed in this study included backing, raising, tensing, laxing, rounding, decentralization, and diphthong reduction.

These findings have clinical implications for the approach that providers of English pronunciation instruction may take when working with ELLs. Clinical approaches, such as the Cycles Approach, address phonological processes by targeting one to two speech sounds within a class with the expectation that accurate production of one sound will generalize to other sounds within that class. Although this approach is typically used in the remediation of speech sound errors in children, it is possible that such an approach may also prove efficacious in pronunciation training for ELLs.

Years Speaking English and Rate of Occurrence of Processes

The second research question addressed was (2) What is the relationship between the number of years a Japanese ELL has been speaking English and the rate of occurrence of phonological processes? The results of the study do not support the hypothesis that there will be an inverse relationship between years speaking English and the frequency of occurrence of processes. The three most frequently occurring vowel processes were rounding, tensing, and decentralization. Although Speaker 2 had been speaking English for the greatest amount of time—21 years—he exhibited the highest rate of occurrence of raising and laxing. By contrast Speaker 4, who had been speaking English for the least amount of time—three months—exhibited the lowest rate of occurrence of raising. Nevertheless, Speaker 5, who had also been speaking English only three months, exhibited the highest rate of occurrence of diphthong reduction and decentralization. Diphthong reduction was observed more than 40% of the time for one speaker, whereas the other four speakers did not exhibit any vowel processes beyond a 40% rate of occurrence.

The most common consonant processes observed were vowelization, final consonant devoicing, and cluster reduction. However, much variation was noted, and no clear relationship was found between the rate of occurrence of processes and the number of years speaking English across all five speakers. For example, Speaker 2 had been speaking English for 21 years yet exhibited the highest percentage of occurrence of vowelization. By contrast Speaker 4, who had been speaking English only 3 months at the time of data collection, exhibited the lowest percentage of occurrence of cluster reduction. However, Speaker 4 did present the highest percentage of occurrence of final consonant devoicing and stopping. Vowelization was the only

process to occur at a rate higher than 40%, which is typically considered the percentage necessary for sound changes to be classified as phonological processes in children. Even then, vowelization only exhibited a rate of occurrence higher than 40% for two of the five speakers. The other three speakers did not exhibit a rate of occurrence greater than 40% for any consonant phonological processes.

The SIT produces sentence sets that are phonetically balanced. This means that the frequency of individual phonemes reflects the frequency of phonemes in English and is equivalent across sets. In this sense, speakers who are assigned different sentence sets will have essentially the same opportunities for the production of English phonemes. However, phonetic balance does not always account for coarticulatory variation. This raises the possibility that the variability observed in rate of process occurrence across speakers might be attributable to the different phonetic contexts surrounding the phonemes in different sentence sets. Speakers 1 and 5 read the same sentence set and had been speaking English for 21 years and 3 months, respectively. When comparing speakers who read identical sentence sets, our hypothesis was partially supported; overall, Speaker 5 exhibited a higher rate of occurrence of consonant and vowel processes than did Speaker 1. Perhaps if all five speakers had read the same sentence set, we would have observed a relationship between the years speaking English and the rate of occurrence of phonological processes.

Process Comparison between Japanese ELLs and English Children

The third research question addressed was (3) What are the similarities and differences between the phonological processes observed in Japanese ELLs and the developmental processes established for monolingual English children? The results of the study do support the hypothesis that the processes that are suppressed late in monolingual English children have the highest rate of occurrence in the sentences of Japanese ELLs. Both consonants and vowels were included in the analysis of phonological processes. However, unlike consonants, some of which are mastered as late as 8 years of age such as /r/ and /ð/ (Sander, 1972), vowels are generally mastered by the age of 3 years in monolingual US English children. Since the age range for mastery of consonants is greater, only the results of the consonant analysis are being compared to known developmental data for phoneme mastery and suppression of processes in monolingual US English speaking children. Vowels have been included in this study because Japanese has a

much smaller vowel inventory than English. Japanese ELLs are likely to encounter many new English vowels, which may be produced inaccurately.

Of the three consonant processes most often observed in this study (vowelization, final devoicing, and cluster reduction), vowelization is the only process that does not begin to decline in a monolingual, English-speaking child's speech until age 4 years. Although cluster reduction begins to decline between 3 years and 4 years of age, it can remain present as a normal phonological process until age 5 years. Final devoicing begins to decline around age 3 years and disappears by age 4 years. Therefore, the three most commonly occurring consonant processes observed in this study are among the last to be suppressed in typically developing monolingual English speaking children. Of the processes observed in this study, only two, prevocalic voicing and velar fronting, are expected to be suppressed by age 3 in the speech of monolingual English speaking children. In this study, these processes were found to have a low rate of occurrence and each process only affected one phoneme.

Many of the consonants affected by phonological processes in these five adults are expected to be mastered relatively late in typically developing monolingual English children. For example, the unshared phonemes that are specific to English are /f, v, θ, ð, ʃ, ʒ, l/. With the exception of /f/, which is usually mastered by age 4, the remaining phonemes are mastered later in development, between 6 and 8 years of age (Sander, 1972). One concept that may explain the similarities between the English sounds that were most commonly in error and those sounds that are mastered later in development is markedness. Marked phonemes are those phonemes that occur less frequently across languages and are also expected to be mastered later in development. Accordingly, English phonemes that do not exist in a speaker's L1 and that are more marked than existing L1 phonemes will be relatively difficult to learn (Eckman, 1977). It is here that we see an overlap between L1 acquisition and L2 learning. The markedness of L2 phonemes impacted the phonological patterns observed in ELLs. Additionally, those phonemes that were most affected by phonological processes (/v, ð, θ, l/) are the same phonemes that are mastered late in L1 acquisition and are more difficult for Japanese ELLs to learn. The clinical implication for this finding is that these phonemes may be more resistant to change, due to markedness, and will likely require more training to be produced accurately than earlier developing phonemes, such as /f/.

Conclusion

This study presents pilot data for further investigations concerning the presence of phonological processes in the speech of ELLs. Future studies must be conducted with larger sample sizes and a variety of language backgrounds to determine if similar overlap between L1 acquisition and L2 learning can be established. Additional research should examine how the presence of phonological processes impacts listener ratings of comprehensibility and intelligibility. If it is found that certain processes have a negative impact on speaker comprehensibility and intelligibility, then future research should also address the effectiveness of current approaches to phonological process training on the speech of ELLs. As stated earlier, clinical approaches based on phonological processes, such as the Cycles Approach, are typically used in the remediation of speech sound errors in children. The authors of this study are aware that foreign-accented speech constitutes a difference and not a disorder. Nevertheless, the following question is worth posing, in our well-intentioned efforts to distinguish difference from disorder: Could speech-language pathologists be overlooking effective approaches for ELL pronunciation instruction simply because those approaches are already associated with the remediation of speech disorders in children? Given the results of this study, it is our assertion that an approach to instruction for ELLs based on phonological processes could very well provide more clinical efficacy than an articulatory approach in which phonemes are targeted individually. It is our hope that this study, and similar studies, could provide a basis for further investigations to determine the validity of our assertion.

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Table 1: Shared and Unshared Consonant Phonemes between English and Japanese

Sound classes	Shared phonemes	Unshared phonemes specific to English	Unshared phonemes specific to Japanese
Plosives	/p, b, t, d, k, g/		
Nasals	/n, m, ŋ/		/ɴ/
Fricatives	/s, z, h/	/f, v, θ, ð, ʃ, ʒ/	/ ɸ, ç/
Affricate	/tʃ, dʒ/		/dᶻ, tˢ/
Approximants: liquid glide	/r/ /j, w/	/l/	

Note: SLPs typically classify /ʃ/ and /ʒ/ as palatal fricatives. However, these phonemes are articulatory post-alveolar in English and therefore differ from the Japanese voiceless palatal fricative.

Table 2: Shared and Unshared Vowel Phonemes between English and Japanese

Sound classes	Shared phonemes	Unshared phonemes specific to English	Unshared phonemes specific to Japanese
High front	/i/	/ɪ/	
Mid front	/e/	/ɛ/	
Low front		/æ/	
Mid central		/ə, ʌ/	
Low central			/a/
High back		/u, ʊ/	/ɯ/
Mid back	/o/	/ɔ/	
Low back		/ɑ/	

Note: Japanese vowels have phonemic length contrasts, which result in five vowel qualities but 10 vowel phonemes.

Table 3: Demographic Information for Japanese Speakers

ELL Speaker	Gender	Age	Age of Learning	Years speaking English
Speaker 1	Female	37 yr	13 yr	7 yr
Speaker 2	Male	35 yr	12 yr	21 yr
Speaker 3	Male	46 yr	13 yr	3 yr
Speaker 4	Female	22 yr	13 yr	3 mo
Speaker 5	Female	39 yr	13 yr	3 mo

Table 4: Vowel Processes Included

Vowel Processes	**Vowel Shifts Included**
Raising	/ɛ/ → /ɪ/ /æ/ → /ɛ/
Lowering	/ɪ/ → /ɛ/ /ɛ/ → /æ/
Tensing	/ɪ/ → /i/ /ɛ/ → /e/ /ʊ/ → /u/
Laxing	/i/ → /ɪ/ /u/ → /ʊ/ /e/ → /ɛ/
Rounding	/ɑ/ → /o/ /ɑ/ → /ɔ/
Backing	/æ/ → /ɑ/
Decentralization	/ə/ → any front or back vowel /ʌ/ → any front or back vowel
Diphthong Reduction	/o͡ʊ/ → /o/

Table 5: Phonological Processes Affecting Consonants

Phonological Process	Speaker 1	Speaker 2	Speaker 3	Speaker 4	Speaker 5
FCD	4.5	19.66	12.93	3.39	12.61
CR	15.48	15.07	18.07	13.04	15.48
PVV	0	0	0	1.61	3.77
Fdev	10.71	11.29	12	33.33	28.57
Gl	0	0	6.45	0	13.89
VF	2.33	0	5.41	6.25	0
St	3.96	5.62	2.17	23.6	11.88
Vw	32.35	56.67	36.67	31.43	52.94

Note: FCD – Final consonant deletion; CR – Cluster reduction; PVV – Prevocalic voicing; Fdev – Final consonant devoicing; Gl – Gliding; VF – Velar fronting; St – Stopping; Vw - Vowelization

Table 6: Consonant Phonemes Affected

ELL Speaker	FCD	CR	PVV	Fdev	Gl	VF	St	Vw
Speaker 1	/n, t, r/	/nt, nd, rd, mz, dz, bl, rs, rt/		/z, d/		/ŋ/	/ð/	/ɚ/
Speaker 2	/n, r, l, v/	/rl, ld, nk, ts, rg, zd, mf, ls, dz, rk/		/z, d/			/v, ð/	/ɚ/
Speaker 3	/n, r, l, v/	/rdʒ, rm, ts, mz, nd, ld, rtʃ, gr, nz, dz, ld, st, rt/	/t/	/z, v/	/r, l/	/ŋ/	/ð/	/l, ɚ/
Speaker 4	/n, v, r/	/st, dz, nd, ts, tr, ns/		/z, d, g, dʒ/		/ŋ/	/θ, ð/	/l, ɚ/
Speaker 5	/l, d, n, r, v/	/nt, nd, md, nz, dz, rs, rt, ns, rd/	/t/	/z, d/	/r, l/		/ð,v/	/l, ɚ/

Table 7: Phonological Processes Affecting Vowels

Vowel Processes	Speaker 1	Speaker 2	Speaker 3	Speaker 4	Speaker 5
Laxing	1.61	6.67	1.89	5.56	3.23
Tensing	11.11	19.44	6.17	26.32	6.94
Lowering	0	0	0	0	0
Raising	2.33	4.55	2.27	2	2.33
Decen	0	11.29	7.35	12.5	17.2
Backing	0	0	16	0	0
Rounding	12.5	25	7.14	50	25
Diphthong Reduction	0	0	11.1	0	42.9

Note: Decen – Decentralization

Table 8: Vowel Phonemes Affected

ELL Speaker	Laxing	Tensing	Lowering	Raising	Decen	Backing	Rounding	Diphthong Reduction
Speaker 1	/i/	/ɪ, ʊ/		/æ/	/ʌ/		/ɑ/	
Speaker 2	/i, e/	/ɪ/		/æ, ɛ/	/ə, ʌ/		/ɑ/	
Speaker 3	/e/	/ɪ/		/ɛ/	/ə/	/æ/	/ɑ/	/o͡ʊ/
Speaker 4	/e/	/ɪ, ʊ/		/æ/	/ə/		/ɑ/	
Speaker 5	/i, e/	/ɪ/			/ə, ʌ/	/æ/	/ɑ/	/o͡ʊ/

Note: Decen – Decentralization

Figure 1: Sentence Lists

Speakers 1 and 5 Sentence List
They will make many friends
Money wasn't a big problem
I don't want to discourage people
The book is small and lightweight
I feel I can play this weekend
Now I'm living exactly as I choose
A low price will sell a house quickly
It can lead to any number of adventures
We cannot and need not back either side totally
They are important natural sources of vitamins and minerals
Accordingly, when it is gone it is gone for good
They almost had to lift me out of the car
There are many dozens of worthwhile places to break the trip
My mother nursed me in the wings and in dressing rooms
After what seemed like hours of waiting, the taxi finally showed up
He seeks constantly to improve his product and maintain high quality standards
Telephone operators take messages but never give the room number of the patrons
I used to watch it all the time but now I become bored
If you have a complaint, first ask the merchant to take care of it
It is unrealistic to expect any human personality to remain frozen for two decades
Yet, it is so different from other flowers that it needs its own special terms
If he and his wife are having difficulties he will talk them out with her

Speaker 2
The workout lasted two hours
We know we can score
He took me out one day
The wallpaper is green and blue
The team had me do the throwing
I am not trying to antagonize judges
The airplane came in for a swift landing
From politics, the emphasis shifted to economic affairs
That's not the word to describe it at all
It cannot live in animals or elsewhere in nature
He is a wonderful person and a very good teacher
Perhaps his music might succeed where his words could not
They bring it in on freighters and airliners, and in cars
When looking over something, you should give it a good look
I was worried about what I was going to say to him
They're asking more questions and doctors, for the most part, are answering
The innate ability to find water has fascinated and puzzled mankind for centuries
As long as one can admire and love, then one is young forever
The children were now daring each other to feats of wild speed and recklessness

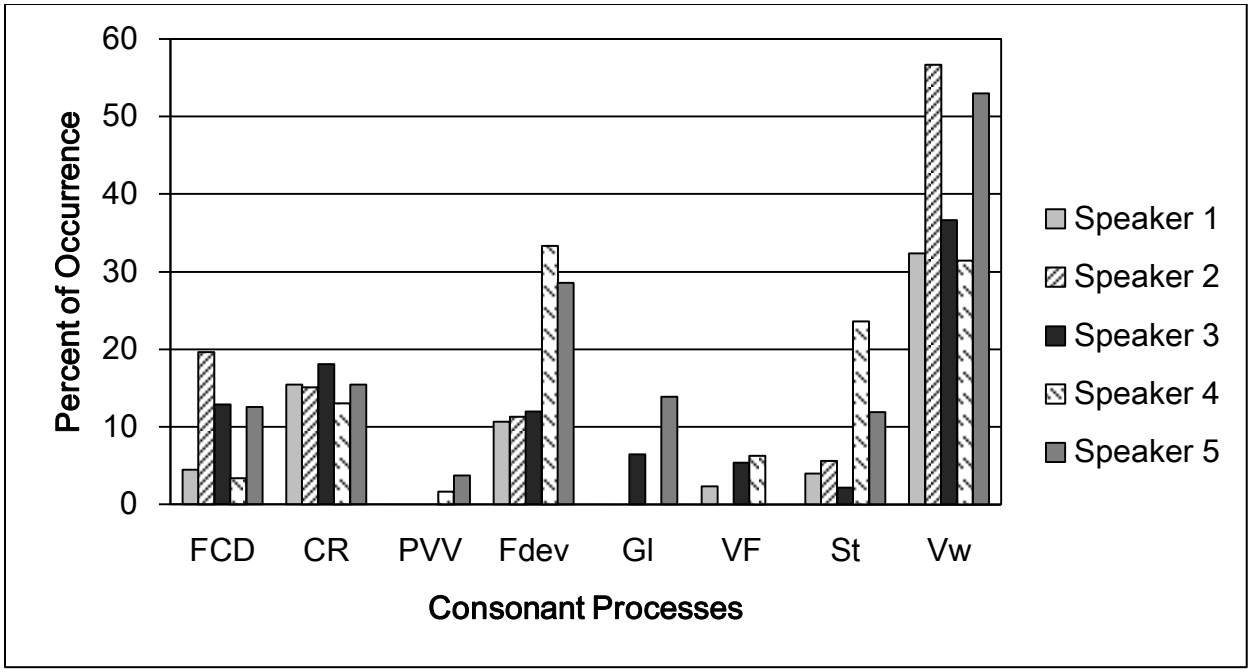
No one will ever play what you could consider a perfect game of golf
No one had to tell what organized labor could do for working men and women
The moon and wind turn the sugar cane fields into oceans of sparkling green waves

Speaker 3
That day might be here
The humidity is overwhelming there
The snow blew into large drifts
He'll sell them by the box
No one can quarrel with the aim
He ignores them, concentrating on his work
For casual walking, you need no special equipment
Natural poisons have always existed in our foods
You're not supposed to be talking during the performance
There is nothing in this world he cannot do
Giving away tickets to women attracted them to the games
Just as often, it's the businessman who is considered right
He seems to hit higher on each of his great rounds
So far as is known, the disease resides only in people
He will regard his wife and family as full partners and friends
You will have to dig into your wallet as deeply as I
We were under a tremendous amount of pressure, but handled it very well
Her position is basically the same as it was a few weeks ago
Some individuals have actually been able to control their heart rate and blood pressure
Why not walk part of the way down the mountain to the lookout point?
We're fortunate that there are still people like him around to develop good social programs
It may seem that there are a number of steps in the processing of cheese

Speaker 4
The cat had five kittens
He has played very well
The sailboat flew the red flag
The pair of shoes was new
They had no natural interest in sports
You can wade in the cool slow river
He is capable and willing to make decisions
I have three tiny screaming babies in my arms
He could never understand people who complained about age
They are some of the best vegetable protein foods known
My that's a big word for such a little child
When looking over something you should give it a good look
You are not really supposed to look at it like that
When her son graduated from college with honors, she beamed with pride
How did such an unlikely pair ever meet in the first place?
We were under a tremendous amount of pressure but handled it very well
Telephone operators take messages but never give the room number of the patrons

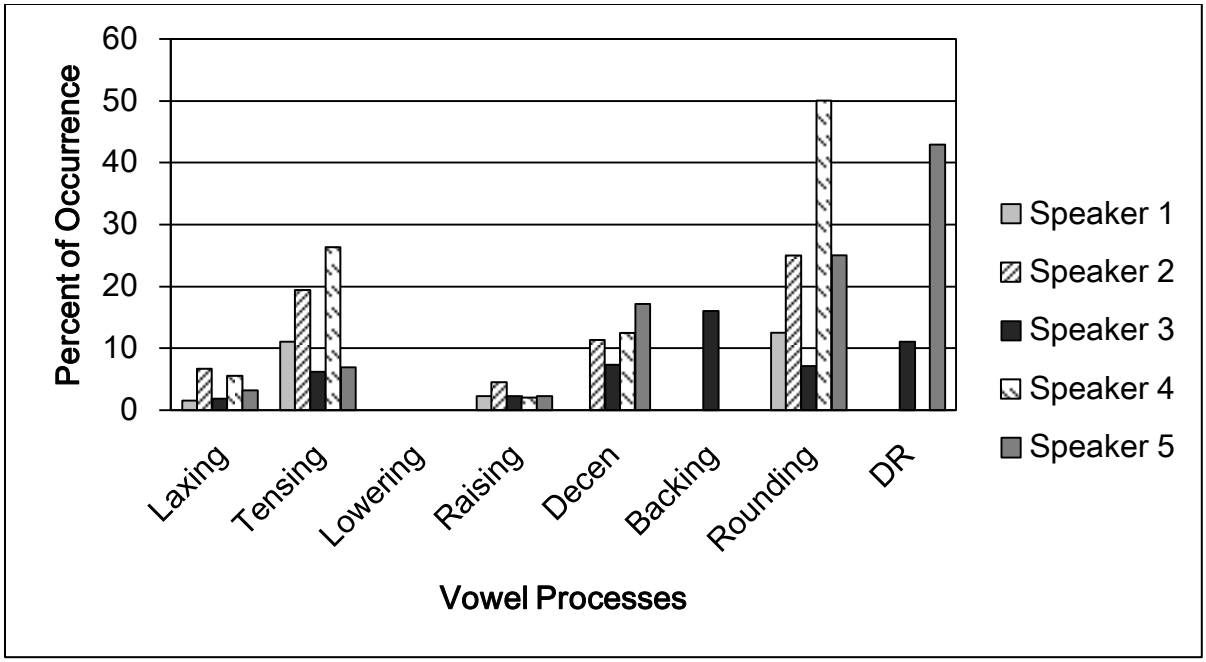
Enlightened coaches encourage players to bring their mates along with them on athletic trips
Teach the subject how to score higher on the test that measures his imagination
It ran north and south so that the sun made a complete arc over it
We had the chance and we felt it would be sinful not to take it

Figure 2: Phonological Processes Affecting Consonants



Note: FCD – Final consonant deletion; CR – Cluster reduction; PVV – Prevocalic voicing; Fdev – Final consonant devoicing; Gl – Gliding; VF – Velar fronting; St – Stopping; Vw – Vowelization

Figure 3: Phonological Processes Affecting Vowels



Note: Decen – Decentralization; DR – Diphthong reduction