PITCH ACCENT PRODUCTION BY NATIVE AND NON-NATIVE SPEAKERS OF JAPANESE

by

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A THESIS

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Incorrect pronunciation of pitch accent in Japanese can have negative impacts on a speaker's comprehensibility. In order to correct non-native speaker errors in this area, we must first understand how and why they are making errors. The present study analyzed the pronunciation of two different groups of non-native speakers—native English (NE) speakers and native Chinese (NC) speakers—in order to examine how they produce Japanese pitch accent patterns compared to native Japanese (NJ) speakers. Five speakers of each language group participated in the experiment. Pronunciation samples were gathered by eliciting pitch accent minimal pairs within sentence frames. These were then analyzed with the speech analysis software Praat, and measurements for the pitch, duration, and intensity for all vowels of each word were gathered.

It was found that non-native speakers were unsuccessful nearly two-thirds of the time in matching the dictionary form of pitch accent patterns. When not matching the dictionary form, NJ speakers often defaulted to a pitch pattern with the accent on the second mora. Four non-native speakers who had strong English backgrounds and lesser experience with Japanese showed preference for producing most words with the accent

on the penultimate mora. All NE speakers also showed preference for pitch patterns with only one high pitch. This suggests L1 transfer of English prosodic features, an idea supported by previous research (Nishinuma, Arai, & Ayusawa, 1996; Yamada, 1996).

The NE speakers often produced the minimal pairs with the same pitch patterns. This implies that NE speakers are not perceptually distinguishing pitch patterns for minimal pairs. The NC speakers had similar behavior, to a lesser extent. Both groups of non-native speakers also had a positive correlation between pitch~intensity and a negative correlation between pitch~duration. This ran counter to both the expectation that the NE speakers would show positive correlations among all of pitch, duration, and intensity, and the expectation that NC speakers would show few correlations. The NJ speakers had clear positive correlations between pitch~duration and duration~intensity, which challenges the traditional notion that pitch has little relation to duration and intensity in Japanese. For individual correlations, the NC speakers patterned similarly and the NE speakers did not pattern similarly. The NJ speakers patterned together by gender. In general, correlations found for individual speakers did not match the correlations found for language groups as a whole. These results show a need for further research in pitch, duration, and intensity correlation for both native and non-native Japanese speakers.

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Introduction

Second language acquisition

As anyone who has studied a second language will attest, language learning is no simple process. There are a variety of factors that affect one's ability to competently learn and use a second language. A person's age, exposure to the second language, amount and type of prior instruction, aptitude, attitude, motivation, and native language all affect the learning process. This last factor—the effect of one's first language on one's acquisition of a second language[1]—has been the focus of much study and research over the last few decades (Celce-Murcia, Brinton, & Goodwin, 1996, p. 14-28).

One specific area of interest is that of L2 pronunciation. Until relatively recently, research on the effect of L1 on L2 pronunciation has mostly focused on *segmental* features (Jun & Oh, 2000; Moyer, 1999). Segmental features are those that consist of a discrete unit or phone; that is, a language's inventory of consonants and vowels. Languages also have *suprasegmental* features that transcend the segmental level, such as voice quality, nasality, or prosody.[2] Current research is beginning to focus more on these suprasegmental features, especially prosody (Celce-Murcia, Brinton, & Goodwin, 1996, p. 25-28), and the results suggest that prosodic errors are often more detrimental to comprehensibility than segmental errors, due to their significance for discourse fluency (Moyer, 1999; Munro, 1998; Munro & Derwing, 1995). Improvement in comprehensibility for non-native speakers of a language, then, is more likely to occur

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[1] Hereafter, I will use the established convention of using L1 to refer to "first language" as L2 to refer to "second language."

[2] *Prosody* is composed of intonation, volume, rhythm, and stress (Celce-Murcia, Brinton, & Goodwin, 1996, p. 200).

with prosodic proficiency than with a sole focus on segmental proficiency. An example of this is non-native speakers of a language who have a strong accent (due to segmental but not suprasegmental errors) but are still highly intelligible to native speakers of the language (Derwing & Munro, 1998).

Unfortunately, most foreign language learners and instructors have ignored the importance of prosody in fluent speech, or at best have consigned it to the more advanced levels of language learning (Hirata, 1999). Instructors perhaps see it as too difficult, or do not completely understand it—let alone understand how to teach it. For this reason, there is a great need "to incorporate suprasegmental training in language instruction, acknowledging the importance of intonation and stress for discourse fluency" (Moyer, 1999, p. 99). Correlated with this is the need to understand how non-native speakers are currently producing prosodic errors, in order to better help them improve the comprehensibility of their speech.

Pitch, tone, and stress

One of the important prosodic features in language is pitch. Pitch is the perceived "highness" or "lowness" of a sound wave, corresponding to the wave's *frequency*. In his well-known text *A Course in Phonetics*, Peter Ladefoged (2001) defines frequency as "the number of complete repetitions (cycles) of variations in air pressure occurring in a second" (p. 164). Thus, frequency is measured in cycles per second, known as Hertz (Hz). The sound waves composing speech are actually a combination of a number of different waves—the complexity that this yields is what creates the richness of the human voice. The lowest frequency wave of this composite is known as the *fundamental*

frequency of the wave, denoted as F0 (f-zero). This correlates with the number of vibrations per second of the vocal folds. Pitch can therefore be seen as a perceptual correlate of F0.

The usage of pitch in languages can be described as a continuum. At one end there exist non-tonal languages, which do not use pitch to distinguish between words. These are often referred to as stress languages, because they use stress[3] on certain syllables of words. English is one of these stress languages. For example, in English, noun-verb pairs are often distinguished by stress placement, such as *rébel* (one who is in rebellion) and *rebél* (to resist or defy an authority). Other examples of stress languages include most Romance languages, Dutch, Chichewa, and Seminole/Creek (Gussenhoven, 2004, p. 16).

At the other end of the continuum there exist tonal languages, which *do* use pitch distinctively. Though the American perspective tends to be that these tonal languages are rare, in reality 60 to 70 percent of the world's languages are tonal (Gussenhoven, 2004, p. 28; Yip, 2002, p. 1). Chinese is one well-known tone language. The classic example of pitch differentiation in Chinese is the form *ma*: depending on the pitch contour of the word, *ma* can mean 'mother' (flat pitch), 'hemp' (rising pitch), 'horse' (falling then rising pitch), or 'scold' (falling pitch) (Gussenhoven, 2004, p. 28). Other examples of tone languages include Lithuanian, Norwegian, Siane, and Punjabi (Yip, 2002, p. 18).

Tonal languages can further be divided into tone languages and pitch accent languages. Yoko Hasegawa (1999) succinctly describes the difference between these two types:

---

[3] Stress is a combination of prominence in pitch, intensity, duration, and voice quality (Gussenhoven, 2004; Yip, 2002).

> In tone languages, the tone of each syllable is unpredictable and, therefore, must be specified in the lexicon [the mental list of words]. No syllable in tone languages is considered more prominent (i.e. accented) than any other(s). In pitch-accent languages, by contrast, the specification of some accent location(s) is sufficient to predict the tonal configuration, or melody, of the entire word. Therefore, the syllable on which such an accent falls is considered more prominent than other syllables. (p. 1)

An example of this in Japanese is the form *hashi*. With an accent on the first part of the word (*háshi*) it means 'chopsticks'; with an accent on the second part of the word (*hashí*) it means 'bridge'; with no accent (*hashi*) it means 'edge'. This example will be explained in more detail in a moment. One should keep in mind that this accent is done mainly with pitch, unlike the English stress accent, which is a combination of pitch, duration, intensity, and voice quality. Some other examples of pitch accent languages include Tonga, New Chongming Chinese, Serbo-Croatian, and Swedish (Yip, 2002, p. 259).

In reality, the division between stress, tone, and pitch accent is not quite as simple as this. Labeling a language a "stress language" does not imply that pitch plays no role in the language—pitch may be utilized as a clue to signal pragmatic, semantic, syntactic, morphological, or even lexical information (Yip, 2002, p. 256). Likewise, a "tone language" may utilize prominence among its syllables—certain syllables may be longer, louder, or more prone to attract tonal contrasts (Yip, 2002, p. 256). This reflects the idea that pitch usage exists along a continuum.

Similarly, "There is no absolute division between [pitch] accent languages and tone languages, just a continuum from 'accent' to 'tone' as the number and denseness of tones increase, and they become freer to move around" (Yip, 2002, p. 257). Thus, one might say that pitch accent languages occupy a transitional ground between pure stress languages and pure tone languages (Yip, 2002, p. 260).

The mora

Pitch accent in Japanese is placed on one *mora* of a word. Morae[4] are similar to syllables in English, but have important differences. In simplest terms, "A mora is a unit of timing. Each mora takes about the same length of time to say" (Ladefoged, 2001, p. 233). A mora also corresponds to one character of the *hiragana* or *katakana* writing syllabaries, and can be one of the following three things (Tsujimura, 1996, p. 75):

a. (C)V
b. the first part of a long consonant (i.e. a geminate)
c. syllable-final, or "moraic," nasal *n*

In part (a) of this definition, C stands for any consonant and V for any vowel, with the parentheses around the C indicating its optionality—thus indicating both V and CV as possibilities for morae. This is the case for words like *omoi* (おもい) meaning 'heavy' or 'remembrance', which is composed of three morae: the V mora *o* (お), the CV mora *mo* (も), and the V mora *i* (い). Part (b) refers to geminate consonants, which are held for the length of one mora and therefore known as "long" consonants. An example of this is the long *k* in the word *gakkô* (がっこう) 'school', which has the four morae *ga* (が), *k* (っ), *ko* (こ), and *u* (う). No words included in the current experiment had geminate consonants.[5] Part (c) includes words like *kanji* (かんじ) 'feeling' or 'Chinese character', which has three morae: *ka* (か), the "moraic nasal" *n* (ん), and *ji* (じ).

A simple yet effective example of the reality of the mora is in haiku poetry. In English, we form haikus with a 5-7-5 *syllable* pattern. In Japanese, however, it is a 5-7-5 *mora* pattern. The following poem, a haiku by Bashô Matsuo, is an example of this (Vance, 1987, p. 64):

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[4] *Morae* is the standard plural form of *mora*.

[5] For more information on how gemination affects pitch accent, see Shport (2003).

Ran no ka ya	/ra-n-no-ka-ya/	'The fragrant orchid
Chou no tsubasa ni	/cho-u-no-tsu-ba-sa-ni/	Into a butterfly's wings
Takimono su	/ta-ki-mo-no-su/	It breathes the incense.'

Here, the CV mora type is evident (e.g. the *ra* of *ran*), the moraic nasal is evident (e.g. the *n* of *ran*), and the V mora type is evident (e.g. the *u* of *chou*). All are counted as one piece of the 5-7-5 pattern. Understanding the mora in this way provides a foundation for talking about the placement of pitch accent, and how that placement determines a word's pitch pattern.

Determining pitch patterns

Every word in Japanese is specified as either unaccented or with an accent on a particular mora. From this specified accent location, one can determine the pitch pattern for the entire word. One method of determining this pitch pattern, known as McCawley's treatment (Vance, 1987, p. 89), is comprised of three ordered rules, with H indicating a high pitch on a mora and L indicating a low pitch on a mora:

1. Make every mora H.
2. Make every mora after the accented syllable L.
3. Make the first mora L if it is not accented.

Hereafter, I will use this L/H system for describing the words in my study.

As an example, let us look again at the variant forms of *hashi*. To repeat, there exist three distinct words with the romanization[6] *hashi*, one meaning 'bridge' (橋), one meaning 'chopsticks' (箸), and one meaning 'edge' (端). *Hashi* is composed of two morae, *ha* (は) and *shi* (し). In terms of pitch, *hashi* 'bridge' has the accent on the second

[6] *Romanization* is transliterating non-Roman alphabet characters into the Roman alphabet.

mora, *hashi* 'chopsticks' has the accent on the first mora, and *hashi* 'edge' has no accent. Using McCawley's treatment (with the accented mora italicized for readability):

	hashí 'bridge'	*háshi* 'chopsticks'	*hashi* 'edge'
1.	H *H*	*H* H	H H
2.	H *H*	*H* L	H H
3.	**L *H***	***H* L**	**L H**

From this, one can see that *hashi* 'bridge' and *hashi* 'edge' end up with the same pitch pattern. In actuality, they can be differentiated by adding a postposition, such as the subject-marker *ga*, which becomes part of the pitch pattern of the word. Again using McCawley's treatment:

	hashí ga 'bridge'	*háshi ga* 'chopsticks'	*hashi ga* 'edge'
1.	H *H* (H)	*H* H (H)	H H (H)
2.	H *H* (L)	*H* L (L)	H H (H)
3.	**L *H* (L)**	***H* L (L)**	**L H (H)**

I have enclosed the pitch of the postposition in parentheses, which is a convention I will continue to use throughout this study. Because adding a postposition like this helps differentiate unaccented words and words with the accent on the final mora, it is important to elicit data that includes both the word and the postposition.

Research questions

In my research, I looked at two different groups of non-native speakers—native English speakers and native Chinese speakers—in order to examine how they produce Japanese pitch accent patterns. I chose these two language groups because they were easily accessible on the University of Oregon campus, prevalent within the university's Japanese language program, and represented both stress and tone languages. I also included native Japanese speakers, so that I could compare non-native and native

speakers' productions, as well as compare the native speaker productions with previous research on Japanese pitch accent.

My research poses the following questions:

(1) How often do each language groups' pitch patterns match the dictionary form of the pitch patterns? How do the non-native speakers compare to the native speakers?

Based on the established difficulty of non-native speakers to perceive and produce L2 prosody (Derwing & Munro, 1998; Hirata, 1999; Moyer, 1999; Munro, 1998; Munro & Derwing, 1995), I hypothesize that the non-native speakers will be less accurate than native speakers in matching the dictionary form of the pitch patterns. Also, given the use of pitch to differentiate words in both tone languages and pitch accent languages (Gussenhoven, 2004, p. 26; Hasegawa, 1999; Yip, 2002, p. 257), I hypothesize that the native Chinese speakers will outperform the native English speakers.

(2) With what overall consistency do the language groups produce pitch patterns?

In light of research suggesting L1 English speakers' preference for English intonation patterns in Japanese pitch perception (Nishinuma, Arai, & Ayusawa, 1996) and preference in accenting certain morae (including the penultimate[7] mora) over others (Yamada, 1996), my hypothesis is that native English speakers will consistently produce patterns with a typical English stress pattern: one place of prominence, usually on the penultimate mora. I hypothesize that this will occur across all pitch pattern types. My

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[7] *Penultimate* means next-to-last. English preference for penultimate stress can be seen in changes like *phó-neme* to *pho-né-tic* to *pho-ne-tí-cian.*

hypothesis for native Chinese speakers and native Japanese speakers is that they will have less consistent productions than the English speakers, across all pitch pattern types.

(3) Do non-native speakers make a distinction in their production of two words differing only in pitch accent?

Using the evidence cited in (1) and (2), I hypothesize that the non-native speakers will often produce the same pitch pattern for words differing only in the dictionary placement of pitch accent—that is, they will not differentiate pitch accent minimal pairs. I also hypothesize that the native Chinese speakers will make a greater differentiation than the native English speakers.

(4) Are there correlations between pitch, duration, and intensity for any of the language groups?

Based on the idea of preference for English stress patterns set out in (2), my hypothesis is that native speakers of English will have correlations between the pitch, duration, and intensity of their vowels, more so than either of the other language groups. This would reflect L1 transfer in L2 production—specifically, production of the prominent place in a word. With Gussenhoven's (2004) assertion in mind that "duration and [intensity] of an accented [mora] of Tokyo Japanese only marginally exceed those of an otherwise equivalent unaccented [mora]" (p. 40), my hypothesis for native Japanese speakers is that they will have little to no correlation between pitch, duration, and intensity.

Method

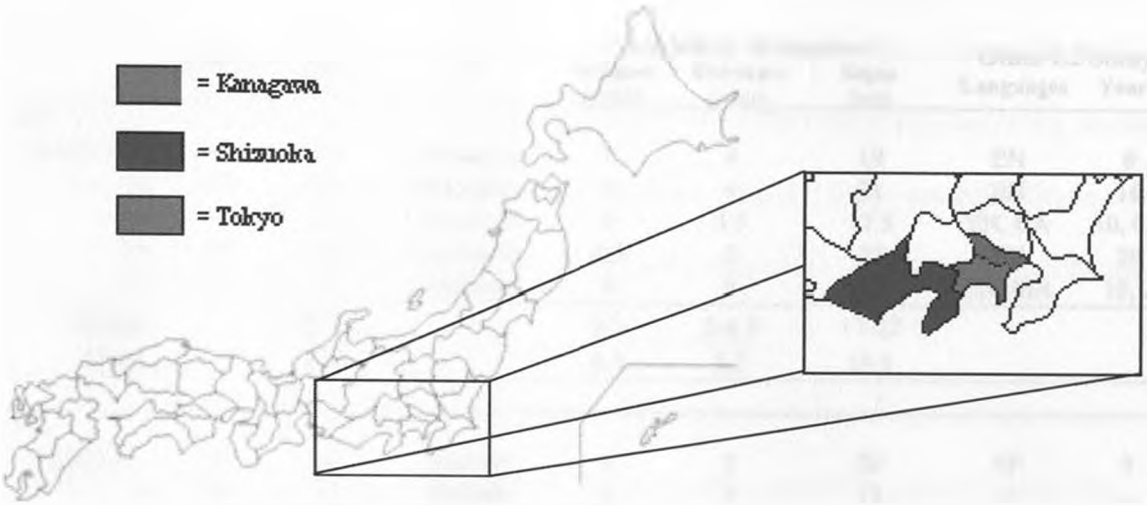
Participants

Three groups of Japanese-speaking volunteers participated in the experiment: 10 native English speakers (hereafter, NE speakers), 5 native Chinese speakers (hereafter, NC speakers), and 5 native Japanese speakers (hereafter, NJ speakers). The NJ participants were Japanese exchange students with whom I have direct contact. The information they provided in their language background questionnaires is shown below. (The language background questionnaires I used are included in Appendix B.)

		Gender	Age	L1	L2 Study in English (years)	Prefecture in Japan
NJ						
Speaker No.	5	F	20	Japanese	8	Kanagawa
	7	F	25	Japanese	13	Kanagawa
	10	M	19	Japanese	5	Tokyo
	17	M	19	Japanese	6	Kanagawa
	22	F	22	Japanese	10	Shizuoka
Range			19-25		5-13	
Mean			21		8.4	

Notes: L1 = first language, L2 = second language, Prefecture in Japan = region of Japan raised and lived in

Since the dictionary pitch accent is based on Tokyo Standard Japanese, I strived to find speakers from the Kanto region (the region where Tokyo Standard Japanese is spoken, including the prefectures of Gunma, Tochigi, Ibaraki, Saitama, Tokyo, Chiba, and Kanagawa). However, I could only find 4 speakers from this region at the time I performed the recordings. The fifth participant, Speaker 22, came from the neighboring prefecture of Shizuoka. I could not find any resources on how the accents differed, even contacting a number of Japanese linguists, all of whom did not respond or could not give me a definite answer. I kept this possible source of error in mind while analyzing the data. See the maps on the following page for the relative locations of the prefectures.



The NE and NC participants were students in the Japanese language program at the University of Oregon. I visited four of the fourth- and fifth-year classes, describing who I was, why I was writing a thesis, and the type of volunteers I needed. People interested in participating in the experiment provided their contact information, which I then used to set up appointments with each of them.

Because the primary participants in the Japanese program are American speakers of English, I ended up with twice as many NE participants as NC participants. To create equity among the groups, from the 10 NE participants, I chose the 5 that most closely resembled the NC and NJ participants, based on their language background questionnaires. This left me with equal groups of 5 for the three different language groups. The non-native speakers' data is summarized in the table on the following page.

	Gender	Age	L1	L2 Study in Japanese			Other L2 Study	
				In Japan (years)	Elsewhere (years)	Began (age)	Languages	Years
NC								
Speaker # 3	F	32	Mandarin	1	4	19	EN	6
14	F	28	Mandarin	0	4	21	EN	16
16	F	23	Mandarin	0	4.5	17.5	EN, CA	10, 0.5
18	M	24	Cantonese	0.5	2	22	EN	20
21	F	21	Cantonese	0	4	17	EN, MA	10, 2
Range		21-32		0-1	2-4.5	17-22		
Mean		25.6		0.3	3.7	19.3		
NE								
Speaker # 1	M	23	English	1	2	20	SP	9
2	M	17	English	1	3	13	—	—
13	F	18	English	0	5	5*	—	—
19	M	23	English	1	3	16.5	FR, SP	0.5, 0.5
23	F	22	English	1	2	14.5	GE, FR	1, 3
Range		17-23		0-1	2-5	5*-20		
Mean		20.6		0.8	3	13.8		
RANGE		17-32		0-1	2-5	5*-22		
MEAN		23.1		0.6	3.4	16.6		

Notes: L1 = first language, L2 = second language, EN = English, CA = Cantonese, MA = Mandarin, SP = Spanish, FR = French, GE = German, * = an estimation; the participant answered "child" because she couldn't remember exactly when she began learning Japanese

Materials

For the experiment I used 20 sets of words, 15 of which were *minimal pairs.* Minimal pairs are words that differ by only one phonetic feature—for the purposes of this research, differing only in pitch accent. In actuality, 3 of the words sets were triads (like *hashi*) instead of pairs, yielding a total of 43 words. I placed these words in contextual sentences, which I then printed onto 3x5 cards.

Each card contained two sentences. The first was just to orient the speaker to which word of the minimal pair it was. The second was to obtain a production of the

word in the sentence frame *Watashi wa ____ ga suki desu*[1], meaning "I like ____." (All sentences in their entirety are included in Appendix A.) I used the same sentence frame so that the environment around each minimal pair word was consistent, removing another variable that might have affected the results. Another reason for the sentence frame was to include a postposition (*ga*) in order to differentiate the words with no pitch accent from the words with the pitch accent on the penultimate mora.[2]

Since the experiment relied on a participant's knowledge of the word, I chose words that I believed would be familiar to the non-native speakers, yet still satisfy the requirement of having an appropriate minimal pair. Since I gathered my non-native speakers from the University of Oregon Japanese language program, and I had gone through the program myself, I could base the non-native speakers' familiarity with the words on my own familiarity with them. Naturally, speakers vary in the vocabulary they remember and learn from outside sources, and while it occasionally became difficult to find two familiar words that were minimal pairs in pitch accent, I always strived to choose words that speakers either had learned in the program or would most likely have heard from a native Japanese speaker.

I also tried to choose words with a variety of morae. Of the 20 sets of words, 10 of them were two-mora minimal pairs with differing pitch accents, 1 of which was a minimal triad; 5 of them were three-mora minimal pairs with differing pitch accents, 1 of which was a minimal triad; and 5 of them were homophones with the same pitch accent, 1 of which was a homophonous triad. I chose this variety in order to help see patterns across differing word types. All 20 sets are listed on the following page.

---

[1] 私は_____が好きです。

[2] See the section "Determining pitch patterns" in the Introduction for how this differentiation works.

Romanization		Meaning	Written	Mora	Pitch Accent
Two-Mora					
1.	iki	go	行き	No accent	LH(H)
	iki	breath	息	Mora 1	HL(L)
2.	ame	candy	飴	No accent	LH(H)
	ame	rain	雨	Mora 1	HL(L)
3.	ishi	stone	石	Mora 2	LH(L)
	ishi	will	意志	Mora 1	HL(L)
4.	kaku	angle	角	No accent	LH(H)
	kaku	to write	書く	Mora 1	HL(L)
5.	kiru	to wear	着る	No accent	LH(H)
	kiru	to cut	切る	Mora 1	HL(L)
6.	suu	to smoke	吸う	No accent	LH(H)
	suu	number	数	Mora 1	HL(L)
7.	shiro	castle	城	No accent	LH(H)
	shiro	white	白	Mora 1	HL(L)
8.	kami	paper	紙	Mora 2	LH(L)
	kami	spirit	神	Mora 1	HL(L)
9.	koto	thing; matter	事	Mora 2	LH(L)
	koto	(an instrument)	琴	Mora 1	HL(L)
10.	hashi	bridge	橋	Mora 2	LH(L)
	hashi	chopsticks	箸	Mora 1	HL(L)
	hashi	edge	端	No accent	LH(H)
Three-Mora					
11.	atsui	hot	暑い	Mora 2	LHL(L)
	atsui	thick	厚い	No accent	LHH(H)
12.	chikai	near	近い	Mora 2	LHL(L)
	chikai	basement	地階	No accent	LHH(H)
13.	omoi	remembrance	思い	Mora 2	LHL(L)
	omoi	heavy	重い	No accent	LHH(H)
14.	kakeru	to hang	掛ける	Mora 2	LHL(L)
	kakeru	to lack	欠ける	No accent	LHH(H)
15.	kaeru	to change	変える	No accent	LHH(H)
	kaeru	frog	蛙	No accent	LHH(H)
	kaeru	to return	帰る	Mora 1	HLL(L)
Homophonous					
16.	kanji	Chinese characters	漢字	No accent	LHH(H)
	kanji	feeling	感じ	No accent	LHH(H)
17.	oku	interior	奥	Mora 1	HL(L)
	oku	100 million	億	Mora 1	HL(L)
18.	jiko	accident	事故	Mora 1	HL(L)
	jiko	self	自己	Mora 1	HL(L)
19.	kaze	wind	風	No accent	LH(H)
	kaze	a cold	風邪	No accent	LH(H)
20.	utsuru	to be photographed	写る	Mora 2	LHL(L)
	utsuru	to be reflected	映る	Mora 2	LHL(L)
	utsuru	to move/transfer	移る	Mora 2	LHL(L)

The pitch accent was taken from the online *goo Dictionary*.[3] Using McCawley's treatment[4], I converted from the *goo Dictionary*'s numbered system (0 = no pitch accent, 1 = accent on first mora, 2 = accent on second mora) to the L/H system.

Procedure

To begin, I had the participant fill out a departmental consent form and a language background questionnaire (included in Appendix B), which took 5-10 minutes. I then recorded the participant using Sound Studio (version 2.1.1b3) on an Apple iBook[5] with a Plantronics SP-500 headset. Files were recorded in mono AIFF format, at a sampling rate of 22.05 kHz and a bit depth of 16 bits. Each recording session took about 15 minutes. I recorded in the top-most floor of the University of Oregon's EMU, in the skylight area. Background noise was kept to a minimum by recording in that area, because it is a quiet place intended for study, there are typically very few people there, and I recorded in a far back and usually unoccupied corner. The Plantronics headset was also of high quality and picked up only the participant's voice.

Before reading the sentences, the participants were instructed that they could repeat a sentence if they stuttered or felt they said it incorrectly, and to read at a comfortable speed. With the 43 target sentences on 3x5 index cards, I first shuffled the cards a number of times to put the sentences in a random order, and then had the volunteers read all 43 cards once through. When they were finished with this, I again

[3] Recommended to me by Dr. Tetsuo Harada, a University of Oregon professor of who specializes in Japanese applied linguistics, specifically L2 phonetics and phonology and Japanese language pedagogy.
[4] For more information on McCawley's treatment, see Vance (1987, p. 89).
[5] 500 MHz PowerPC G3 with an integrated sound card, running OS X 10.3.6

shuffled the cards a number of times, and had the participant read through the 43 sentences once again. This gave me a total of 86 tokens for each participant with which to work.

After finishing the recording, I asked the participant to fill out a short questionnaire on their experience with pitch accent (also included in Appendix B). This asked them to detail any instruction they had been given in this area before, and any personal intuitions or observations they had made about pitch accent. I then discussed this with them for about 5 minutes, making the entire process a total of approximately 30 minutes.

To protect the participants' anonymity, I assigned each participant a number and made sure that only their assigned number was attached to both the sound file and questionnaires. The number key was kept separate from the files and questionnaires. I will use this number to refer to participants for the rest of the study; for example, "Speaker 7 showed such-and-such a quality" or "Speaker 22 matched Speaker 17 in this area." I also made sure that each participant had no prior knowledge about what I was studying before entering the recording, so that their prior knowledge would not affect the results. Upon completion, I asked them not to discuss my research with other potential participants (i.e. people in their Japanese classes, or Japanese-speaking friends) to ensure that no other potential participants became informed before their recording.

Measurements

Once I had collected all the recordings, I spliced the sound files into individual sentences, relabeling the files according to the speaker number and the English translation of the key word in each. I then gathered measurements from the recordings with the speech analysis software Praat (version 4.3.02). For each mora in the key word, I gathered three different measurements:

1. The vowel length (measured in seconds).
2. The average intensity over the vowel (measured in decibels).
3. The pitch contour, by measuring the vowel's pitch at seven points: $^{1}/_{8}$, $^{2}/_{8}$, $^{3}/_{8}$, etc. of the length of the vowel (measured in Hertz).

Taking these three measurements by hand would have been too time-consuming, so I looked into the scripting capabilities of Praat. After investigating and practicing a little with the script syntax, I understood enough to create a script to take these three measurements with a single mouse-click. This greatly increased the speed with which I was able to take these measurements. (The scripts I used, and a brief explanation of how I used them, are included in Appendix C.) An example of a word (*kami ga*) in the Praat window is given on the following page, with letters in red corresponding to the sound being produced at each temporal point. Praat does not display these letters, but I have superimposed them for ease of readability.

The top part of the window is an oscillogram of the sound wave, and the bottom a spectrogram of the sound wave. The yellow line in the spectrogram represents intensity (dB) and the blue line represents the pitch contour (Hz). The spectrogram makes it easy to pick out the beginning and ending of the vowels in each mora, given the darker areas of the vowels' formant[6] structure surrounded by the lighter areas of the consonants.

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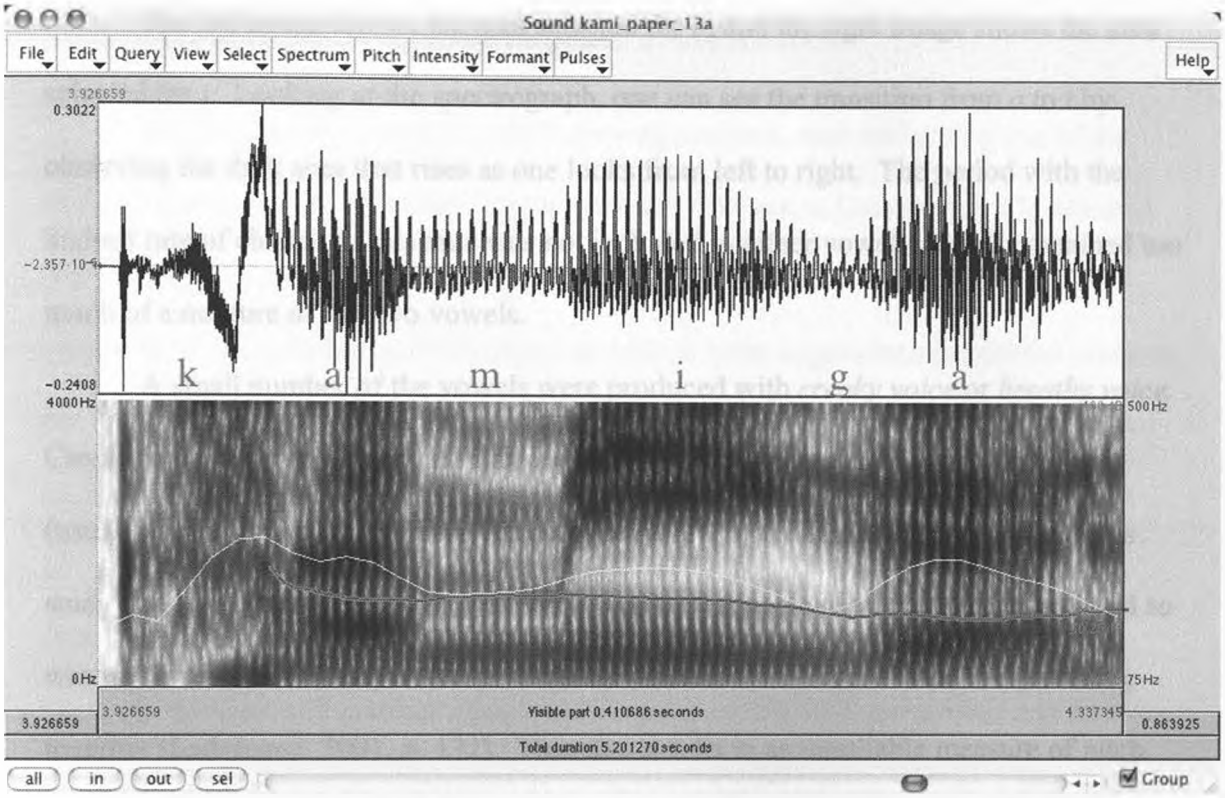
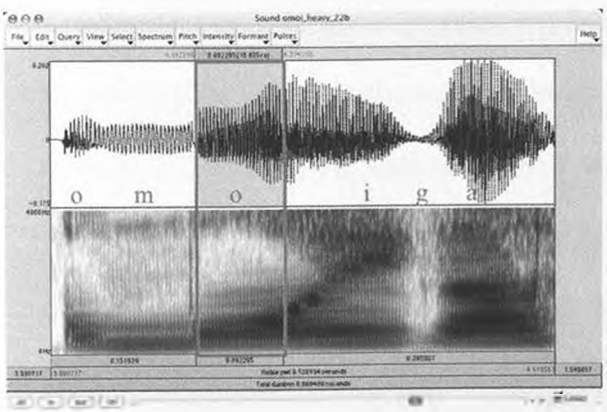
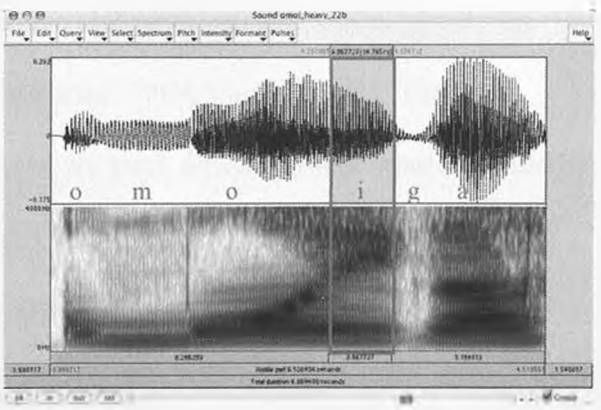
[6] *Formants* are frequency regions of greater intensity, which together determine the characteristic quality of a vowel.



However, when two vowels occur next to one another, picking out where one vowel ends and another vowel begins can be difficult. When measuring words like this that had a sequence of vowels (e.g. *omoi*), I tried to only use the part of the vowel that was clearly not transitioning into or out of the other vowel. An example of this is presented below. Two images of *omoi* are pictured, with the areas for which I took measurements surrounded by red boxes.





The left image shows the area selected for *o*, and the right image shows the area selected for *i*. Looking at the spectrograph, one can see the transition from *o* to *i* by observing the dark area that rises as one looks from left to right. The period with the highest rate of change in this area was not included in either vowel, since it contained too much of a mixture of the two vowels.

A small number of the vowels were produced with *creaky voice* or *breathy voice*. Creaky voice is when the vocal folds are held tightly together in the back, but vibrate (usually at a low rate) in the front (Ladefoged, 2001, p. 132). For the purposes of this study, the rate of front vibration was too low to be a reliable measure of the pitch, and so was not included. Breathy voice is when the vocal folds vibrate without fully coming together (Ladefoged, 2001, p. 132). This also results in an unreliable measure of pitch, and was not included either. Additionally, a few of the vowels were produced with laughter, devoicing, etc. or not produced at all, either from mispronunciation or from the participant skipping one of the cards. From these types of productions, no data could be obtained. The amount of data discarded for these reasons was approximately 3.7%.

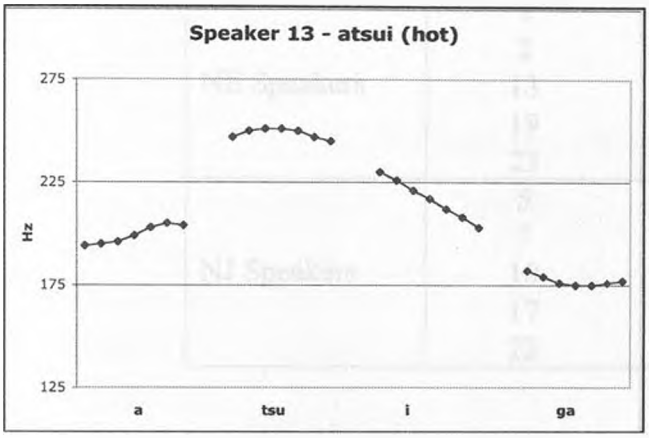
Results and Discussion

The results are divided into the following sections, each addressing one of the research questions: (1) Dictionary Agreement, (2) Production Consistency, (3) Minimal Pair Distinction, and (4) Pitch/Duration/Intensity Correlations. This is followed by a section on Other Interesting Phenomena, as well as some suggestions for further research. For all data tables presented, means of data are presented in bold, and interesting results are enclosed in dotted-line, shaded boxes.

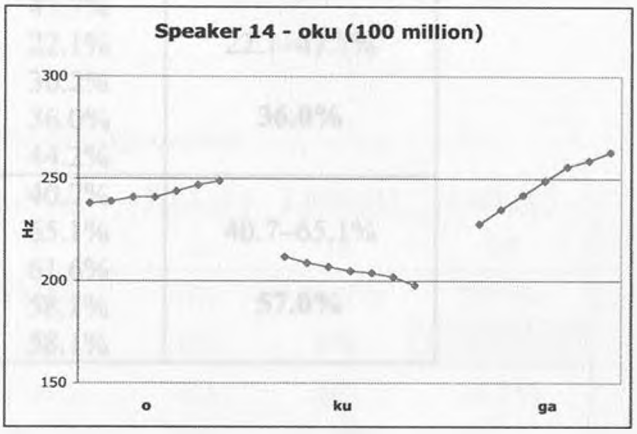
Dictionary Agreement

In determining whether a participant's pitch accent for a given word matched the dictionary form (hereafter referred to as Dictionary Agreement, or % DA), I first looked at the participant's pitch graph for the word. I then judged the relative highness or lowness of each vowel in relation to the vowel with the highest pitch, and from this determination created a representation of the pitch contour using H and L (e.g. LH(L) or HH(L)). Vowels that overlapped the same frequency range as, or had frequencies within a few Hertz of, the highest pitched vowel were labeled as H, while vowels that were lower than this in pitch were labeled as L. Devoiced vowels were treated as L, on the assumption that non-native speakers would behave like native speakers, who usually do not devoice the vowel of the accented mora (Shibatani, 1990; Vance, 1987). The pitch contour of the vowel was also considered: very minor pitch downdrift was ignored, while very steep rising or falling pitches (unless greatly higher or lower than the other vowels' pitches) were labeled as H for rising and L for falling.

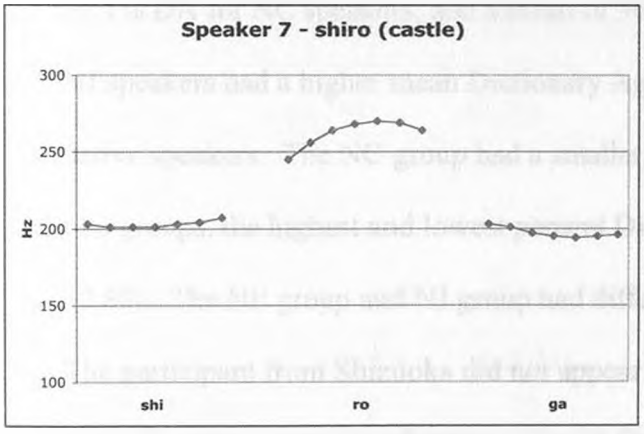
It is easier to show this than explain in words. See the following graphs (of different speakers, with different F0's) for examples of pitch patterns and the way that these were labeled. The pitch that I recorded for each graph is listed below the graph.



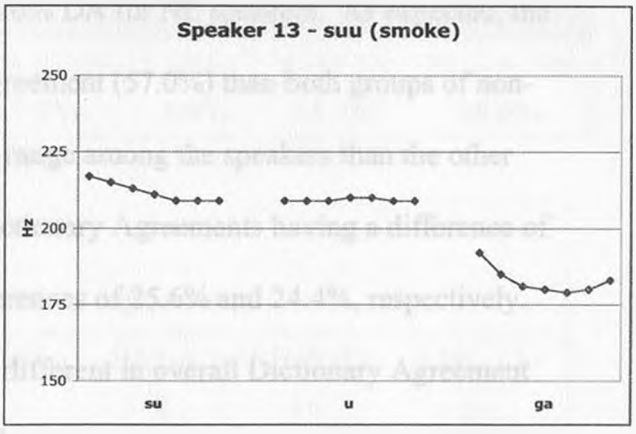
LHL(L)



HL(H)



LH(L)



HH(L)

After running each word for every speaker through this process, I had a table of pitch patterns that I could compare to the dictionary form of the pitch accent. I compared individual speakers on an overall basis, seeing if the speaker's pitch for a given word corresponded to the dictionary form, and gathered a percentage of agreement for each speaker. I then averaged these over the five speakers in each language group. These results are reported on the following page.

Speaker Group	Speaker No.	% DA	Range and Mean
NC Speakers	3	37.2%	26.7–39.5%
	14	38.4%	
	16	33.7%	**35.1%**
	18	39.5%	
	21	26.7%	
NE Speakers	1	47.7%	22.1–47.7%
	2	22.1%	
	13	30.2%	**36.0%**
	19	36.0%	
	23	44.2%	
NJ Speakers	5	40.7%	40.7–65.1%
	7	65.1%	
	10	61.6%	**57.0%**
	17	58.1%	
	22	58.1%	

Overall, the non-native speakers matched each other quite closely, with a mean of 35.1% DA for NC speakers, and a mean of 36.0% DA for NE speakers. As expected, the NJ speakers had a higher mean Dictionary Agreement (57.0%) than both groups of non-native speakers. The NC group had a smaller range among the speakers than the other two groups, the highest and lowest percent Dictionary Agreements having a difference of 12.8%. The NE group and NJ group had differences of 25.6% and 24.4%, respectively. The participant from Shizuoka did not appear different in overall Dictionary Agreement from the others, matching Speaker 17 in % DA.

Though this data gives a good overall picture, for further specificity the words can be divided up according to their dictionary pitch accent. This results in a classification into six types: HL(L), LH(H), and LH(L) for two-mora words, and HLL(L), LHH(H), and LHL(L) for three-mora words. Dividing up the words this way allows us to see if speakers are more accurate in reproducing the dictionary form for a certain word type. Below are tables of how individual speakers fared for each word according to its pitch

accent. The word type is given across the top, along with the number of productions per speaker. The number of productions is twice the number of words of that word type, since I recorded each speaker twice. The speaker number is given along the left side, and range and mean are given at the bottom.

NC Speakers – Dictionary Agreement

	HL(L)	LH(H)	LH(L)	HLL(L)	LHH(H)	LHL(L)
# of Productions	28	18	8	2	16	14
Speaker 3	60.7%	22.2%	50.0%	0%	18.8%	28.6%
Speaker 14	50.0%	33.3%	0%	0%	0%	92.9%
Speaker 16	39.3%	33.3%	37.5%	0%	0%	64.3%
Speaker 18	75.0%	22.2%	0%	0%	6.3%	57.1%
Speaker 21	3.6%	50.0%	0%	0%	31.3%	57.1%
Range	3.6–75.0%	22.2–50.0%	37.5–50.0%	0%	0–31.3%	28.6–92.9%
Mean	**45.7%**	**32.2%**	**17.5%**	**0.0%**	**11.3%**	**60.0%**

NE Speakers – Dictionary Agreement

	HL(L)	LH(H)	LH(L)	HLL(L)	LHH(H)	LHL(L)
# of Productions	28	18	8	2	16	14
Speaker 1	96.4%	0%	0%	0%	6.3%	92.9%
Speaker 2	10.7%	22.2%	25.0%	0%	6.3%	64.3%
Speaker 13	28.6%	0%	75.0%	0%	0%	85.7%
Speaker 19	67.9%	0%	50.0%	0%	0%	57.1%
Speaker 23	92.9%	0%	25.0%	0%	0%	71.4%
Range	10.7–96.4%	0–22.2%	0–75.0%	0%	0–6.3%	57.1–92.9%
Mean	**59.3%**	**4.4%**	**35.0%**	**0.0%**	**2.5%**	**74.3%**

From this we can see that both the NC speakers and the NE speakers had the highest correct percentage for the HL(L) and LHL(L) words. In particular, of the NE group, Speaker 1 and Speaker 23 had over 90% DA for HL(L) and Speaker 1 and Speaker 13 had over 85% DA for LHL(L). Of the NC group, Speaker 18 had 75% DA for HL(L) and Speaker 14 had nearly 93% DA for LHL(L). This suggests one of two possibilities: either these speakers can consistently produce these pitch patterns better than the others—in which case we must ask why they would be able to for these particular pitch patterns and not the others—or these speakers consistently produce most of their words with these pitch patterns. It turns out that this second possibility is what seems to be happening. The answer comes by looking at Production Consistency, which is addressed in the next section.

The table of NJ speakers' Dictionary Agreement is given below.

NJ Speakers – Dictionary Agreement

	HL(L)	**LH(H)**	**LH(L)**	**HLL(L)**	**LHH(H)**	**LHL(L)**
# of Productions	28	18	8	2	16	14
Speaker 5	35.7%	38.9%	100%	0%	0%	71.4%
Speaker 7	57.1%	61.1%	100%	50.0%	37.5%	100%
Speaker 10	85.7%	33.3%	100%	100%	0%	92.9%
Speaker 17	57.1%	61.1%	100%	50.0%	0%	100%
Speaker 22	71.4%	66.7%	62.5%	0%	25.0%	71.4%
Range	35.7–89.3%	33.3–66.7%	62.5–100%	0–100%	0–37.5%	71.4–100%
Mean	**62.1%**	**52.2%**	**92.5%**	**40.0%**	**12.5%**	**87.1%**

For the NJ speakers, the highest Dictionary Agreement percentage (over 85%) was for the LH(L) and LHL(L) words. They also had a surprisingly low Dictionary

Agreement percentage (12.5%) for the LHH(H) words. Speaker 22 did show a difference in this analysis: she showed higher than average Dictionary Agreement for words with no accent (LH(H) and LHH(H)), and lower than average Dictionary Agreement for words with the accent on the second mora (LH(L) and LHL(L)).

Overall, it seems that the NJ speakers had good Dictionary Agreement for some patterns and only marginal Dictionary Agreement for others. However, this table may not paint an entirely accurate picture. Speaker 7, in her post-experiment interview, asserted that it is possible for the pitch of the postposition to be either H or L, at least in the case of the three-mora words. As a former Japanese radio DJ, she stated that she had had to learn and knew how to speak Tokyo Standard Japanese well, which is supported by the fact that she had the highest overall Dictionary Agreement (65.1%) of all the speakers. Though the view she suggests is not the usual or "correct" method of determining standard pitch accent, it does seem to explain the low LHH(H) percentage: if we do allow for the postposition to be H or L in the three-mora words, we find that the % DA for the LHH(H) words jumps to from 12.5% to 48.8%. (% DA for the other three-mora words stays the same.)

Even if we do not believe Speaker 7's proposition, this finding does show that the NJ speakers are often producing the LHH(H) words as LHH(L). One reason for this might be that all the LHH(H) words except one were verbs, which are not grammatical within the sentence frame. This might have influenced speaker pronunciation, although none of the participants seemed to have a problem reading the sentence as written.

In any case, this finding possibly suggests that the NJ speakers are making consistent production differences from the dictionary form of the pitch accent. In order

to study this aspect of their production, I rated for every speaker the percentage of time the dictionary form was used versus the percentage of time a variant form was used, and tabulated the results. These are reported in the following tables.

NJ Speakers – Dictionary Form vs. Actual Production

Dictionary Form	Match	LHL	HLL	LHH	HHL	HLH	LLH
HL(L)	60.0%	23.6%	——	2.1%	4.3%	10.0%	0%
LH(H)	52.2%	27.8%	6.7%	——	8.9%	2.2%	2.2%
LH(L)	92.5%	——	0%	5.0%	0%	2.5%	0%

Dictionary Form	Match	LHL(L)	HLL(L)	LHH(H)	LHH(L)	LHL(H)	LLH(L)	LLH(H)	HHL(H)	HHL(L)	HLH(L)
HLL(L)	40.0%	10.0%	——	0%	0%	0%	0%	0%	20.0%	30.0%	0%
LHH(H)	12.5%	26.3%	11.3%	——	28.8%	7.5%	5.0%	1.3%	1.3%	0%	6.3%
LHL(L)	87.1%	——	0%	2.9%	8.6%	0%	1.4%	0%	0%	0%	0%

Here, in addition to seeing the LHH(L) pattern being used for LHH(H) words, we notice that the pattern substituted most often for the dictionary form is a LH(L) or LHL(L) pattern. The only exception to this is the HLL(L) dictionary form, which is skewed because there was only one word with this pattern included in the experiment. Apart from this anomaly, when NJ speakers did match the dictionary form of a given word, it appears that they typically defaulted to a LH(L) or LHL(L) pattern. This helps to explain the high Dictionary Agreement found for these pitch patterns.

In summary, the overall Dictionary Agreements of non-native speakers were quite close to one another, each agreeing with the dictionary form just over a third of the time. This supports my hypothesis that non-native speakers would make errors in matching the

dictionary form of the pitch patterns. However, it also does not support the hypothesis that NC speakers would outperform NE speakers. For the NJ speakers, though they had a higher mean Dictionary Agreement than the other groups as predicted, it was surprisingly low at 57% DA. The exact reason for this low DA is unknown, though it possibly reflects either generational changes in pitch accent, or a mismatch between word choice and sentence frame choice.

When dividing Dictionary Agreement by pitch pattern, there were two NE Speakers (1 and 23) and one NC Speaker (18) who had very high percentages for the HL(L) pitch pattern. There were also two NE Speakers (1 and 13) and one NC Speaker (14) who had high percentages for the LHL(L) pitch pattern. I suggest that this is because they consistently produce these patterns for all word types. This proposal is addressed in the next section on Production Consistency. The NJ speakers had very high percentages for the LH(L) and LHL(L) pitch patterns, and a surprisingly low percentage for the LHH(H) pitch pattern. When the NJ speakers did not match the dictionary form, they often used a LHH(L) pattern for the LHH(H) words. Other than this substitution, they typically defaulted to a LH(L) or LHL(L) pattern when not matching the dictionary form.

Production Consistency

In order to determine a speaker's Production Consistency, I used the list of pitch patterns established in the previous section and simply counted the productions by each speaker. I separated the results by pitch pattern and speaker number. The following

tables summarize the Production Consistency for the NE participants. The first table is for two-mora words, and the second is for three-mora words.

NE Speakers – Production Consistency

Speaker #	HL(L)	LH(H)	LH(L)	HH(L)
1	94.4%	0%	5.6%	0%
2	20.4%	33.3%	44.4%	1.9%
13	35.2%	1.9%	55.6%	7.4%
19	63.0%	1.9%	27.8%	7.4%
23	96.3%	1.9%	1.9%	0%
Range	20.4-96.3%	0-33.3%	1.9-55.6%	0-7.4%
Mean	**61.9%**	**7.8%**	**27.0%**	**3.3%**

Speaker #	LHL(L)	LHH(L)	LLH(L)	HLL(L)	HHL(L)
1	62.5%	3.1%	0%	28.1%	6.3%
2	56.3%	18.8%	18.8%	6.3%	0%
13	68.8%	0%	0%	15.6%	15.6%
19	50.0%	6.3%	0%	28.1%	15.6%
23	43.8%	0%	0%	25.0%	31.3%
Range	43.8-68.6%	0-18.8%	0-18.8%	6.3-28.1%	0-31.3%
Mean	**56.3%**	**5.6%**	**3.8%**	**20.6%**	**13.8%**

From the previous section on Dictionary Agreement, we discovered that Speakers 1 and 23 had extremely high Dictionary Agreement for the HL(L) words, and Speakers 1 and 13 had high Dictionary Agreement for the LHL(L) words. Examining the tables in this section, we find that Speaker 1 produced the HL(L) pitch pattern 94.4% of the time and Speaker 23 produced it 96.3% of the time. For the LHL(L) pattern, Speaker 1 produced it 62.5% of the time and Speaker 13 produced it 68.8% of the time. The other speakers produced this LHL(L) pattern often, as well.

This helps explain why these speakers had such high percentages of Dictionary Agreement for the HL(L) pattern: they simply produced the same pitch pattern nearly all of the time. The LHL(L) pattern seems to show the same effect, but to a lesser degree.

Thus, the speakers' consistent productions gave them high Dictionary Agreements for those patterns, but low Dictionary Agreements for the other patterns.

The table also shows that NE speakers seem to prefer patterns with only one H: if we add the means together, NE speakers used either HL(L) or LH(L) 88.9% of the time, and used either LHL(L), LLH(L), or HLL(L) 80.7% of the time. Given that English only has one major stressed syllable per word, it is not surprising that all speakers seem to prefer having only one H point in each word.

The NC speakers seem to have a similar, if weaker, pattern.

NC Speakers – Production Consistency

Speaker #	HL(L)	LH(H)	LH(L)	HH(L)	HL(H)	LL(H)
3	38.9%	16.7%	35.2%	7.4%	0%	1.9%
14	37.0%	25.9%	0%	1.9%	31.5%	3.7%
16	33.3%	38.9%	13.0%	11.1%	3.7%	0%
18	79.6%	11.1%	9.3%	0%	0%	0%
21	3.7%	53.7%	24.1%	0%	13.0%	5.6%
Range	3.7-79.6%	11.1-53.7%	0-35.2%	0-11.1%	0-31.5%	0-5.6%
Mean	**38.5%**	**29.3%**	**16.3%**	**4.1%**	**9.6%**	**2.2%**

Spkr#	LHL(L)	LHH(L)	LHH(H)	LHL(H)	LLH(H)	HLL(L)	HHL(L)	HHL(H)
3	37.5%	25.0%	15.6%	0%	6.3%	3.1%	12.5%	0%
14	56.3%	0%	0%	12.5%	0%	3.1%	15.6%	12.5%
16	50.0%	12.5%	12.5%	0%	0%	12.5%	12.5%	0%
18	65.6%	0%	9.4%	0%	0%	18.8%	6.3%	3.1%
21	28.1%	15.6%	34.4%	6.3%	0%	12.5%	3.1%	0%
Range	28.1-65.6%	0-25.0%	0-34.4%	0-12.5%	0-6.3%	3.1-18.8%	3.1-15.6%	0-12.5%
Mean	**47.5 %**	**10.6%**	**14.4%**	**3.8%**	**1.3%**	**10.0%**	**10.0%**	**2.5%**

The most consistent HL(L) producer was Speaker 18 at 79.6%. However, his Dictionary Agreement with HL(L) words was only 75.0%—not nearly as high as Speakers 1 and 23, though higher than the other NC speakers. Surprisingly, the most consistent LHL(L) producer was not Speaker 14, who had the highest Dictionary Agreement, but Speaker 18 again, at 65.6%.

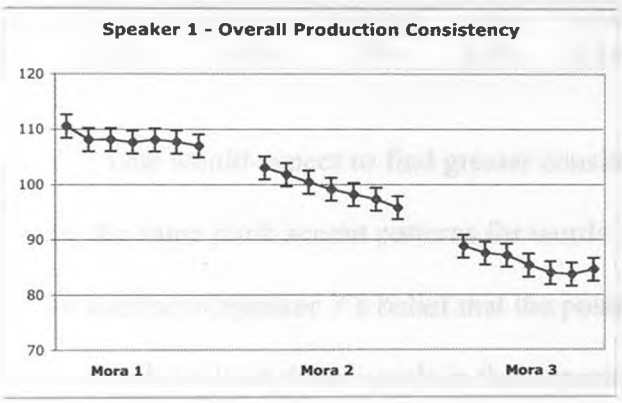
Why would these speakers (in particular Speakers 1, 23, and 18, who all consistently produced the HL(L) pattern three-fourths of the time or more, and to a lesser extent Speaker 19) produce most of their words with this pitch pattern? Given that LHL(L) is the other most common pitch pattern, it appears that speakers are producing their words with a typical English stress pattern, that of penultimate stress. A look into their background information supports this hypothesis. Speakers 1 and 23 are native English speakers, and Speaker 18, though a native Cantonese speaker, has studied English for 20 years, starting at age four (possibly within the window of L1 acquisition). Furthermore, these three speakers all have less than four years of Japanese instruction, while all seven of the other NE and NC speakers have four years or more of instruction. Interestingly, the NE speakers with more Japanese experience produced the LH(L) pattern the most often, which is similar behavior to the NJ speakers.

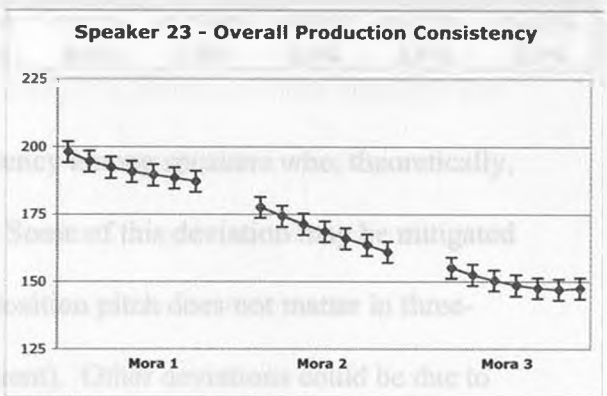
This idea is supported by two previous studies. The first (Nishinuma, Arai, & Ayusawa, 1996) found that native English speakers preferred English intonation patterns when perceiving Japanese pitch. The preference of English stress patterns in production is a natural extension of this. The second study (Yamada, 1996) examined the "Japanese accentuations" of a variety of speakers of various L1 backgrounds. Speakers were found to have a number of "interlanguage strategies" (specifically, strategies utilizing L1), one of which was penultimate mora accenting.

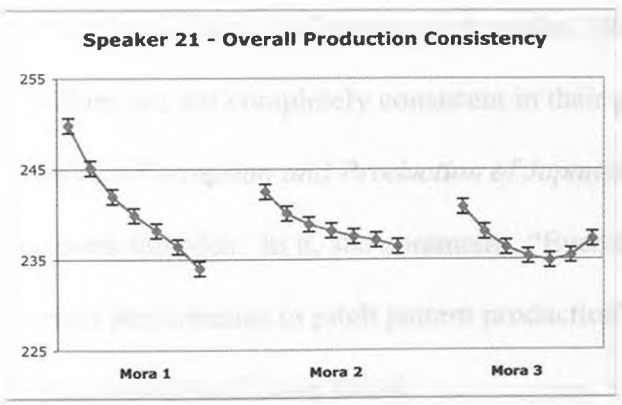
Thus, it seems that those non-native speakers with less experience in Japanese and a strong background in English use a more English-like stress pattern in their pitch production. Since Speaker 18 is the only male NC participant, it is possible that sex plays a role for the NC speakers. However, without more male NC participants, it is

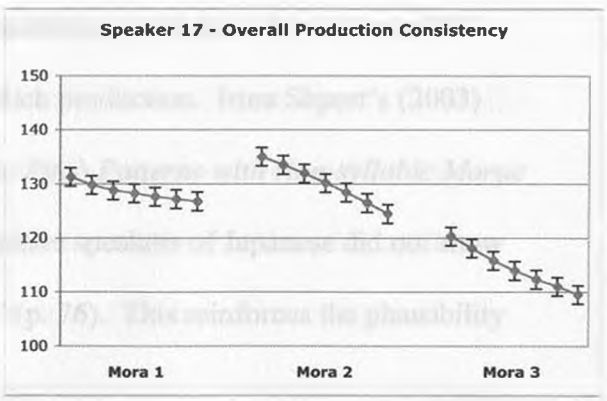
impossible to tell. It seems more likely to me that his English background influences Speaker 18's production of words in Japanese.

Admittedly, the subjective nature of labeling words with H's and L's may lead to some small errors. In this case, however, the finding is supported by averaging the speaker's pitch production over all of the words. The following graphs show examples of how, averaged over all words, Speakers 1 and 23 had consistent HL(L) production. This is compared to two examples of the averages for other speakers, which show inconclusive results since both the average pitches and their standard errors overlap.









For thoroughness, the Production Consistency of the NJ speakers is given on the following page. Here, we find a surprisingly inconsistent picture of the NJ behavior.

NJ Speakers – Production Consistency

	HL(L)	LH(H)	LH(L)	HH(L)	HL(H)	LL(H)
Speaker 5	18.5%	13.0%	55.6%	13.0%	0%	0%
Speaker 7	29.6%	20.4%	25.9%	3.7%	20.4%	0%
Speaker 10	51.9%	13.0%	35.2%	0%	0%	0%
Speaker 17	33.3%	16.7%	42.6%	5.6%	1.9%	0%
Speaker 22	37.0%	29.6%	16.7%	3.7%	9.3%	3.7%
Range	18.5-51.9%	13-29.6%	16.7-55.6%	0-13.0%	0-20.4%	0-3.7%
Mean	**34.1%**	**18.5%**	**35.2%**	**5.2%**	**6.3%**	**0.7%**

	LHL(L)	LHH(L)	LHH(H)	LHL(H)	LLH(L)	LLH(H)	HLL(L)	HHL(L)	HHL(H)	HLH(L)
5	37.5%	46.9%	0%	0%	9.4%	0%	0%	6.3%	0%	0%
7	56.3%	12.5%	18.8%	6.3%	0%	0%	3.1%	3.1%	0%	0%
10	46.9%	21.9%	0%	6.3%	3.1%	0%	15.6%	0%	0%	6.3%
17	62.5%	12.5%	0%	0%	0%	0%	15.6%	3.1%	6.3%	0%
22	43.8%	9.4%	18.8%	6.3%	3.1%	3.1%	3.1%	0%	12.5%	0%
Range	37.5-62.5%	9.4-46.9%	0-18.8%	0-6.3%	0-9.4%	0-3.1%	0-15.6%	0-6.3%	0-12.5%	0-6.3%
Mean	**49.4%**	**20.6%**	**7.5%**	**3.8%**	**3.1%**	**0.6%**	**7.5%**	**2.5%**	**3.8%**	**1.3%**

One would expect to find greater consistency among speakers who, theoretically, know the same pitch accent patterns for words. Some of this deviation may be mitigated if we ascribe to Speaker 7's belief that the postposition pitch does not matter in three-mora words (at least those words in this experiment). Other deviations could be due to the subjective nature of eyeing pitch graphs. Nonetheless, this does show that the NJ speakers are not completely consistent in their pitch production. Irina Shport's (2003) thesis on *Perception and Production of Japanese Pitch Patterns with Non-syllabic Morae* supports this idea. In it, she comments, "Even native speakers of Japanese did not show perfect performance in pitch pattern production" (p. 76). This reinforces the plausibility of the results that I have found.

Speaker 22 again shows slight differences in this area, producing pitch patterns that none of the other NJ speakers produce. She is the only one to produce the LL(H) and LLH(H), although she does not produce them that often—the Production Consistencies of

these patterns range from 3.7 to 12.5%. However, this could very well be attributed to her Shizuoka accent. She also produces a greater variety of pitch patterns than the other subjects: six 2-mora patterns (the highest is five for the other NJ speakers) and eight 3-mora patterns (the highest is six for the other NJ speakers). This also might be because of her regional dialect. Information on Shizuoka pitch accent was not easily available—consequently, more research would need to be done to confirm this.

Another thing of note is the greater variety of pitch patterns used by the NC and NJ speakers. One can easily see this by simply looking at the size of their Production Consistency tables compared to the NE speakers' tables. This result seems natural, since contrastive pitch is such a large part of these languages (Chinese as a tone language and Japanese as a pitch accent language), whereas English only uses pitch as one part of contrastive stress. Thus, barring expectations of perfectly regular speaker behavior, it is not surprising that these languages use a greater variety of pitch patterns.

To summarize, speakers with strong English backgrounds and less experience in Japanese (1, 23, 18, and to a lesser extent 19) showed preference for producing the HL(L) and LHL(L) patterns. This was confirmed by examining graphs of overall Production Consistency. All NE speakers also showed preference for pitch patterns with one H accent. Both of these results support my hypothesis, and can be explained by an L1 transfer of English prosodic features, an idea supported by previous research (Nishinuma, Arai, & Ayusawa, 1996; Yamada, 1996). Also in support of the original hypothesis are the less consistent productions of the NC and NJ speakers. Correlated with this is the

greater variety of pitch patterns used by these two language groups, which is a natural result of the greater use of contrastive pitch in these languages.

Minimal Pair Distinction

In order to study whether speakers produced each set of words with the same pitch accent, I compared the pitch patterns established by the previous method for each pair (or triad) of words. I analyzed the 20 sets of words for each speaker, and calculated a percentage of complete homophony. This means that for each set of words, all four productions (2 productions x 2 words) for pairs or all six productions (2 productions x 3 words) for triads were required to have the same transcribed pitch pattern. The results are summarized in the following table.

Speaker Group	Speaker No.	% Homophony	Mean
NC Speakers	3	30%	**41%**
	14	30%	
	16	20%	
	18	80%	
	21	45%	
NE Speakers	1	80%	**63%**
	2	50%	
	13	55%	
	19	60%	
	22	70%	
NJ Speakers	5	25%	**24%**
	7	35%	
	10	30%	
	17	25%	
	22	5%	

As stated in the Method section, 4 pairs and 1 triad of homophonous words were included in the study (5 out of 20 sets). Thus, for perfect pitch accent production in this study, we would expect to see 25% homophony. The NJ speakers were quite close to this standard, with a mean of 24% homophony. The NE speakers, as hypothesized, had a much greater mean (63%) than the other two groups. The NC speakers, also as hypothesized, had greater distinction between words than the NE speakers, with a mean of 41%.

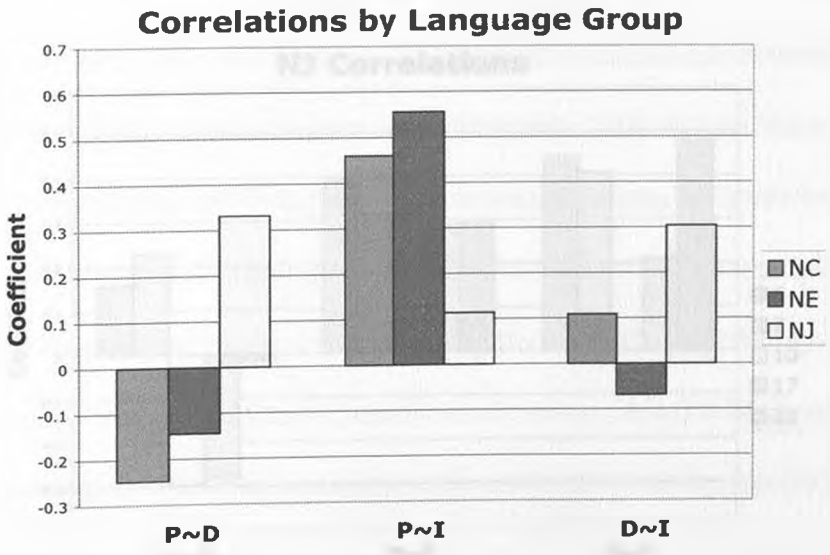
Also as expected, those speakers with greater Production Consistency (1, 23, and 18) had the highest percent of homophony. In fact, Speaker 18's percentage is nearly double (80%) the mean of his group (41%). This reflects his English background and strong HL(L) Production Consistency. If we remove him from the NC group mean, we find that it drops from 41% to 31%, which is even less average homophony for the NC speakers. Speaker 22 was also inconsistent with the other NJ speakers, only producing 5% of the words with the same pitch pattern. Again, this might reflect her Shizuoka accent, but more research would need to be done to confirm this.

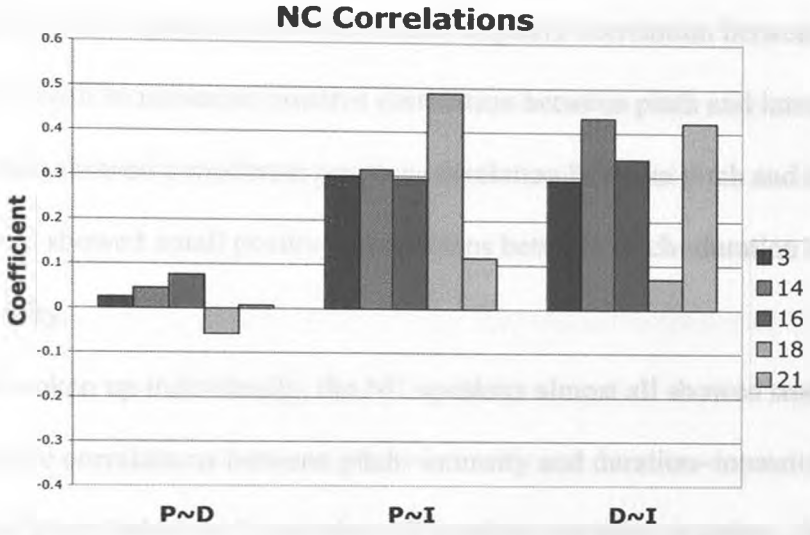
In summary, all hypotheses were supported: the NE speakers had the highest percentage of homophonous production, followed by the NC speakers, followed by the NJ speakers. The NC participant Speaker 18 patterned more like the NE participants, most likely due to his strong English background. Speaker 22, the NJ speaker from Shizuoka, had the least percentage of homophonous production, possibly reflecting a different accent.

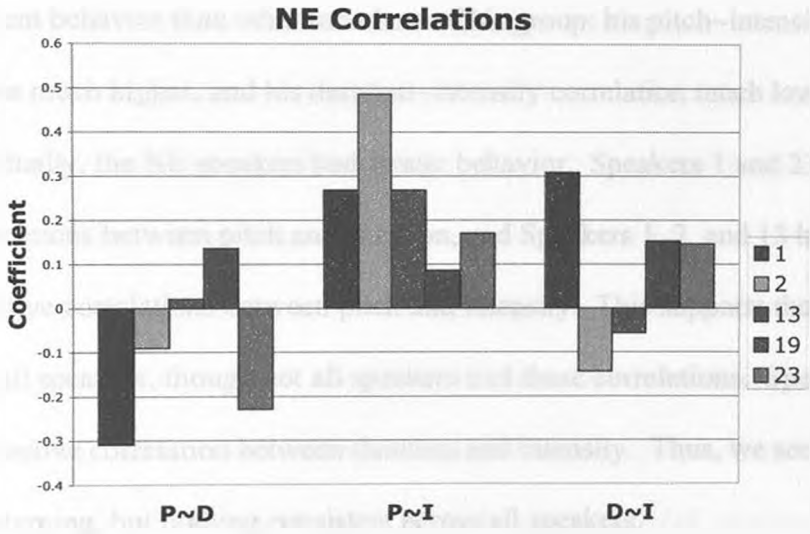
Pitch/Duration/Intensity Correlations

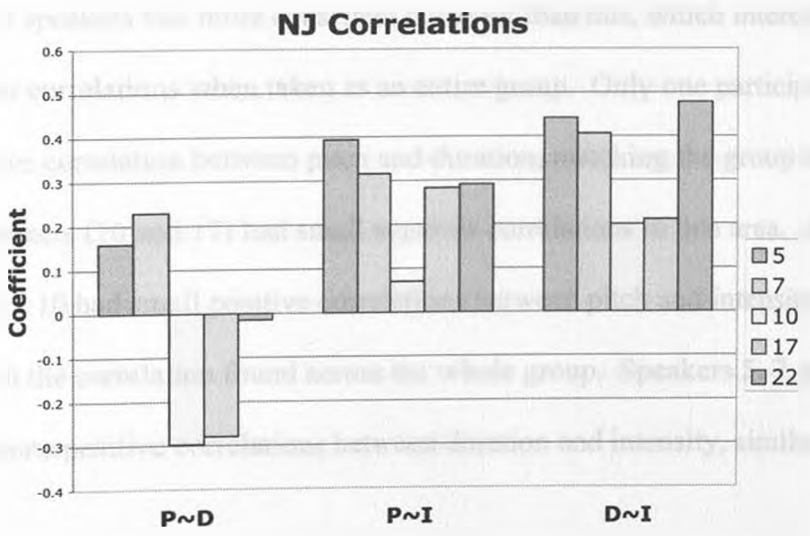
To calculate correlations, I used Microsoft Excel to calculate three separate correlation coefficients for language groups as a whole and for individual speakers: the correlation of pitch with duration (pitch~duration), the correlation of pitch with intensity (pitch~intensity), and the correlation of duration with intensity (duration~intensity).

Correlation coefficients range from –1.0 to 1.0. A coefficient of 1.0 represents a perfect positive correlation—that is, as one thing increases, the other increases by the same amount. A coefficient of –1.0 represents a perfect negative correlation—that is, as one thing increases, the other decreases by the same amount. A coefficient of 0 represents no correlation. The following graphs show the correlation coefficients for all speakers, divided by language group. For the purposes of this study, the following categorical scale will be used, where x is the absolute value of the coefficient: $x < .25$ = no correlation, $.25 \leq x < .5$ = small correlation, $.5 \leq x < .75$ = moderate correlation, $x \geq .75$ = strong correlation. The first graph shows the correlations by language group. The subsequent graphs show correlations by speaker, within each language group.




NC Correlations
Coefficient
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
P~D
P~I
D~I
3
14
16
18
21


NE Correlations
Coefficient
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
P~D
P~I
D~I
1
2
13
19
23


NJ Correlations
Coefficient
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
P~D
P~I
D~I
5
7
10
17
22

Overall, the NC speakers showed a small negative correlation between pitch and duration, and a small to moderate positive correlation between pitch and intensity. The NE speakers also showed a moderate positive correlation between pitch and intensity. The NJ speakers showed small positive correlations between pitch~duration and duration~intensity.

When broken up individually, the NC speakers almost all showed small to moderate positive correlations between pitch~intensity and duration~intensity. This does not support the group behavior found when all speakers are taken together. Speaker 18 showed different behavior than other members of his group: his pitch~intensity correlation was much higher, and his duration~intensity correlation much lower.

Individually, the NE speakers had erratic behavior. Speakers 1 and 23 had small negative correlations between pitch and duration, and Speakers 1, 2, and 13 had small to moderate positive correlations between pitch and intensity. This supports the behavior found across all speakers, though not all speakers had these correlations. Speaker 1 also had a small positive correlation between duration and intensity. Thus, we see a slight amount of patterning, but nothing consistent across all speakers.

The NJ speakers had more consistent behavior than this, which interestingly did not match their correlations when taken as an entire group. Only one participant, Speaker 7, had a positive correlation between pitch and duration, matching the group behavior. Two other speakers (10 and 17) had small *negative* correlations in this area. All of the speakers except 10 had small positive correlations between pitch and intensity, which does not match the correlation found across the whole group. Speakers 5, 7, and 22 had small to moderate positive correlations between duration and intensity, similar to the

group finding. One thing of note is that Speakers 10 and 17—the male speakers—patterned similarly while Speakers 5, 7, and 22—the female speakers—patterned similarly. Clearly, this reveals some effect of native speaker gender on pitch accent pronunciation.

So what generalities can one extract from this web of correlations? For non-native speakers, as a whole, taking all these correlations together implies a general relationship of higher pitch and intensity for shorter vowels, and lower pitch and intensity for longer vowels. For native speakers, as a whole, this implies a relationship of higher pitch and intensity for longer vowels, and lower pitch and intensity for shorter vowels.

These statements perhaps over-generalize, but I believe they give a good overall picture of what is happening for whole language groups. This picture supports my hypothesis for the NE group, to an extent—however, we would expect to see positive correlations among all of pitch, duration, and intensity, since these are all components of stress (Gussenhoven, 2004, p. 14-15; Yip, 2002, p. 256). One possible cause of this might be the fact that the correlations are based on averages of the pitch and intensity. Longer vowels have more time for the pitch and intensity to trail off, or at least decrease somewhat, which would lower the pitch and intensity means. Perhaps taking peak pitch and peak intensity would give slightly different results.

My hypothesis for the NC group was not supported: in most cases, their correlations were about as prominent as the NE group. The NC group correlations were more prominent than one might expect for a tone language. This could be due to the fact that all NC speakers had studied English for at least 6 years and were currently living in the United States, reflecting stress language influence.

My hypothesis for the NJ group was not supported. They had an obvious correlation between pitch~duration and duration~intensity, which challenges the notion that duration and intensity are not correlated with pitch in Japanese (Gussenhoven, 2004, p. 40). It is interesting to note, though, that their correlations were opposite of the other two groups' correlations: instead of higher pitch/intensity correlated with shorter vowels, NJ speakers had higher pitch/intensity correlated with longer vowels. Thus, even though the hypothesis for NJ speakers was not supported, they still differed in important ways from the other two groups.

There is no easy answer to this finding, given that most scholars in this area have asserted that there is no correlation between pitch and duration/intensity. Consequently, this brings up the interesting question of what is causing this. It could be due to English influence, since all NJ speakers had studied English for at least 5 years, and were currently living in the United States. This is unlikely, however, since it would reflect L2 effect on L1. It also could be due to generational tendencies in pitch accent pronunciation. The individual speaker behavior, for all language groups, usually did not support the group findings. This adds even more complexity to the problem, for we must discover if the group findings are real, with plenty of speaker variation, or if they are an illusion, and speakers have different consistent behavior. More research must be done to discover the veracity and generalizabilty of these findings.

To summarize, non-native speakers as a whole showed a small to moderate positive correlation between pitch and intensity. This partially supports the hypothesis for the NE speakers, and does not support the hypothesis for the NC speakers. The

hypothesis for the NJ group was also not supported: they had a definite positive correlation between pitch~duration and duration~intensity. This challenges the traditional notion that pitch has little relation to duration and intensity in the Japanese language. Individually, the NC speakers patterned similarly, and the NE speakers patterned erratically. For the NJ speakers, the male speakers patterned similarly and the female speakers patterned similarly. In general, correlations found for individual speakers did not match the correlations found for language groups as a whole.

Other Interesting Phenomena

Subsequent improvement

In a number of post-experiment questionnaires, speakers mentioned that they figured out by the end of the first reading through the sentences that the experiment was studying pitch accent. By comparing the Dictionary Agreement of the first reading with the Dictionary Agreement of the second reading, we can get an idea of any speaker-initiated improvement.

NE Speakers – DA Improvement

	1st Reading	2nd Reading
Speaker 1	46.5%	48.8%
Speaker 2	23.3%	20.9%
Speaker 13	30.2%	30.2%
Speaker 19	30.2%	41.9%
Speaker 23	41.9%	46.5%
Mean	**34.4%**	**37.7%**

NC Speakers – DA Improvement

	1st Reading	2nd Reading
Speaker 3	39.5%	34.9%
Speaker 14	37.2%	39.5%
Speaker 16	32.6%	34.9%
Speaker 18	39.5%	39.5%
Speaker 21	25.6%	27.9%
Mean	**34.9%**	**35.3%**

NJ Speakers – DA Improvement

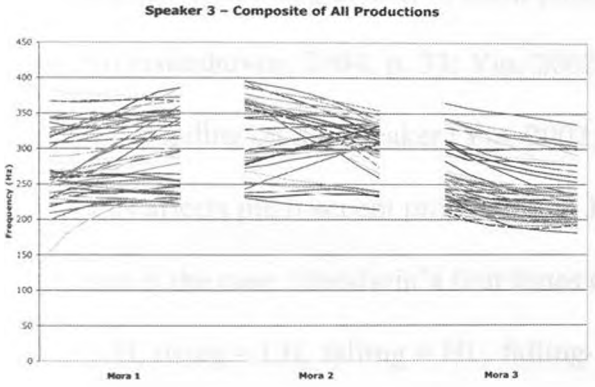
	1st Reading	2nd Reading
Speaker 5	44.2%	37.2%
Speaker 7	62.8%	67.4%
Speaker 10	60.5%	62.8%
Speaker 17	55.8%	60.5%
Speaker 22	58.1%	58.1%
Mean	**56.3%**	**57.2%**

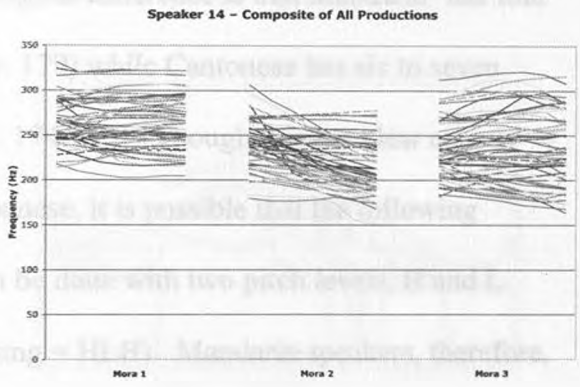
The NE group's mean improvement for Dictionary Agreement was 3.3%. The NC group's mean improvement was 0.4%. The NJ group's mean improvement was 0.9%. Though tests for statistical significance were not done, all speakers differed in their first and second readings by only a few percentage points. Even if the speakers were trying harder to achieve the dictionary pitch accent form on the second reading, they do not seem to have reached this goal.

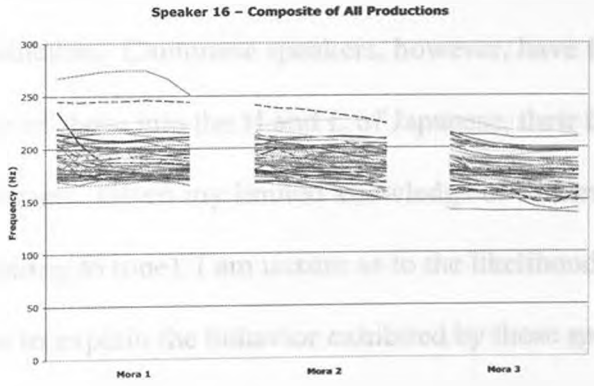
High pitch concentration for the Cantonese speakers

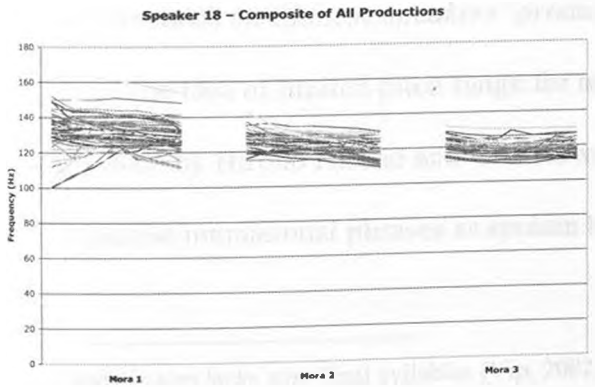
When I was compiling composite graphs of all productions for each speaker, I noticed an interesting phenomenon in the distribution of the pitch patterns for the NC speakers. I found that two of the speakers had very concentrated pitch ranges, within a 20-50 Hz range. Checking their background information for similarities between them, I

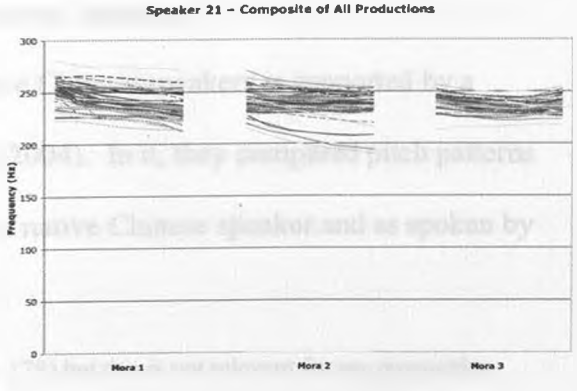
immediately noticed that they both spoke Cantonese, while the other NC participants spoke Mandarin. These composite graphs are given below. The top three graphs show the Mandarin speakers, and the bottom two graphs show the Cantonese speakers. Each colored line represents one production of one word—obviously, there are too many lines to distinguish actual words, but the differences in distribution are striking.











This phenomenon holds for the three-mora words, as well, though with not quite as drastic effects. Notice also the slightly greater concentration of Speaker 16—pictured in the middle graph—than the other two Mandarin speakers. It turns out that this speaker had taken half a year of Cantonese, which might have influenced her pronunciation.

One must suppose that the differences between Mandarin and Cantonese are causing this interesting effect. A main phonological difference is that Mandarin[1] has four tones (Gussenhoven, 2004, p. 33; Yip, 2002, p. 179) while Cantonese has six to seven tones, depending on the speaker (Yip, 2002, p. 174-175). Though it is not clear exactly how this affects pitch accent production in Japanese, it is possible that the following scenario is the case: Mandarin's four tones can be done with two pitch levels, H and L (flat = H, rising = LH, falling = HL, falling-rising = HLH). Mandarin speakers, therefore, can transfer these two pitch levels into the H and L pitches of Japanese, allowing for a full range of pitch production. Cantonese speakers, however, have four or five pitch levels; transferring two of these into the H and L of Japanese, their L2 tone range would be more tightly constrained. Given my limited knowledge of Chinese tone and L1 transfer (especially relating to tone), I am unsure as to the likelihood of this scenario. However, it does serve to explain the behavior exhibited by these speakers.

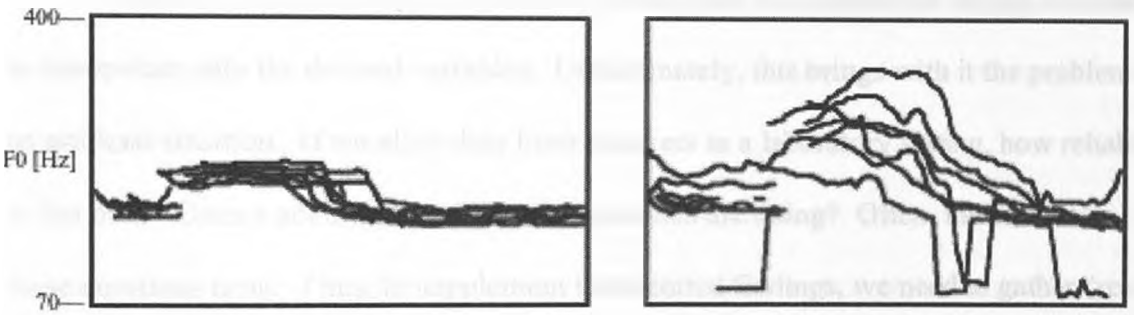
Other research on Chinese speakers' production of Japanese

The idea of limited pitch range for native Chinese speakers is supported by a study done by Hiroko Hirano and Goh Kawai (2004). In it, they compared pitch patterns of Japanese intonational phrases as spoken by a native Chinese speaker and as spoken by

[1] Mandarin also lacks stop-final syllables (Yip, 2002, p. 179) but this is not relevant for my proposition.

a native Japanese speaker. There were a number of pitch errors made by the Chinese speaker. One of these errors was a smaller pitch contour repertoire.

An example of Hirano and Kawai's results is pictured below. Pitch contours for seven phrases involving *Hokkaido* (the name of the northern island of Japan) followed by a variety of postpositions (*o, no, ni, & wa* and combinations of these) are shown overlapped on the two graphs below, time-normalized for phrase length.



A cursory examination of my own data, to compare to this, revealed that the NC speakers in my study did not have flattened pitch contours like this, and the NJ speakers did not have noteworthy differences in pitch range from the non-native speakers. The limited range of pitch repertoire, however, does seem similar to my finding on Cantonese pitch concentration. This may or may not help support my finding: the Chinese speaker in Hirano and Kawai's study was from Taiwan, which has Mandarin as the official language. The authors did not say which language the Chinese participant spoke. If the participant spoke Mandarin, this finding contradicts my previous finding. If the participant spoke Taiwanese (which has 7 tones) then this finding supports my previous finding. More research on the source of limited pitch range in L2 production must be done to prove or disprove this.

Suggestions for further research

The first, and most obvious, suggestion for further research in any study is to expand the scope of the current research already performed, to provide greater generalizability. Incorporating more language groups, greater age variety, and varying speaker familiarity with English (or other stress languages) would allow for a more comprehensive review of pitch accent production by native and non-native speakers.

Naturally, studies such as this must be conducted in a controlled setting, in order to manipulate only the desired variables. Unfortunately, this brings with it the problem of an artificial situation. If we elicit data from speakers in a laboratory setting, how reliable is that data? Does it accurately reflect what speakers are doing? Often, the answer to these questions is no. Thus, to supplement these initial findings, we need to gather "real" data: native and non-native speakers in real situations, using the language to communicate their real ideas and desires, without influence from a researcher or tape recorder. One not quite ideal, but feasible, way to do this is to create a more truly communicative task for the participants to engage in, even if they know they are being recorded. Once we obtain some data of this form, we can then analyze this data to see if my findings hold, or if they are a product of the original artificial context.

One of the most interesting questions to pursue is the relationship between pitch, intensity, and duration for native Japanese speakers. Some questions we might ask are: do the particular vowel and consonant qualities of the word play a role? Does this finding hold for more words than the 43 used in this experiment, and for words with greater than three morae? Does it hold for Japanese speakers with no English background? Does it even hold for other Japanese speakers with backgrounds in English,

or is my finding some sort of anomaly? I believe this is an area of interest that warrants additional research, even if only to disprove my findings.

Another interesting, further study on speaker improvement would be to *tell* the participants, between readings, that pitch accent is being studied. Or, one might actually give the participants the correct pitch accent on the second reading, and see if they can accurately reproduce it. Previous research where the participants were given the correct pitch pattern (Shport, 2003) has shown non-native speakers to still make many errors even when having the correct pitch pattern right in front of them, so we would expect improvement to be minimal.

There are a variety of other subjects that are related to my research. Some studies have found that varying the postposition can have an effect on the pitch accent (Miyamoto & Johnson, 2002; Vance, 1987, p. 93). Another study shows a correlation between aptitude in music and aptitude in Japanese phonetics, including pitch (Nakata, 2002). Yet another suggests that a speaker's L1 has an effect on their ability to read text in their L2 (Upton & Lee-Thompson, 2001). One study, essentially the reverse of my own (Japanese L1 effect on English L2 acquisition), found native Japanese speakers storing English stress lexically, much like pitch accent is stored lexically (Archibald, 1997 as cited in Archibald, 1998). The examination of any of these topics in relation to my own findings is bound to be of interest.

Conclusion

In this study, it was found that non-native speakers as a whole were unsuccessful nearly two-thirds of the time in matching the dictionary form of pitch accent patterns. There was little difference between NE and NC speakers, suggesting that having an L1 tone language does not necessarily indicate better learning of an L2 pitch accent language, even though both use pitch distinctively. NJ speakers performed better at matching the dictionary form than the non-native speakers, though not perfectly—they often used a LHH(L) pattern for LHH(H) words, or defaulted to a LH(L) pattern for two-mora words or LHL(L) pattern for three-mora words. More research should be done on when these non-dictionary patterns occur, or if the dictionary patterns are still correct for the general Tokyo population. Four of the ten non-native speakers showed preference for producing most words with HL(L) and LHL(L) patterns. Most likely, this was due to their strong English backgrounds and lesser experience with Japanese than the other participants. All NE speakers also showed preference for pitch patterns with only one H accent. These results suggest L1 transfer of English prosodic features, an idea supported by previous research (Nishinuma, Arai, & Ayusawa, 1996; Yamada, 1996).

The NE speakers often produced the minimal pairs with the same pitch patterns. This implies that NE speakers are not perceptually distinguishing pitch patterns for minimal pairs. The NC speakers had similar behavior, to a lesser extent. Both groups of non-native speakers also had a positive correlation between pitch~intensity and a negative correlation between pitch~duration. This ran counter to both the expectation that the NE speakers would show positive correlations among all of pitch, duration, and intensity, and the expectation that NC speakers would show few correlations. The NJ

speakers had clear positive correlations between pitch~duration and duration~intensity, which challenges the traditional notion that pitch has little relation to duration and intensity in Japanese. Individually, the NC speakers patterned similarly and the NE speakers did not pattern similarly. The NJ speakers patterned together by gender. In general, correlations found for individual speakers did not match the correlations found for language groups as a whole. These results show a need for further research in pitch, duration, and intensity correlation for both native and non-native Japanese speakers.

Overall, there seemed to be a variety of L1 effects on L2 prosody. As established in the Introduction, this is an important area of study, given the limited past research (Jun & Oh, 2000; Moyer, 1999) and the extent to which prosodic errors can influence comprehensibility (Moyer, 1999; Munro, 1998; Munro & Derwing, 1995). In light of this fact, and the established need of prosody teaching in prosodic-deficient learning settings (Hirata, 1999; Moyer, 1999), instructors need to understand how non-native speakers are currently producing prosodic errors, so that they might help correct them.

Given the tendency of native English speakers to use English stress patterns in their Japanese pitch production, instructors need to educate their English-speaking students about this information, detailing the similarities and differences between English stress and Japanese pitch accent. Non-native speakers of Japanese also have a tendency to not discriminate between pitch accent minimal pairs, which instructors can help correct by focusing on how differing pitch patterns sound. Instructors need to take this responsibility upon themselves, because Japanese textbooks often over-simply the complexity of the pitch accent system, or do not address it at all. In fact, one researcher (Hasegawa, 1995), in an article entitled *Against marking accent locations in Japanese*

textbooks, argues that "marking accent locations in textbooks without a detailed explanation about accent is merely an extra complication that introductory textbooks should avoid" (p. 95). Therefore, instead of giving a cursory treatment of pitch accent, instructors should acknowledge and teach about the complexity inherent in the prosodic system of Japanese. If non-native speakers can be taught the most common pitfalls of L1 transfer, their L2 speaking comprehensibility should improve.

My research is one step in this direction of understanding L2 pitch accent errors. Since pitch accent falls under the general category of tone, understanding these errors is important because "there are very few studies on second-language acquisition of tone, particularly on the production end" (Yip, 2002, p. 310). Past studies on pitch accent have focused on such things as non-native speakers' perception of pitch accent (Nishinuma, Arai, & Ayusawa, 1996), the relationship between pitch accent and other phonetic features (Hasegawa, 1995; Hasegawa, 1999; Shport, 2003), or the effectiveness of various methods in improving pitch accent perception and production (Hirata, 1999). These studies, however, often do not delineate *how* non-native speakers are producing the wrong pitch accent; they just observe the effects of the incorrect pronunciation. Furthermore, few studies look *cross-linguistically* at non-native pitch accent production.

In this study, I attempt to begin this kind of examination. By discovering how non-native speakers of different language backgrounds are making errors, we can not only make better generalizations about non-native speaker difficulties as a whole, but also better understand the problems specific language groups encounter. This knowledge will, in turn, help us better understand how to help correct non-native speakers and teach them how and why they are making mistakes.

Appendix A – Contextual Sentences

(Romanizations are in italics, translations are in single-quotes, key words are in bold)

でんしゃ　とうきょう　い この電車は東京行きです。	*kono densya wa tôkyô-**iki** desu*	'This train is **headed** to Tokyo.'
私は行きが好きです。	*watashi wa **iki** ga suki desu*	'I like ***iki*** (going).'
はな　いき 鼻で息をします。	*hana de **iki** o shimasu*	'**Breathe** through your nose.'
私は息が好きです。	*watashi wa **iki** ga suki desu*	'I like ***iki*** (breath).'
あめ　あま 飴は甘いです。	***ame** wa amai desu*	'**Candy** is sweet.'
私は飴が好きです。	*watashi wa **ame** ga suki desu*	'I like ***ame*** (candy).'
きょう　あめ　ふ 今日は雨が降るでしょう。	*kyô wa **ame** ga furu desyô*	'Today it's probably going to **rain**.'
私は雨が好きです。	etc.	

かれ　　いし　な 彼はグレーの石を投げた。	*kare wa gurê no **ishi** o nageta*
私は石が好きです。	'The man threw a grey **rock**.'
こども　い し　つよ その子供は意志が強い。	*sono kodomo wa **ishi** ga tsuyoi*
私は意志が好きです。	'That child is strong-**will**ed.'
ど　かく　つく ３０度の角を作ってください。	*san-do no **kaku** o tsukutte kudasai*
私は角が好きです。	'Please make a 30° **angle**.'
まいにち　わたし　にっき　か 毎日、私は日記に書くよ。	*mainichi, watashi wa nikki ni **kaku** yo*
私は書くが好きです。	'Everyday, I **write** in my journal.'

わたし　ふく　き
私、はでな服を着る。
私は着るが好きです。

*watashi, hade na fuku o **kiru***
'**I wear** gaudy clothes.'

かみ　き　す
髪を切るのが好きですか？
私は切るが好きです。

*kami o **kiru** no ga suki desu ka*
'Do you like **cut**ting hair?'

ばあ　す
お婆さんはタバコを吸う。
私は吸うが好きです。

*obaasan wa tabako o **suu***
'My grandmother **smokes** tabacco.'

すう　つか
「数」ってあまり使いません。
私は数が好きです。

*"**suu**" tte amari tukaimasen*
'I don't often use "***suu***" (number).'

との　しろ　おお
お殿さまの城はとても大きいです。
私は城が好きです。

*otonosama no **shiro** wa totemo ookii desu*
'The lord's **castle** is really big.'

しろ　いろ
白はきれいな色だね。
私は白が好きです。

***shiro** wa kirei na iro da ne*
'**White** is a pretty color, isn't it?'

ほん　うえ　かみ　あか
本の上にある紙が赤いです。
私は紙が好きです。

*hon no ue ni aru **kami** ga akai desu*
'The **paper** on top of the book is red.'

かみ　いの
神に祈りましょう。
私は神が好きです。

***kami** ni inorimasyô*
'Let's pray to **God** (or the **spirits**).'

やさい　た　たいせつ　こと
野菜を食べるのは大切な事です。
私は事が好きです。

*yasai o taberu no wa taisetsu na **koto** desu*
'Eating vegetables is an important **thing**.'

わたし こと ひ じょうず
私は琴を弾くのが上手です。
私は琴が好きです。

*watashi wa **koto** o hiku no ga jôzu desu*
'I'm skilled at playing the ***koto***.'

はし わた
トムさんは橋を渡ります。
私は橋が好きです。

*tomu-san wa **hashi** o watarimasu*
'Tom-san crossed the **bridge**.'

こめ た はし
米を食べるために箸を使います。
私は箸が好きです。

kome o taberu tame ni hashi o tsukaimasu
'In order to eat rice, we use chopsticks.'

みぎ はし
スープのスプーンは右の端にあります。
私は端が好きです。

*sûpu no supûn wa migi ni **hashi** ni arimasu*
'The soup spoon is on the right-hand **side**.'

きょう あつ
今日は暑いですねえ。
私は暑いが好きです。

*kyô wa **atsui** desu nee*
'Today is **hot**, isn't it.'

ほん あつ
その本は厚いです。
私は厚いが好きです。

*sono hon wa **atsui** desu*
'That book is **thick**.'

じょうず と
かえるは上手に飛びますね。
私はかえるが好きです。

***kaeru** wa jôzu ni tobimasu ne*
'**Frogs** are good at jumping, aren't they.'

わたし かんが か
すぐに私の考えを変える。
私は変えるが好きです。

*sugu ni watashi no kangae o **kaeru***
'I quickly **change** my mind.'

あした あに かえ おも
明日、兄が帰ると思います。
私は帰るが好きです。

*ashita, ani ga **kaeru** to omoimasu*
'I think my brother **returns** tomorrow.'

としょかん　わたし　いえ　ちか
図書館は私の家に近いです。
私は近いが好きです。

*toshokan wa watashi no ie ni **chikai** desu*
'The library is **close** to my house.'

きっさてん　　みせ　ちかい
喫茶店はその店の地階にあります。
私は地階が好きです。

*kissaten wa sono mise no **chikai** ni arimasu*
'That coffeeshop is in the **basement** of that store.'

りょこうちゅう　た　　おも
旅行中　楽しい思いをした。
私は思いが好きです。

*ryokôchuu tanoshii **omoi** o shita*
'I have pleasant **memories** from that trip.'

わたし　ばあ　　ひじょう　おも
私のお婆さんは非常に重いです。
私は重いが好きです。

*watashi no obaasan wa hijô ni **omoi** desu*
'My grandmother is extremely **heavy**.'

らいしゅう　わたし いちばん す　　え　か
来週、私の一番好きな絵を掛ける
つもりだ。
私は掛けるが好きです。

*raishuu, watashi no iti-ban suki na e o **kakeru***
tsumori da
'Next week, I intend to **hang** my favorite picture.'

きじ　じょうほう　か
その記事は情報に欠ける。
私は欠けるが好きです。

*sono kiji wa jôhô ni **kakeru***
'That article **lacks** information.'

かんじ　べんきょう
いつもいつも漢字を勉強しています。
私は漢字が好きです。

*itsu mo itsu mo **kanji** o benkyô shite imasu*
'I'm always studying **kanji**.'

にお　　かん
いい匂いがいい感じをあたえる。
私は感じが好きです。

*ii nioi ga ii **kanji** o ataeru*
'Good smells bring about good **feelings**.'

へや おく ちい いぬ
部屋の奥に小さい犬がいます。
私は奥が好きです。

*heya no **oku** ni chiisai inu ga imasu*
'There is a small dog **inside** the room.'

おく
１０億ドルがほしいです。
私は億が好きです。

*juu **oku** doru ga hoshii desu*
'I want one billion (lit. ten **100 million**) dollars.'

きのう わる じこ お
昨日、悪い事故が起こりました。
私は事故が好きです。

*kinô, warui **jiko** ga okorimashita*
'Yesterday, a bad **accident** occurred.'

わたし じこしょうかい
私は自己紹介をしなければなりません。
私は自己が好きです。

*watashi wa **jiko**shôkai o shinakereba narimasen*
'I must give a **self**-introduction.'

さむ かぜ つよ
寒くて、風が強かった。
私は風が好きです。

*samukute, **kaze** ga tsuyokatta*
'It's cold, and the **wind** is strong.'

きのう か ぜ
昨日、風邪をひきました。
私は風邪が好きです。

*kinô, **kaze** o hikimasita*
'Yesterday I caught a **cold**.'

みず すいめん けしき うつ
水の水面に景色が映る。
私は映るが好きです。

*mizu no suimen ni keshiki ga **utsuru***
'The water's surface **reflects** the scenery.'

うつ ことば
「写る」ってきれいな言葉ですねえ。
私は写るが好きです。

*"**utsuru**" tte kirei na kotoba desu nee*
'"***utsuru***" (to photograph) is a beautiful word, isn't it.'

とうきょう うつ
東京に移るつもりです。
私は移るが好きです。

*tôkyô ni **utsuru** tsumori desu*
'I intend to **move** to Tokyo.'

Appendix B – Background and Consent Forms

Subject Number_____
Date of Testing_____

Language Background Questionnaire for Native Participants

Gender ____ Race/Ethnicity _____ Current age ____

Date of birth _____ Place of birth _____

Is your hearing OK as far as you know? ☐ Yes ☐ No

Have you been diagnosed with any language or reading problems? ☐ Yes ☐ No

If yes, please explain: _____

	First Language(s)	From what country or region(s) (e.g. city, state, country)
You	_____	_____
Your Mother	_____	_____
Your Father	_____	_____

What language(s) were spoken at home while you were growing up?

_____

Have you studied any foreign languages? ☐ Yes ☐ No

If yes, indicate language(s) and years studied: _____ for ____ years
_____ for ____ years
_____ for ____ years

Countries you have lived in for 3 months or longer, beginning with place of birth:

_____ from age ____ to age ____
_____ from age ____ to age ____
_____ from age ____ to age ____

What is your highest level of education to date? (e.g. 2 years of college, high school degree,

Bachelor's degree, etc.) _____

Subject Number_____
Date of Testing_____

Language Background Questionnaire for Non-Native Participants

Gender ____ Race/Ethnicity _____ Current age ____
Date of birth _____ Place of birth _____

Is your hearing OK as far as you know? ☐ Yes ☐ No

Have you been diagnosed with any language or reading problems? ☐ Yes ☐ No

If yes, please explain: _____

	First Language(s)	From what country or region(s) (e.g. city, state, country)
You	_____	_____
Your Mother	_____	_____
Your Father	_____	_____

What language(s) were spoken at home while you were growing up?

_____

Have you studied any foreign languages besides Japanese? ☐ Yes ☐ No

If yes, indicate language(s) and years studied: _____ for ____ years
_____ for ____ years
_____ for ____ years

Countries you have lived in for 3 months or longer, beginning with place of birth:

_____ from age ____ to age ____
_____ from age ____ to age ____
_____ from age ____ to age ____

What is your highest level of education to date? (e.g. 2 years of college, high school degree, Bachelor's degree, etc.) _____

How old were you when you first started learning Japanese? ____ years and ____ months

Where did you start learning Japanese?

☐ At school in your home country (If so, what type of school? _____)
☐ At school in Japan
☐ At home
☐ With Japanese-speaking friends (If so, where? _____)
☐ Other (Please explain: _____)

How much instruction of Japanese have you received? ____ years

Amount in your home country: ____ years

Amount in Japan: ____ years

How would you rate your proficiency in Japanese?

	Very Poor								**Native-like**
Speaking									
	1	2	3	4	5	6	7	8	9
Listening									
	1	2	3	4	5	6	7	8	9
Reading									
	1	2	3	4	5	6	7	8	9
Writing									
	1	2	3	4	5	6	7	8	9

What percentage of the time do you use Japanese in the following situations?

Talking to your parents

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Talking to your grandparents

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Talking to your siblings

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Talking to your children (if relevant)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

At home

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Talking to your friends

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Talking to people at work (if relevant)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Talking to people at school

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Current overall use of Japanese in your daily life

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Subject Number_____
Date of Testing_____

Language Background Questionnaire Supplement

Pitch accent *is defined as "emphasis that results from pitch [i.e. the 'highness' or 'lowness' of a sound] rather than loudness." For example,* はし 橋 *(bridge) is pronounced hashi, whereas* はし 箸 *(chopsticks) is pronounced hashi.*

Are you conscious of your pitch accent usage while speaking Japanese? ☐Yes ☐No

Have you had any formal instruction in Japanese pitch accent? ☐Yes ☐No

If so, what have you been taught?

_____

_____

_____

_____

_____

Have you made any personal observations about pitch accent? ☐Yes ☐No

If so, please detail them below.

_____

_____

_____

_____

_____

Language Consultant Volunteer Consent Form

You are invited to help us study language by serving as a consultant on one of the languages that you speak fluently. The faculty in the Department of Linguistics at the University of Oregon are interested in accurately describing the grammatical structure of language X, and in teaching linguistics students how to formulate such descriptions. You were selected as a possible language consultant because you have native knowledge of a language currently under study in the Linguistics Department.

If you decide to participate, we will ask you questions about particular grammatical constructions in your language. Specifically, we will ask you to judge whether different kinds of sentences are acceptable to you, the native speaker. We will also ask you how to pronounce different words in your language. We will tape record the interview session so that we have an audio record of our conversation. This will allow us to listen and possibly analyze pronunciation in your language, and also to keep an accurate record of our interview (against which we can check our notes).

Remember that you are the expert here, and your answers are by definition the right answers. All we are asking is that you share your intuitions about your language with us. If you find that the interaction makes you uncomfortable in any way, you are free to withdraw as a language consultant at any time and with no penalty. If you do decide to consult for us, and your decision is completely voluntary and will in no way affect your relationship with the Linguistics Department or the University of Oregon. The minimum time that we would ask for your participation is 1 hour, but you may have the choice to continue consulting for us up to 30 hours in a term. We will not be able to compensate you for your time, financially or with course credit. This means that if you decide to participate, you will be volunteering your time to us, and we greatly appreciate that.

Any information that is obtained in connection with the study of your language that can be identified with you will remain confidential and will be disclosed only with your permission. Your identity will be confidential because the records surrounding the interview (i.e., the notes and tape) will not be associated with any identifying information. This consent form, for instance, will be kept separately from the language notes and tapes in a filing cabinet in a locked office.

If you have any questions, please feel free to contact Professor Melissa Redford by email at redford@darkwing.uoregon.edu or by phone at 346-3789. Prof. Redford is the Department's Human Subject representative. If you have questions regarding your rights as a research subject, and wish to contact someone outside of the Linguistics Department, contact the Office of Human Subjects Compliance, University of Oregon, Eugene, OR 97403, (541) 346-2510.

Your signature indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation without penalty, that you have received a copy of this form, and that you are not waiving any legal claims, rights or remedies. Please request a copy of this form if you would like to keep it for your records.

Print Name_____

Signature_____

Date_____

PI or co-PI's signature_____

Date_____

Appendix C – Praat Scripts

getfiles.txt

The following script was used to read in a large number of files at once, where *filepath* is the file path of the directory holding all the files.

```
directory$ = "filepath"
Create Strings as file list... list 'directory$'
numberOfFiles = Get number of strings
for ifile to numberOfFiles
    select Strings list
    fileName$ = Get string... ifile
    Read from file... 'directory$'/'fileName$'
endfor
```

newline.txt

This was used to append a blank line in between measurements. The measurements were written out to the file `pitch_log.txt` from the script on the following page, titled `script.txt`.

```
fileappend "~/Desktop/pitch_log.txt" 'newline$'
```

script.txt

This script was used to gather the measurements for pitch, duration, and intensity, writing them out to a file titled `pitch_log.txt`. The first part establishes the necessary variables and gathers the duration and average intensity measurements; the second part gets the positions of 1/8, 2/8, etc. of the vowel; the third part gathers the pitch measurements; and the fourth part writes out the measurements to the log file.

```
begin = Get begin of selection
mid = Get cursor
end = Get end of selection
length = Get selection length
intensity = Get intensity

one = (mid-begin)/4+begin
two = (mid-begin)/2+begin
three = (mid-begin)/4+two
four = mid
five = (end-mid)/4+mid
six = (end-mid)/2+mid
seven =(end-mid)/4+six

Move cursor to... one
pitch1 = Get pitch
Move cursor to... two
pitch2 = Get pitch
Move cursor to... three
pitch3 = Get pitch
Move cursor to... four
pitch4 = Get pitch
Move cursor to... five
pitch5 = Get pitch
Move cursor to... six
pitch6 = Get pitch
Move cursor to... seven
pitch7 = Get pitch

fileappend "~/Desktop/pitch_log.txt"
'tab$''length:3''tab$''intensity:1''tab$''tab$''pitch1:0''t
ab$''pitch2:0''tab$''pitch3:0''tab$''pitch4:0''tab$''pitch5
:0''tab$''pitch6:0''tab$''pitch7:0''newline$'
```

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