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# Japanese Students' Pitch Patterns in Relation to English Sentence Stresses

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English sentence stresses are characterized by higher pitch. In this study the pitch patterns of Japanese students were analyzed in comparison with those of native speakers of English in relation to sentence stresses. The Japanese speakers' tendencies were 1) not to raise their pitch at all or significantly in predicate verbs, adjectives, or intensifiers with a sentence stress and 2) to make the pitch in subject pronouns as high as or higher than that in predicate verbs, adjectives, or intensifiers.

**Key Words:** [sentence stresses] [pitch rise in verbs] [higher pitch in subject pronouns] [pitch contours] [acoustic analysis software]

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## 1. Introduction

This study investigates characteristics of Japanese students' pitch use in relation to sentence stresses. Their pitch patterns in English sentences will be physically captured by means of acoustic analysis software and will be compared with those of native speakers of English. The study focuses on observation and description of their pitch use in the subject pronoun (canonically unstressed) and the predicate verb, adjective, or intensifier (canonically stressed) in a sentence. It will become the first stepping-stone to an ultimate goal of creating e-learning exercises that visualize pitch contours and enhancing students' acquisition of English sentence stresses and intonation.

In principle English sentence stresses are placed on content words, i.e. nouns, verbs (except for 'be' and 'have'), adjectives, adverbs and wh-words. In contrast function words (ex. pronouns, prepositions, articles, conjunctions, and auxiliaries) are usually not stressed in a sentence unless they have some semantic emphasis. Sentences stresses are easily associated with larger volume but are actually a combination of higher intensity, higher pitch, longer time, and more clarity in vowels. Bolinger (1958 cited in Sugito 2012) and Liberman (1967

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cited in Sugito 2012) claim that producing higher pitch, in particular, is crucial to successful perception of English stresses by the listeners.

Hearing my students' English pronunciation in class, I often notice that a good number of them do not pay much attention to raising pitch in syllables with sentence stresses and to lowering it in unstressed syllables. It is important for them to acquire basic pitch patterns necessary for marking English sentence stresses so that they will be better understood. By using higher pitch in a word without a sentence stress they might be misunderstood because it indicates a special semantic emphasis on that particular word. For example, if they use higher pitch in a subject pronoun such as "I" and "you", it means "I don't know about the other people, but as for me/you...". They happen to convey such a special meaning to the listeners even when their intention is otherwise.

The Course of Study for Lower Secondary Schools issued in 2008 and partly revised in 2015 by Ministry of Education, Culture, Sports, Science and Technology, Japan, states that instructions should be given in order for students to "become familiar with the basic characteristics of English sounds such as stress, intonation and pauses and pronounce English sounds correctly" (Section 9: MEXT 2011 and 2015). I strongly feel the need to develop awareness-raising exercises for my students, particularly those who aim to be junior high school English teachers, to check their pronunciation visually and to acquire correct pitch patterns for English sentence stresses and intonation.

## 2. Previous Research

Sugito (1983) compared the pitch contours of 12 non-native speakers of English with those of 6 native speakers in the sentences "Everyman carries two bags about with him. One in front, one behind, and both are full of faults." According to this experiment, most of the Japanese speakers (the non-native speakers of English) raised their pitch in the pronoun "one", a function word not to be stressed, both times, whereas the native speakers did not. The non-native group was less likely to raise pitch in "front", the content word that all the native speakers stressed with higher pitch (Sugito 1983). Mori (2005) and Maeda and Imanaka (1999) report Japanese speakers' tendency to use higher pitch in subject pronouns than in verbs which native speakers of English would stress.

Research has also been conducted on the effectiveness of e-learning exercises on English stresses and intonation by the use of acoustic analysis software such as *Praat*. Le and Brook (2011) found that the visual feedback such as pitch contours displayed by *Praat* was beneficial for Japanese learners to improve their intonation. Wilson (2008) recommends an eclectic use of *Praat* and Moodle for enhancing Japanese students' autonomous learning of English pronunciation including stresses and intonation.

## 3. Experiment

### 3.1 Purpose

I will compare Japanese students' pitch change between a subject pronoun and a predicate verb, adjective or intensifier with those of native speakers. In principle the verb, adjective, or intensifier in the predicate gets a sentence stress while the subject pronoun does not unless it has a special semantic emphasis on it. Therefore, native speakers of English are likely to raise the pitch of their voice in the predicate verb, adjective, or intensifier but not in the pronoun. This study will observe to what extent Japanese learners of English will follow this pitch pattern based on sentence stresses.

### 3.2 Method

6 native speakers of English and 12 Japanese students who are non-native speakers of English read two sets of English texts. Their speech was recorded by the use of WaveSurferⓒ 1.8.8p5 (2000-2017), the acoustic analysis software developed by Jonas Beskow and Kare Sjolander.

### 3.3 Subjects

The six native speakers who participated in the recording are as follows:

1 female American in her late-twenties
1 male Australian in his early-thirties
1 female Canadian in her mid-thirties
1 female South African in her mid-thirties
1 Englishman in his early-fifties
1 Scotsman in his early-fifties

All are teachers of English with 3-28 years of experience.

The twelve non-native speakers who participated in the recording are Japanese college students who are 18-19 years of age. All of them learned English at high schools in Kagoshima, Japan, for about 6 years. Two of them took weekly private English conversation lessons taught by native speakers for a year and one for 7 years. Two students stayed in Canada for a month on a study-abroad program. All the twelve students had not learned about sentence stresses in my phonetics class when the recording for this study took place.

### 3.4 Text

The two sets of text that the speakers read are as follows:

**Text 1**

A: What's the matter?

B: I lost my glasses.

A: Where'd you put them?

B: If I knew, I could find them.

(Judy B. Gilbert. 1993. *Clear Speech Student's Book: Basic Pronunciation and Listening Comprehension in North American English.* Cambridge: Cambridge University Press)

*There was no underline in this text when the subjects read it.

**Text 2**

Dear Lisa,

Hi! I have been very busy since we moved here. Kagoshima is a good place to live. It is nicer than I thought. There are a lot of sightseeing spots, and I like Sakurajima the best. Have you ever seen a volcano? Sakurajima has three active volcanoes, Kita-dake, Naka-dake, and Minami-dake. I know you have never been to this city. So, if you come here, I will be happy to show you around.

Goodbye now,

Taro

(Masao Niisato et al. 2016. *SUNSHINE ENGLISH COURSE 3.* Tokyo: Kairyudo.)

*There were no underlines in this text when the subjects read it.

The speakers read all the sentences in both sets. In this study I will focus on the following four clauses (underlined parts in the above text) for pitch analysis:

Target 1: "If I knew"

Target 2: "than I thought"

Target 3: "I have been very busy"

Target 4: "I will be happy"

Each clause has the first person pronoun "I" as its subject. Targets 1 and 2 share the same sentence structure: a conjunction + a subject pronoun + a predicate verb. Target 1 appears in the initial position of a complex sentence, whereas Target 2 is in the sentence-final position. Targets 3 and 4 have the structure of "a subject pronoun + an auxiliary + a be-verb (+ an intensifier) + an adjective". Target 3 is in the sentence-initial position of a complex sentence, whereas Target 4 is in the latter half of a complex sentence.

### 3.5 Data Processing

The recorded voice of each speaker reading each text is displayed as pitch contours along with waveforms and spectrograms by the acoustic analyzer WaveSurfer© 1.8.8p5.

First the mean frequency is taken of each speaker's voice in the complex sentence that includes a target clause. Next the fundamental frequency of the vowel (the one with a potential word stress) in each word of the target clause is measured based on the pitch contours. Its ratio to the mean is calculated for more objective comparison among speakers with different basic tones (for example, women usually speak with higher tones than men do). The degree of pitch change is indicated by the difference in the ratio between the two words adjacent to each other. As for Targets 3 and 4 the difference in pitch ratio is also calculated between the subject pronoun and the adjective or its intensifier (i.e. "very" in Target 3 and "happy" in Target 4).

All the ratios (the ratios to the mean frequencies and the differences in ratio between words) are shown to the second decimal place in Tables 1-8 in the format of Microsoft© Excel© for Mac 2011 (ex. In Table 1 the NS1's ratio to the mean frequency in "I" is indicated as 1.05 rather than 1.045, and its difference from the ratio in "If" as -0.14 rather than -0.135).

## 4. Results and Analyses

### 4.1 The Pitch Patterns in the Clauses with the Structure of "a conjunction + a subject pronoun + a verb"

#### 4.1.1 The Pitch Patterns in a Sentence-initial Clause with a Verb (Target 1)

In the first target clause, "If I knew", a sentence stress is usually placed on the verb "knew". On the other hand, the conjunction "If" and the pronoun "I" are not stressed as they are function words without any semantic emphasis. Therefore, it is expected that the pitch will be sustained relatively low in "If" and "I" and will acutely rise in the verb "knew".

The results of the native speakers' pitch use in Target 1 are shown in Table 1. All of them raised the pitch of their voice in the verb "knew" by 0.34 in ratio on average. With this pitch rise a sentence stress was clearly placed on the verb by every native speaker. An example of their pitch contours is shown in Figure 1.

The results of the Japanese students' pitch use in Target 1 are shown in Table 2. On average, they raised the pitch of their voice in the subject pronoun "I" by 0.13 in ratio but lowered it in the verb "knew" by 0.16 (Table 2). A pitch rise that should mark a sentence stress in the verb was not successfully realized by any of the Japanese students.

The pitch contour of a native speaker (NS1) shown in Figure 1 is characterized by an acute rise in the vowel [u:] of the verb "knew" (0.53 increase in ratio) (Table 1). In contrast that of a Japanese student (JS11) in Figure 2 does not indicate any significant pitch rise in

the verb. Her tone remains flat, which means little change in pitch (±0.07), throughout the clause (a slight rise in the end is not that for a sentence stress but rather the result of the intonation for sentence continuation) (Figure 2 and Table 2). The lack of sentence stress makes it harder to tell which word is more important in her speech.

The pitch contour of another Japanese student (JS8) in Figure 3 is featured by a sudden surge in pitch in the subject pronoun (an increase by 0.98 in ratio) (Table 2). Her pitch slightly rises within the verb (Figure 3), but the frequency does not exceed that in the pronoun (a decrease by 0.10 in ratio between the vowels of the two words) (Table 2). Thus, it can hardly be perceived as a sentence stress.

**4.1.2 The Pitch Patterns in a Sentence-Final Clause with a Verb (Target 2)**

The second target clause, "than I thought", has the same construction as the first one, that is, "a conjunction + a subject pronoun + a predicate verb". The only difference is that it appears in the sentence-final position.

In this clause, the native speakers raised their pitch in the verb "thought" by 0.24 on average (Table 3). In contrast the Japanese students lowered their pitch by 0.13 on average in the same verb (Table 4). Most of them failed to realize the sentence stress on the verb. The only difference from the pitch patterns in Target 1 was seen in the pronoun "I". Most of them did not raise their pitch in the pronoun (a decrease by 0.03 on average) after the conjunction "than" in Target 2 (Table 4).

The pitch contour of a native speaker (NS3) (Figure 4) shows a clear rise in her pitch in the vowel of the verb (an increase by 0.25) (Table 3), which marks a sentence stress on the verb. However, there is no such protrusion in the Japanese students' pitch patterns shown in Figures 5 and 6. With regard to the Japanese student No.7 (Figure 5) the peak is in the conjunction "than", and the pitch goes down in the pronoun and keeps falling in the verb (-0.14 in the pronoun and -0.54 in the verb) (Table 4). In the case of another Japanese student (JS11) (Figure 6) her pitch goes flat throughout the clause, and there is no obvious rise in any of the words (a change between -0.03 and -0.04) (Table 4). Both students fail to realize the sentence stress on the verb.

Only one out of the twelve students (JS5) realized a sentence stress by raising her pitch by 0.14 in the verb, whose pattern is close to that of NS6 (a rise by 0.15) (Tables 3 and 4). A pitch rise in the verb is also observed in two other students (JS4 and JS10), but the ratio of their pitch change (+0.05 and +0.08) is not as great as that of most of the native speakers (Tables 3 and 4).

### 4.2 The Pitch Patterns in the Clauses with the Structure of "a subject pronoun + an auxiliary + a be-verb + a predicate adjective"

#### 4.2.1 The Pitch Patterns in a Sentence-initial Clause with a Predicate Adjective (Target 3)

The third target clause is "I have been very busy". The predicate is "be + an intensifier + an adjective", and it does not appear right after the subject pronoun (in Targets 1 and 2 the predicate verbs were immediately after the subject pronouns). A sentence stress can be placed on the adjective "busy" or its intensifier "very" (the copula "be", unlike the other verbs, is not stressed unless there is a semantic emphasis on it).

The native speakers, except for one, raised their pitch by 0.19 on average in "very", the intensifier for the following adjective (Table 5). The general tendency of the Japanese students was to increase the pitch in "very" by 0.04 on average from the preceding word (Table 6). Their degree of pitch rise is not as large as that of the native speakers.

In addition, in terms of the difference in pitch ratio between the pronoun "I" and "very" (Tables 5 and 6), the Japanese students showed a pattern opposite to those of the native speakers. Their pitch in "very" was lower than that of "I" by 0.14 on average, whereas the native speakers' was higher by 0.15 on average (Tables 5 and 6).

The pitch contour of NS1 (Figure 7) clearly shows a sharp rise in "very" from the preceding word (i.e. an increase by 0.53 in ratio), which marks the first sentence stress in the clause (Table 5). The pitch of JS10 rises very little, only by 0.06, in "very" (Figure 8 and Table 6), and that of JS8 falls by 0.12 in it (Figure 9 and Table 6). As a result, both students fail to realize a sentence stress on the content word. A crucial contrast between NS1 and the two Japanese students JS10 and JS8 lies in the pitch difference between "I" and "very". The pitch of NS1 is much higher in "very" than in "I" (an increase by 0.32) (Table 5), whereas that of JS10 and JS8 is lower in "very" (a decrease by 0.27 and by 0.18 respectively) (Table 6). In other words, the Japanese students tend to use higher pitch in the sentence-initial subject pronoun than in the content word in the predicate. This pattern also contributes to failure to realize a sentence stress in the latter.

Only two out of the twelve students (JS3 and JS5) raised their pitch in "very" to the degree (+0.14 and +0.21 respectively) closer to that of the native speakers' average (+0.19) (Tables 5 and 6). However, their pitch level in "very" is almost the same as that in the subject pronoun "I" (+0.02 and +0.03 respectively) while the native speakers' pitch is higher in "very" (by 0.15 on average) (Tables 5 and 6).

#### 4.2.2 The Pitch Patterns in a Sentence-final Clause with a Predicate Adjective (Target 4)

The fourth target clause is "I will be happy". It appears in the latter half of a complex sentence. The native speakers significantly raised their pitch by 0.20 in ratio on average in the predicate adjective "happy" (Table 7), but they did not change it very much (from 0.00

to 0.01 on average) in the preceding function word sequence (Table 7). This pitch pattern clearly marks the sentence stress on the predicate adjective. The Japanese students raised their pitch in "happy" by 0.09 on average, but most of them did not raise it as acutely as the native speakers did (Table 8).

The pitch of all the native speakers was higher in the predicate adjective "happy" than in the subject pronoun "I" by 0.18 in ratio on average (Table 7). However, most of the Japanese students kept the same pitch level in "happy" as in "I" (+0.00 on overall average) (Table 8). This makes their pitch rise in "happy" from the preceding word even less prominent than that of the native speakers. As a result, it is less likely to be perceived as a sentence stress on the adjective.

The protrusion of the pitch in "happy" is obvious in the pitch contour of NS1 (an increase from the pitch in "I" by 0.35 in ratio) (Figure 10 and Table 7). In contrast those of JS4 and JS1 are flatter and do not show any significant rise in their pitch (Figures 11 and 12). In their speech, the pitch in "happy" either becomes lower than that in "I" (a decrease by 0.14 for JS4) or remains almost the same (a change by -0.03 for JS 1) (Figures 11 and 12 and Table 8). These examples indicate the Japanese students' tendency not to raise the pitch high enough for clear marking of a sentence stress in the predicate adjective.

## 5. Conclusion

### 5.1 Findings

In this study it was found that the Japanese students tend not to raise their pitch in predicate verbs at all or not to raise it high enough to make an obvious prominence in predicate adjectives or intensifiers as native speakers do. In most cases the Japanese students' pitch in subject pronouns is the same as or higher than that in predicate verbs, adjectives, or intensifiers. Their pitch tends to go up more positively in the subject pronoun immediately before the predicate verb in a sentence-initial clause. All these features of the Japanese students' typical pitch patterns contribute to the lack of perceivable sentence stresses on the predicate verbs, adjectives or intensifiers in their speech.

### 5.2 Suggestions for the Following Research

In this study the main purpose was to observe some characteristics of Japanese students' pitch patterns in relation to sentence stresses in comparison with those of native speakers. Due to the great amount of time needed for the measurement of the frequencies in words, the number of sample sentences was limited. In the next study the data should be taken from more samples and be statistically analyzed to see whether the tendencies found in this study will be supported more positively.

It is also important to select texts without multiple interpretations on emphasis. Two

native speakers used a higher pitch in the subject pronoun than in "very" in Target 3. One of them commented that "I" had been naturally emphasized in contrast with other things that could keep the person busy. Such a context where a semantic emphasis could be placed on the subject pronoun should be avoided.

Based on the findings of this study and the following research I will create exercises for students to acquire basic pitch patterns for English sentence stresses by comparing their pitch contours with those of native speakers with the help of phonetic analysis software. In such exercises a special focus will be placed on practicing an acute pitch rise in verbs and other content words in the predicates for sentence stresses. In addition students will learn not to raise their pitch in unstressed subject pronouns by utilizing visual feedback of their pronunciation. It may also help to incorporate text analyses to recognize pronouns as old information. The effectiveness of practice assisted by acoustic analysis software should be investigated in relation to the acquisition of English sentence stresses in further research.

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**Table 1: Native Speakers' Pitch Difference Between the Words in "If I knew"**

| Speaker | Sex | Target 1 | If | I | knew | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|
| NS1 | F | Time (sec) | 5,800 | 5,994 | 6,193 | | 6.19 | 7.38 |
| | | Frequency (Hz) | 183 | 162 | 244 | 155 | 244 | 65 |
| | | Ratio to Mean | 1.18 | 1.05 | 1.57 | | | |
| | | Difference | | −0.14 | +0.53 | | | |
| NS2 | M | Time (sec) | 8,434 | 8,623 | 8,934 | | 9,903 | 10,223 |
| | | Frequency (Hz) | 145 | 124 | 193 | 149 | 210 | 88 |
| | | Ratio to Mean | 0.97 | 0.83 | 1.30 | | | |
| | | Difference | | −0.14 | +0.46 | | | |
| NS3 | F | Time (sec) | 7,993 | 8,144 | 8,373 | | 8.37 | 9.6 |
| | | Frequency (Hz) | 207 | 210 | 288 | 206 | 288 | 123 |
| | | Ratio to Mean | 1.00 | 1.02 | 1.40 | | | |
| | | Difference | | +0.01 | +0.38 | | | |
| NS4 | F | Time (sec) | 10,022 | 10,183 | 10,411 | | 10.4 | 11.3 |
| | | Frequency (Hz) | 192 | 193 | 246 | 205 | 246 | 164 |
| | | Ratio to Mean | 0.94 | 0.94 | 1.20 | | | |
| | | Difference | | +0.00 | +0.26 | | | |
| NS5 | M | Time (sec) | 9,033 | 9,203 | 9,394 | | 9,024 | 10,404 |
| | | Frequency (Hz) | 107 | 98 | 121 | 101 | 129 | 73 |
| | | Ratio to Mean | 1.06 | 0.97 | 1.20 | | | |
| | | Difference | | −0.09 | +0.23 | | | |
| NS6 | M | Time (sec) | 7,133 | 7,303 | 7,453 | | 7,113 | 8,504 |
| | | Frequency (Hz) | 131 | 125 | 154 | 140 | 188 | 91 |
| | | Ratio to Mean | 0.94 | 0.89 | 1.10 | | | |
| | | Difference | | −0.04 | +0.21 | | | |
| | | NS Average (Difference) | | −0.06 | +0.34 | | | |

Table 2: Japanese Students' Pitch Difference Between the Words in "If I knew"

| Speaker | Sex | Target 1 | If | I | knew | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|
| JS1 | F | Time (sec) | 8,685 | 8,972 | 9,206 | | 9.59 | 10.42 |
| | | Frequency (Hz) | 233 | 247 | 202 | 208 | 250 | 166 |
| | | Ratio to Mean | 1.12 | 1.19 | 0.97 | | | |
| | | Difference | | +0.07 | −0.22 | | | |
| JS2 | F | Time (sec) | 7,994 | 8,244 | 8,632 | 9 | 8.08 | 10.24 |
| | | Frequency (Hz) | 289 | 262 | 249 | 254 | 324 | 183 |
| | | Ratio to Mean | 1.14 | 1.03 | 0.98 | | | |
| | | Difference | | −0.11 | −0.05 | | | |
| JS3 | F | Time (sec) | 6,313 | 6,634 | 6,882 | | 7.01 | 8.22 |
| | | Frequency (Hz) | 210 | 251 | 200 | 201 | 308 | 94 |
| | | Ratio to Mean | 1.04 | 1.25 | 1.00 | | | |
| | | Difference | | +0.20 | −0.25 | | | |
| JS4 | F | Time (sec) | 7,464 | 7,724 | 8,016 | | 8.77 | 9.85 |
| | | Frequency (Hz) | 242 | 240 | 241 | 226 | 266 | 185 |
| | | Ratio to Mean | 1.07 | 1.06 | 1.07 | | | |
| | | Difference | | −0.01 | +0.00 | | | |
| JS5 | F | Time (sec) | 11,134 | 11,534 | 11,832 | | 11.99 | 11.7 |
| | | Frequency (Hz) | 254 | 284 | 209 | 245 | 288 | 202 |
| | | Ratio to Mean | 1.04 | 1.16 | 0.85 | | | |
| | | Difference | | +0.12 | −0.31 | | | |
| JS6 | F | Time (sec) | 7,255 | 7,523 | 7,824 | | 8.86 | 9.38 |
| | | Frequency (Hz) | 236 | 231 | 213 | 240 | 283 | 196 |
| | | Ratio to Mean | 0.98 | 0.96 | 0.89 | | | |
| | | Difference | | −0.02 | −0.08 | | | |
| JS7 | F | Time (sec) | 7,984 | 8,400 | 8,723 | | 9.69 | 10.7 |
| | | Frequency (Hz) | 240 | 242 | 218 | 175 | 256 | 94 |
| | | Ratio to Mean | 1.37 | 1.38 | 1.25 | | | |
| | | Difference | | +0.01 | −0.14 | | | |
| JS8 | F | Time (sec) | 10,005 | 10,222 | 10,507 | 11 | 10.22 | 11.92 |
| | | Frequency (Hz) | 122 | 311 | 292 | 193 | 311 | 74 |
| | | Ratio to Mean | 0.63 | 1.61 | 1.51 | | | |
| | | Difference | | +0.98 | −0.10 | | | |
| JS9 | F | Time (sec) | 7,602 | 7,961 | 8,222 | | 8.9 | 9.57 |
| | | Frequency (Hz) | 242 | 251 | 209 | 222 | 254 | 189 |
| | | Ratio to Mean | 1.09 | 1.13 | 0.94 | | | |
| | | Difference | | +0.04 | −0.19 | | | |
| JS10 | F | Time (sec) | 7,722 | 8,094 | 8,324 | | 7.39 | 7.86 |
| | | Frequency (Hz) | 251 | 277 | 200 | 217 | 263 | 171 |
| | | Ratio to Mean | 1.16 | 1.28 | 0.92 | | | |
| | | Difference | | +0.12 | −0.35 | | | |
| JS11 | F | Time (sec) | 8,214 | 8,467 | 8,800 | | 8.97 | 10.34 |
| | | Frequency (Hz) | 201 | 215 | 200 | 214 | 266 | 162 |
| | | Ratio to Mean | 0.94 | 1.00 | 0.93 | | | |
| | | Difference | | +0.07 | −0.07 | | | |
| JS12 | F | Time (sec) | 5,934 | 6,252 | 6,532 | | 5.9 | 7.63 |
| | | Frequency (Hz) | 238 | 226 | 208 | 228 | 272 | 184 |
| | | Ratio to Mean | 1.04 | 0.99 | 0.91 | | | |
| | | Difference | | −0.05 | −0.08 | | | |
| | | JS Average (Difference) | | +0.13 | −0.16 | | | |

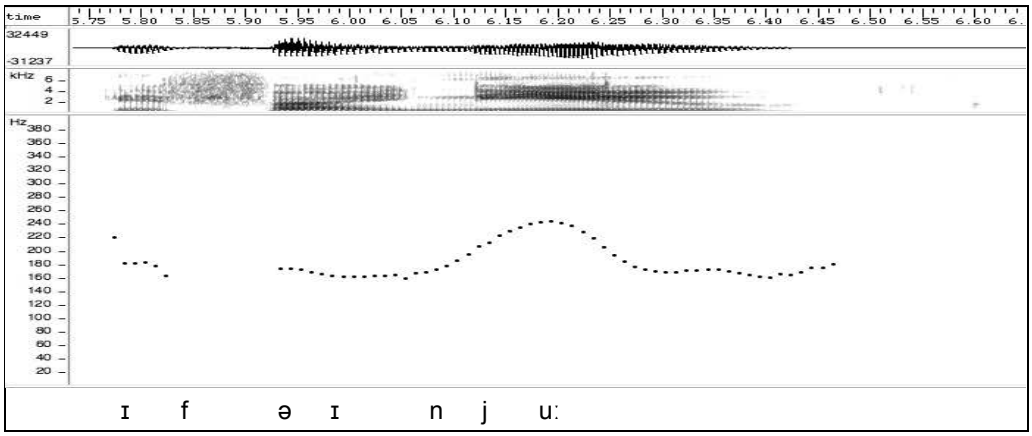


Figure 1：Native Speaker's (NS1) Pitch Contour of " If I knew "

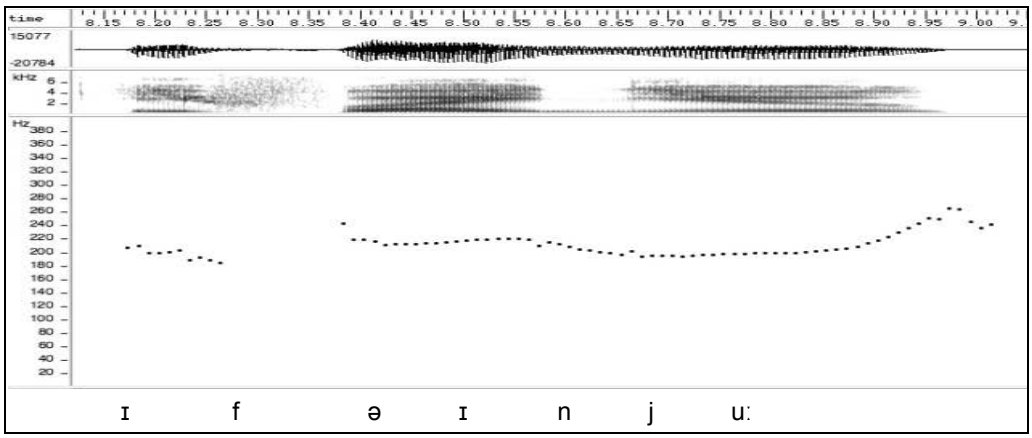


Figure 2：Japanese Student's (JS11) Pitch Contour of " If I knew "

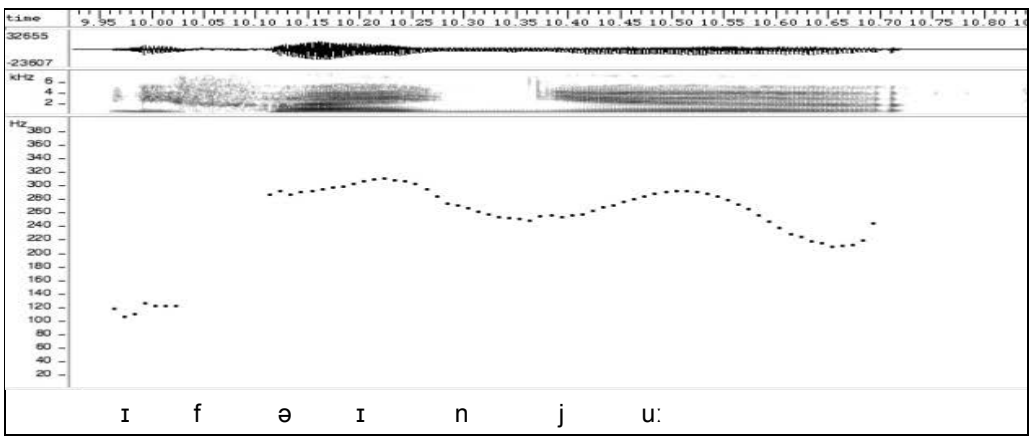


Figure 3：Japanese Student's (JS8) Pitch Contour of " If I knew "

Table 3: Native Speakers' Pitch Difference Between the Words in "than I thought"

| Speaker | Sex | Target 2 | than | I | thought | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|
| NS1 | F | Time (sec) | 10,550 | 10,714 | 10,943 | | 10,193 | 11,064 |
| | | Frequency (Hz) | 155 | 137 | 187 | 183 | 253 | 112 |
| | | Ratio to Mean | 0.85 | 0.75 | 1.02 | | | |
| | | Difference | | −0.10 | +0.27 | | | |
| NS2 | M | Time (sec) | 10,854 | 10,997 | 11,254 | | 11,232 | 10,763 |
| | | Frequency (Hz) | 119 | 127 | 194 | 162 | 239 | 85 |
| | | Ratio to Mean | 0.73 | 0.78 | 1.20 | | | |
| | | Difference | | +0.05 | +0.41 | | | |
| NS3 | F | Time (sec) | 9,856 | 9,945 | 10,217 | | 10,174 | 9,112 |
| | | Frequency (Hz) | 179 | 167 | 209 | 167 | 256 | 78 |
| | | Ratio to Mean | 1.07 | 1.00 | 1.25 | | | |
| | | Difference | | −0.07 | +0.25 | | | |
| NS4 | F | Time (sec) | 9,823 | 9,972 | 10,174 | | 9,024 | 10,264 |
| | | Frequency (Hz) | 177 | 172 | 186 | 157 | 233 | 81 |
| | | Ratio to Mean | 1.13 | 1.10 | 1.18 | | | |
| | | Difference | | −0.03 | +0.09 | | | |
| NS5 | M | Time (sec) | 10,675 | 10,845 | 11,064 | | 10,403 | 10,613 |
| | | Frequency (Hz) | 103 | 90 | 125 | 125 | 163 | 87 |
| | | Ratio to Mean | 0.82 | 0.72 | 1.00 | | | |
| | | Difference | | −0.10 | +0.28 | | | |
| NS6 | M | Time (sec) | 10,328 | 16,487 | 10,658 | | 10,084 | 10,503 |
| | | Frequency (Hz) | 111 | 102 | 125 | 150 | 202 | 97 |
| | | Ratio to Mean | 0.74 | 0.68 | 0.83 | | | |
| | | Difference | | −0.06 | +0.15 | | | |
| | | NS Average (Difference) | | -0.05 | +0.24 | | | |

**Table 4: Japanese Students' Pitch Difference Between the Words in "than I thought"**

| Speaker | Sex | Target 2 | than | I | thought | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|
| JS1 | F | Time (sec) | 12,013 | 12,313 | 12,535 | | 11,014 | 12,683 |
| | | Frequency (Hz) | 203 | 219 | 202 | 237 | 306 | 167 |
| | | Ratio to Mean | 0.86 | 0.92 | 0.85 | | | |
| | | Difference | | +0.07 | −0.07 | | | |
| JS2 | F | Time (sec) | 19,754 | 20,080 | 20,324 | | 18,750 | 20,451 |
| | | Frequency (Hz) | 213 | 220 | 219 | 244 | 320 | 168 |
| | | Ratio to Mean | 0.87 | 0.90 | 0.90 | | | |
| | | Difference | | +0.03 | −0.00 | | | |
| JS3 | F | Time (sec) | 9,873 | 10,105 | 10,413 | | 9,633 | 10,384 |
| | | Frequency (Hz) | 191 | 183 | 103 | 164 | 242 | 86 |
| | | Ratio to Mean | 1.16 | 1.12 | 0.63 | | | |
| | | Difference | | −0.05 | −0.49 | | | |
| JS4 | F | Time (sec) | 11,853 | 12,056 | 12,354 | | 10,799 | 11,155 |
| | | Frequency (Hz) | 231 | 233 | 243 | 212 | 298 | 126 |
| | | Ratio to Mean | 1.09 | 1.10 | 1.15 | | | |
| | | Difference | | +0.01 | +0.05 | | | |
| JS5 | F | Time (sec) | 15,689 | 16,304 | 16,313 | | 14,665 | 16,454 |
| | | Frequency (Hz) | 211 | 222 | 249 | 195 | 308 | 81 |
| | | Ratio to Mean | 1.08 | 1.14 | 1.28 | | | |
| | | Difference | | +0.06 | +0.14 | | | |
| JS6 | F | Time (sec) | 11,074 | 11,314 | 11,546 | | 11,184 | 11,594 |
| | | Frequency (Hz) | 206 | 216 | 120 | 229 | 353 | 104 |
| | | Ratio to Mean | 0.90 | 0.94 | 0.52 | | | |
| | | Difference | | +0.04 | −0.42 | | | |
| JS7 | F | Time (sec) | 12,821 | 13,255 | 13,504 | | 11,081 | 13,624 |
| | | Frequency (Hz) | 254 | 226 | 115 | 205 | 313 | 96 |
| | | Ratio to Mean | 1.24 | 1.10 | 0.56 | | | |
| | | Difference | | −0.14 | −0.54 | | | |
| JS8 | F | Time (sec) | 12,756 | 12,947 | 13,221 | | 11,863 | 13,343 |
| | | Frequency (Hz) | 233 | 202 | 201 | 232 | 366 | 98 |
| | | Ratio to Mean | 1.00 | 0.87 | 0.87 | | | |
| | | Difference | | −0.13 | −0.00 | | | |
| JS9 | F | Time (sec) | 12,522 | 12,875 | 13,793 | | 11,472 | 12,689 |
| | | Frequency (Hz) | 236 | 216 | 123 | 188 | 288 | 87 |
| | | Ratio to Mean | 1.26 | 1.15 | 0.65 | | | |
| | | Difference | | −0.11 | −0.49 | | | |
| JS10 | F | Time (sec) | 12,832 | 13,113 | 13,337 | | 11,970 | 13,042 |
| | | Frequency (Hz) | 201 | 195 | 211 | 195 | 294 | 96 |
| | | Ratio to Mean | 1.03 | 1.00 | 1.08 | | | |
| | | Difference | | −0.03 | +0.08 | | | |
| JS11 | F | Time (sec) | 13,008 | 13,224 | 13,603 | | 12,077 | 13,663 |
| | | Frequency (Hz) | 189 | 185 | 178 | 159 | 229 | 88 |
| | | Ratio to Mean | 1.19 | 1.16 | 1.12 | | | |
| | | Difference | | −0.03 | −0.04 | | | |
| JS12 | F | Time (sec) | 10,585 | 10,804 | 11,054 | | 9,564 | 11,162 |
| | | Frequency (Hz) | 208 | 210 | 209 | 166 | 267 | 64 |
| | | Ratio to Mean | 1.25 | 1.27 | 1.26 | | | |
| | | Difference | | +0.01 | −0.01 | | | |
| | | JS Average (Difference) | | −0.03 | −0.13 | | | |

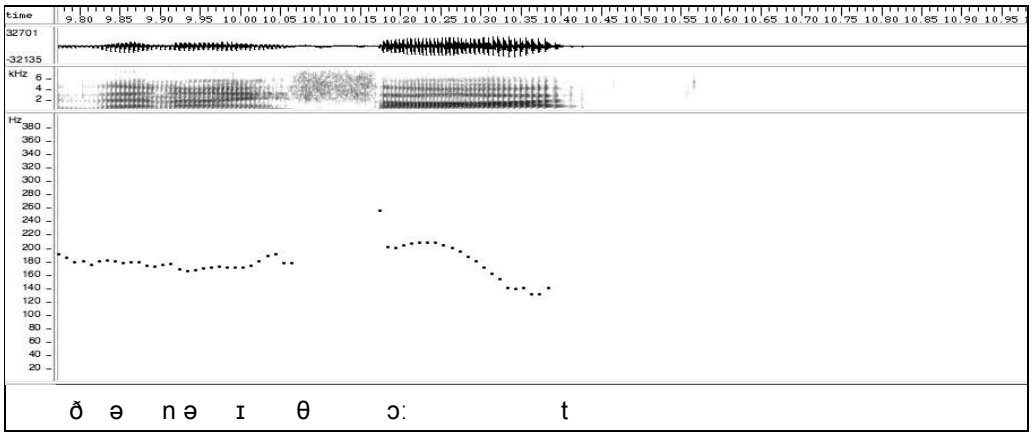


Figure 4： Native Speaker's (NS3) Pitch Contour of " than I thought "

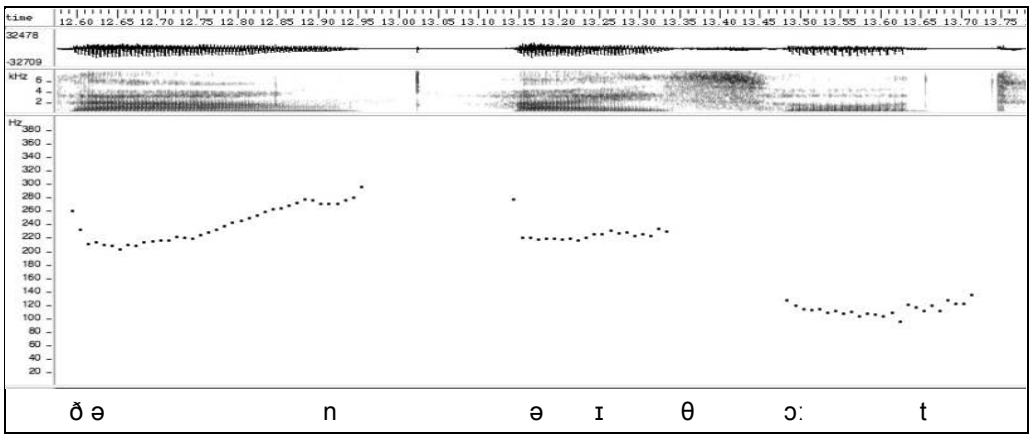


Figure 5： Japanese Student's (JS7) Pitch Contour of " than I thought "

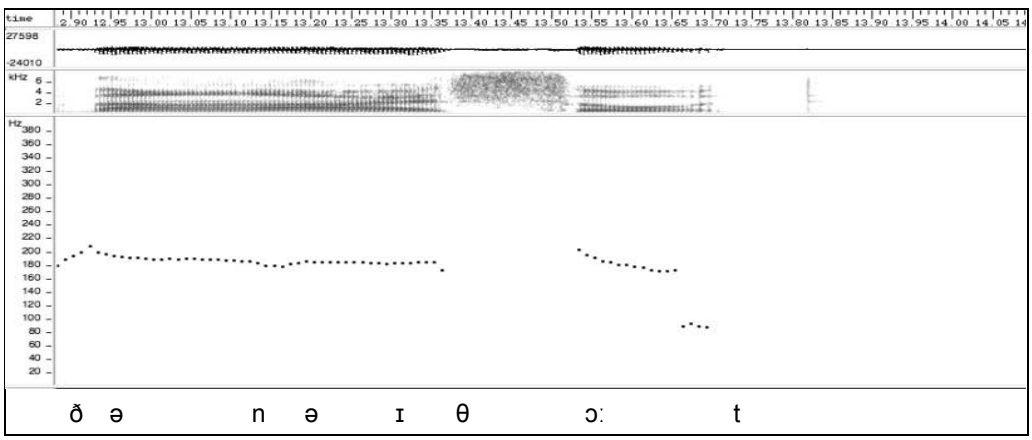


Figure 6： Japanese Student's (JS11) Pitch Contour of " than I thought "

**Table 5 : Native Speakers' Pitch Difference Between the Words in "I have been very busy"**

| Speaker | Sex | Target 3 | I | have | been | very | busy | very-I | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NS1 | F | Time (sec) | 4,421 | 4,447 | 4,723 | 5,083 | 5,293 | | | 5,083 | 4,281 |
| | | Frequency (Hz) | 259 | 259 | 214 | 329 | 220 | | 218 | 329 | 106 |
| | | Ratio to Mean | 1.19 | 1.19 | 0.98 | 1.51 | 1.01 | | | | |
| | | Difference | | +0.00 | −0.21 | +0.53 | −0.50 | +0.32 | | | |
| NS2 | M | Time (sec) | 4,613 | 4,644 | 4,760 | 5,053 | 5,214 | | | 5,053 | 6,144 |
| | | Frequency (Hz) | 159 | 140 | 183 | 229 | 175 | | 166 | 229 | 103 |
| | | Ratio to Mean | 0.96 | 0.84 | 1.10 | 1.38 | 1.05 | | | | |
| | | Difference | | −0.11 | +0.26 | +0.28 | −0.33 | +0.42 | | | |
| NS3 | F | Time (sec) | 3,734 | 3,834 | 3,995 | 4,315 | 4,580 | | | 4,315 | 5,714 |
| | | Frequency (Hz) | 217 | 241 | 243 | 286 | 231 | | 176 | 286 | 66 |
| | | Ratio to Mean | 1.23 | 1.37 | 1.38 | 1.63 | 1.31 | | | | |
| | | Difference | | +0.14 | +0.01 | +0.24 | −0.31 | +0.39 | | | |
| NS4 | F | Time (sec) | 4,014 | 4,043 | 4,136 | 4,324 | 4,610 | | | 4,014 | 5,771 |
| | | Frequency (Hz) | 299 | 275 | 274 | 246 | 229 | | 191 | 299 | 82 |
| | | Ratio to Mean | 1.57 | 1.44 | 1.43 | 1.29 | 1.20 | | | | |
| | | Difference | | −0.13 | −0.01 | −0.15 | −0.09 | −0.28 | | | |
| NS5 | M | Time (sec) | 4,554 | 4,703 | 5,083 | 5,484 | 5,654 | | | 4,554 | 5,874 |
| | | Frequency (Hz) | 157 | 142 | 127 | 144 | 125 | | 122 | 157 | 87 |
| | | Ratio to Mean | 1.29 | 1.16 | 1.04 | 1.18 | 1.02 | | | | |
| | | Difference | | −0.12 | −0.12 | +0.14 | −0.16 | −0.11 | | | |
| NS6 | M | Time (sec) | 4,383 | 4,445 | 4,535 | 4,816 | 5,025 | | | 4,954 | 5,964 |
| | | Frequency (Hz) | 136 | 116 | 144 | 159 | 153 | | 145 | 207 | 82 |
| | | Ratio to Mean | 0.94 | 0.80 | 0.99 | 1.10 | 1.06 | | | | |
| | | Difference | | −0.14 | +0.19 | +0.10 | −0.04 | +0.16 | | | |
| | | NS Average (Difference) | | −0.06 | +0.02 | +0.19 | −0.24 | +0.15 | | | |

Table 6: Japanese Students' Pitch Difference Between the Words in "I have been very busy"

| Speaker | Sex | Target 3 | I | have | been | very | busy | very-I | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JS1 | F | Time (sec) | 4,535 | 4,665 | 4,933 | 5,453 | 5,677 | | | 5,853 | 5,193 |
| | | Frequency (Hz) | 277 | 241 | 231 | 234 | 240 | | 202 | 294 | 109 |
| | | Ratio to Mean | 1.37 | 1.19 | 1.14 | 1.16 | 1.19 | | | | |
| | | Difference | | −0.18 | −0.05 | +0.01 | +0.03 | −0.21 | | | |
| JS2 | F | Time (sec) | 10,411 | 10,554 | 11,462 | 11,876 | 12,121 | | | 13,701 | 14,562 |
| | | Frequency (Hz) | 325 | 286 | 268 | 266 | 257 | | 263 | 327 | 198 |
| | | Ratio to Mean | 1.24 | 1.09 | 1.02 | 1.01 | 0.98 | | | | |
| | | Difference | | −0.15 | −0.07 | −0.01 | −0.03 | −0.22 | | | |
| JS3 | F | Time (sec) | 3,301 | 3,408 | 3,675 | 4,104 | 4,286 | | | 3,346 | 4,583 |
| | | Frequency (Hz) | 221 | 230 | 201 | 225 | 202 | | 174 | 253 | 94 |
| | | Ratio to Mean | 1.27 | 1.32 | 1.16 | 1.29 | 1.16 | | | | |
| | | Difference | | +0.05 | −0.17 | +0.14 | −0.13 | +0.02 | | | |
| JS4 | F | Time (sec) | 3,834 | 3,947 | 4,355 | 4,664 | 4,844 | | | 3,834 | 4,422 |
| | | Frequency (Hz) | 296 | 280 | 254 | 249 | 252 | | 251 | 296 | 206 |
| | | Ratio to Mean | 1.18 | 1.12 | 1.01 | 0.99 | 1.00 | | | | |
| | | Difference | | −0.06 | −0.10 | −0.02 | +0.01 | −0.19 | | | |
| JS5 | F | Time (sec) | 6,683 | 6,923 | 7,293 | 7,919 | 8,162 | | | 10,305 | 10,076 |
| | | Frequency (Hz) | 267 | 277 | 223 | 275 | 241 | | 252 | 313 | 191 |
| | | Ratio to Mean | 1.06 | 1.10 | 0.88 | 1.09 | 0.96 | | | | |
| | | Difference | | +0.04 | −0.21 | +0.21 | −0.13 | +0.03 | | | |
| JS6 | F | Time (sec) | 3,316 | 3,464 | 3,724 | 4,592 | 4,724 | | | 3,195 | 4,095 |
| | | Frequency (Hz) | 251 | 272 | 243 | 263 | 249 | | 225 | 337 | 112 |
| | | Ratio to Mean | 1.12 | 1.21 | 1.08 | 1.17 | 1.11 | | | | |
| | | Difference | | +0.09 | −0.13 | +0.09 | −0.06 | +0.05 | | | |
| JS7 | F | Time (sec) | 3,474 | 3,604 | 3,984 | 4,501 | 4,834 | | | 4,242 | 5,075 |
| | | Frequency (Hz) | 275 | 259 | 233 | 242 | 242 | | 206 | 301 | 111 |
| | | Ratio to Mean | 1.33 | 1.26 | 1.13 | 1.17 | 1.17 | | | | |
| | | Difference | | −0.08 | −0.13 | +0.04 | +0.00 | −0.16 | | | |
| JS8 | F | Time (sec) | 4,854 | 4,974 | 5,224 | 5,534 | 6,148 | | | 4,974 | 7,823 |
| | | Frequency (Hz) | 276 | 312 | 262 | 232 | 225 | | 246 | 312 | 179 |
| | | Ratio to Mean | 1.12 | 1.27 | 1.07 | 0.94 | 0.91 | | | | |
| | | Difference | | +0.15 | −0.20 | −0.12 | −0.03 | −0.18 | | | |
| JS9 | F | Time (sec) | 3,804 | 3,947 | 4,226 | 4,813 | 5,016 | | | 5,854 | 7,125 |
| | | Frequency (Hz) | 257 | 250 | 224 | 239 | 232 | | 223 | 272 | 173 |
| | | Ratio to Mean | 1.15 | 1.12 | 1.00 | 1.07 | 1.04 | | | | |
| | | Difference | | −0.03 | −0.12 | +0.07 | −0.03 | −0.08 | | | |
| JS10 | F | Time (sec) | 3,962 | 4,102 | 4,511 | 4,864 | 5,104 | | | 3,992 | 4,294 |
| | | Frequency (Hz) | 294 | 255 | 227 | 239 | 243 | | 203 | 295 | 110 |
| | | Ratio to Mean | 1.45 | 1.26 | 1.12 | 1.18 | 1.20 | | | | |
| | | Difference | | −0.19 | −0.14 | +0.06 | +0.02 | −0.27 | | | |
| JS11 | F | Time (sec) | 4,725 | 4,843 | 5,115 | 5,486 | 5,800 | | | 4,725 | 8,273 |
| | | Frequency (Hz) | 259 | 241 | 205 | 215 | 200 | | 214 | 259 | 168 |
| | | Ratio to Mean | 1.21 | 1.13 | 0.96 | 1.00 | 0.93 | | | | |
| | | Difference | | −0.08 | −0.17 | +0.05 | −0.07 | −0.21 | | | |
| JS12 | F | Time (sec) | 3,683 | 3,850 | 4,074 | 4,514 | 4,694 | | | 5,153 | 6,354 |
| | | Frequency (Hz) | 227 | 226 | 218 | 212 | 210 | | 190 | 287 | 92 |
| | | Ratio to Mean | +1.19 | +1.19 | +1.15 | +1.12 | +1.11 | | | | |
| | | Difference | | −0.01 | −0.04 | −0.03 | −0.01 | −0.08 | | | |
| | | JS Average (Difference) | | −0.05 | −0.13 | +0.04 | −0.03 | -0.14 | | | |

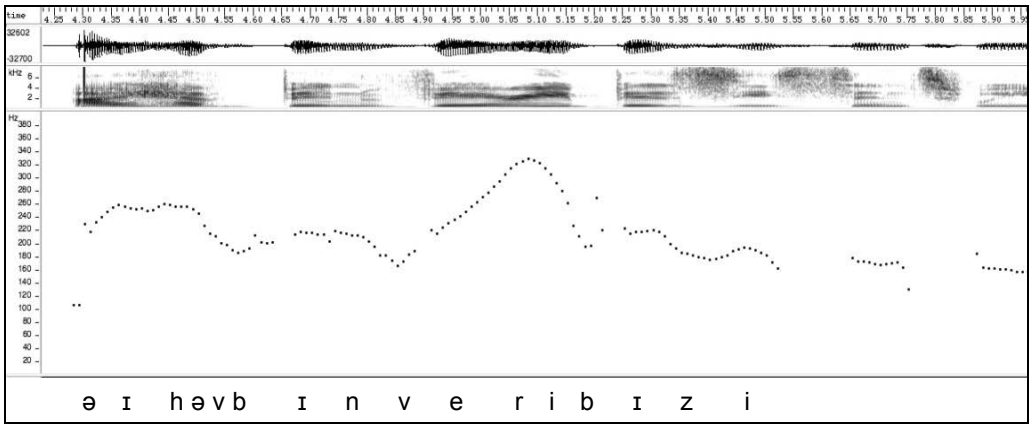


Figure 7： Native Speaker's (NS1) Pitch Contour of " I have been very busy "

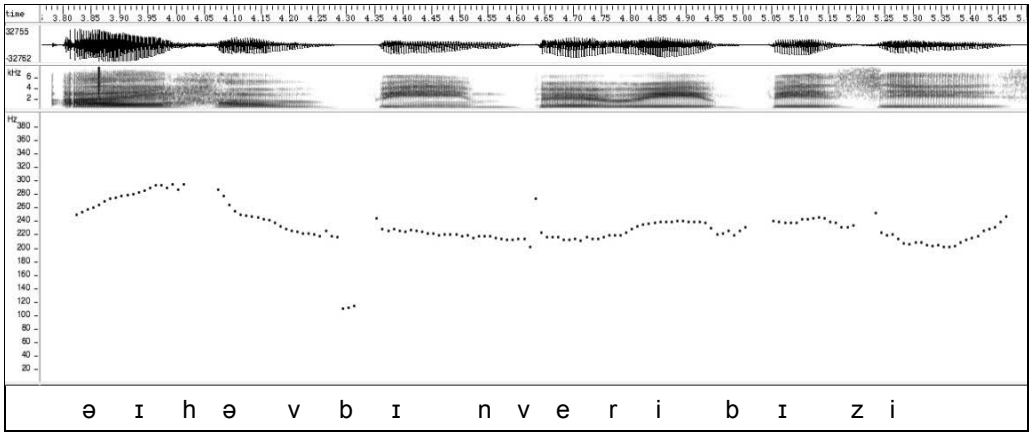


Figure 8： Japanese Student's (JS10) Pitch Contour of "I have been very busy "

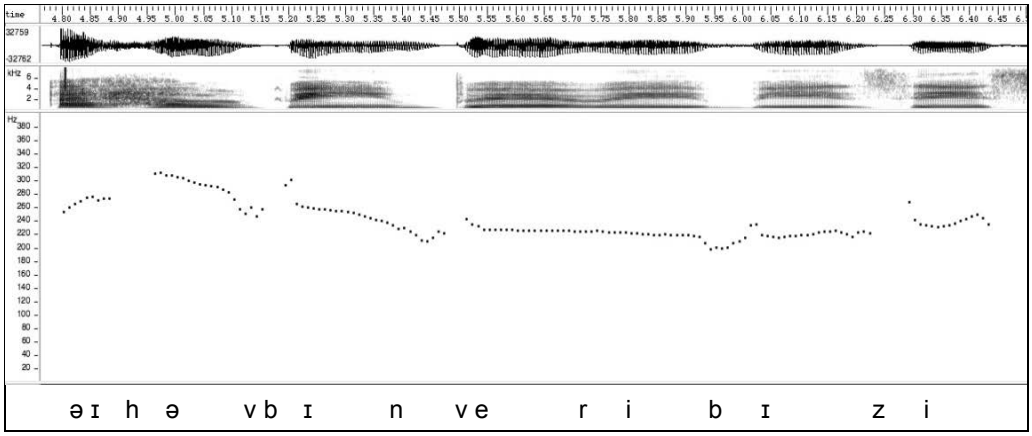


Figure 9： Japanese Student's (JS8) Pitch Contour of " I have been very busy "

Table 7: Native Speakers' Pitch Difference Between the Words in "I will be happy"

| Speaker | Sex | Target 4 | I | will | be | happy | happy-I | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|
| NS1 | F | Time (sec) | 35,584 | 35,622 | 35,753 | 35,964 | | | 33,452 | 37,032 |
| | | Frequency (Hz) | 181 | 182 | 204 | 244 | | 181 | 293 | 69 |
| | | Ratio to Mean | 1.00 | 1.01 | 1.13 | 1.35 | | | | |
| | | Difference | | +0.01 | +0.12 | +0.22 | +0.35 | | | |
| NS2 | M | Time (sec) | 34,064 | 34,112 | 34,222 | 34,464 | | | 32,664 | 32,481 |
| | | Frequency (Hz) | 145 | 136 | 129 | 164 | | 170 | 274 | 65 |
| | | Ratio to Mean | 0.85 | 0.80 | 0.76 | 0.96 | | | | |
| | | Difference | | −0.05 | −0.04 | +0.21 | +0.11 | | | |
| NS3 | F | Time (sec) | 30,274 | 30,383 | 30,533 | 30,915 | | | 28,594 | 31,958 |
| | | Frequency (Hz) | 187 | 197 | 187 | 212 | | 178 | 287 | 68 |
| | | Ratio to Mean | 1.05 | 1.11 | 1.05 | 1.19 | | | | |
| | | Difference | | +0.06 | −0.06 | +0.14 | +0.14 | | | |
| NS4 | F | Time (sec) | 31,314 | 31,413 | 31,524 | 31,674 | | | 30,312 | 30,820 |
| | | Frequency (Hz) | 240 | 244 | 238 | 263 | | 189 | 313 | 64 |
| | | Ratio to Mean | 1.27 | 1.29 | 1.26 | 1.39 | | | | |
| | | Difference | | +0.02 | −0.03 | +0.13 | +0.12 | | | |
| NS5 | M | Time (sec) | 30,514 | 30,690 | 30,824 | 32,123 | | | 29,948 | 32,095 |
| | | Frequency (Hz) | 105 | 105 | 101 | 117 | | 115 | 152 | 77 |
| | | Ratio to Mean | 0.91 | 0.91 | 0.88 | 1.02 | | | | |
| | | Difference | | +0.00 | −0.03 | +0.14 | +0.10 | | | |
| NS6 | M | Time (sec) | 32,825 | 32,893 | 32,972 | 33,103 | | | 31,813 | 34,029 |
| | | Frequency (Hz) | 127 | 120 | 117 | 162 | | 130 | 170 | 90 |
| | | Ratio to Mean | 0.98 | 0.92 | 0.90 | 1.25 | | | | |
| | | Difference | | −0.05 | −0.02 | +0.35 | +0.27 | | | |
| | | NS Average (Difference) | | +0.00 | −0.01 | +0.20 | +0.18 | | | |

**Table 8: Japanese Students' Pitch Difference Between the Words in "I will be happy"**

| Speaker | Sex | Target 4 | I | will | be | happy | happy-I | Mean | Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|
| JS1 | F | Time (sec) | 37,465 | 37,581 | 37,823 | 38,022 | | | 37,166 | 39,009 |
| | | Frequency (Hz) | 229 | 221 | 205 | 222 | | 211 | 332 | 89 |
| | | Ratio to Mean | 1.09 | 1.05 | 0.97 | 1.05 | | | | |
| | | Difference | | −0.04 | −0.08 | +0.08 | −0.03 | | | |
| JS2 | F | Time (sec) | 45,024 | 45,123 | 45,476 | 46,104 | | | 46,022 | 46,921 |
| | | Frequency (Hz) | 297 | 305 | 235 | 284 | | 258 | 356 | 159 |
| | | Ratio to Mean | 1.15 | 1.18 | 0.91 | 1.10 | | | | |
| | | Difference | | +0.03 | −0.27 | +0.19 | −0.05 | | | |
| JS3 | F | Time (sec) | 29,345 | 29,494 | 29,686 | 30,062 | | | 27,671 | 29,276 |
| | | Frequency (Hz) | 199 | 193 | 182 | 219 | | 191 | 276 | 106 |
| | | Ratio to Mean | 1.04 | 1.01 | 0.95 | 1.15 | | | | |
| | | Difference | | −0.03 | −0.06 | +0.19 | +0.10 | | | |
| JS4 | F | Time (sec) | 38,291 | 38,434 | 38,719 | 38,954 | | | 36,086 | 38,133 |
| | | Frequency (Hz) | 272 | 254 | 237 | 244 | | 198 | 309 | 87 |
| | | Ratio to Mean | 1.37 | 1.28 | 1.20 | 1.23 | | | | |
| | | Difference | | −0.09 | −0.09 | +0.04 | −0.14 | | | |
| JS5 | F | Time (sec) | 43,433 | 43,594 | 43,864 | 44,484 | | | 41,816 | 44,773 |
| | | Frequency (Hz) | 238 | 229 | 213 | 300 | | 209 | 315 | 102 |
| | | Ratio to Mean | 1.14 | 1.10 | 1.02 | 1.44 | | | | |
| | | Difference | | −0.04 | −0.08 | +0.42 | +0.30 | | | |
| JS6 | F | Time (sec) | 33,394 | 33,473 | 33,774 | 34,204 | | | 34,923 | 34,067 |
| | | Frequency (Hz) | 245 | 250 | 220 | 241 | | 230 | 351 | 109 |
| | | Ratio to Mean | 1.07 | 1.09 | 0.96 | 1.05 | | | | |
| | | Difference | | +0.02 | −0.13 | +0.09 | −0.02 | | | |
| JS7 | F | Time (sec) | 46,885 | 46,984 | 47,393 | 47,585 | | | 49,231 | 49,555 |
| | | Frequency (Hz) | 248 | 252 | 237 | 240 | | 205 | 322 | 87 |
| | | Ratio to Mean | 1.21 | 1.23 | 1.16 | 1.17 | | | | |
| | | Difference | | +0.02 | −0.07 | +0.01 | −0.04 | | | |
| JS8 | F | Time (sec) | 37,564 | 37,595 | 37,793 | 38,324 | | | 37,296 | 39,406 |
| | | Frequency (Hz) | 257 | 263 | 233 | 245 | | 212 | 340 | 84 |
| | | Ratio to Mean | 1.21 | 1.24 | 1.10 | 1.16 | | | | |
| | | Difference | | +0.03 | −0.14 | +0.06 | −0.06 | | | |
| JS9 | F | Time (sec) | 37,454 | 37,654 | 37,922 | 38,124 | | | 39,554 | 38,519 |
| | | Frequency (Hz) | 211 | 232 | 236 | 224 | | 200 | 299 | 100 |
| | | Ratio to Mean | 1.06 | 1.16 | 1.18 | 1.12 | | | | |
| | | Difference | | +0.11 | +0.02 | −0.06 | +0.07 | | | |
| JS10 | F | Time (sec) | 39,570 | 39,544 | 39,783 | 40,184 | | | 37,597 | 38,910 |
| | | Frequency (Hz) | 254 | 256 | 223 | 235 | | 186 | 280 | 92 |
| | | Ratio to Mean | 1.37 | 1.38 | 1.20 | 1.26 | | | | |
| | | Difference | | +0.01 | −0.18 | +0.06 | −0.10 | | | |
| JS11 | F | Time (sec) | 41,974 | 42,064 | 42,322 | 42,662 | | | 42,831 | 39,553 |
| | | Frequency (Hz) | 216 | 223 | 194 | 213 | | 197 | 266 | 128 |
| | | Ratio to Mean | 1.10 | 1.13 | 0.98 | 1.08 | | | | |
| | | Difference | | +0.04 | −0.15 | +0.10 | −0.02 | | | |
| JS12 | F | Time (sec) | 35,684 | 35,793 | 36,084 | 36,201 | | | 36,350 | 37,412 |
| | | Frequency (Hz) | 222 | 220 | 224 | 213 | | 187 | 280 | 93 |
| | | Ratio to Mean | 1.19 | 1.18 | 1.20 | 1.14 | | | | |
| | | Difference | | −0.01 | +0.02 | −0.06 | −0.05 | | | |
| | | JS Average (Difference) | | +0.00 | −0.10 | +0.09 | +0.00 | | | |

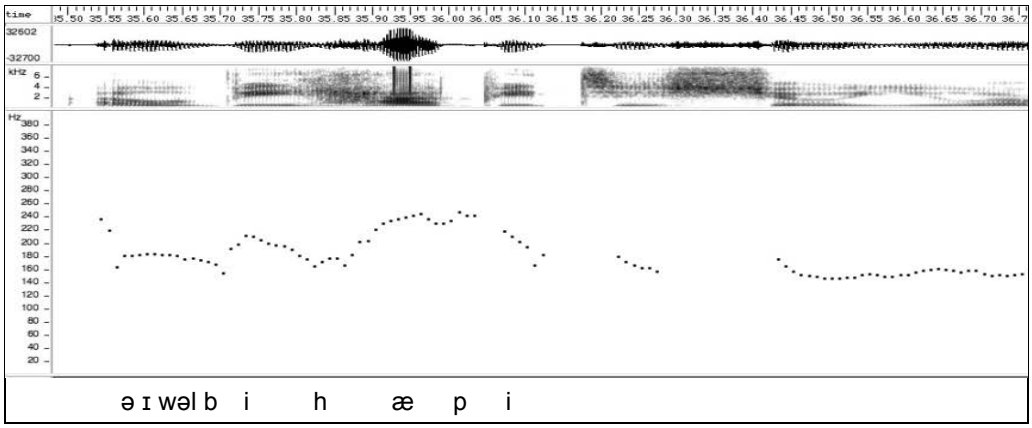


Figure 10： Native Speaker's (NS1) Pitch Contour of " I will be happy "

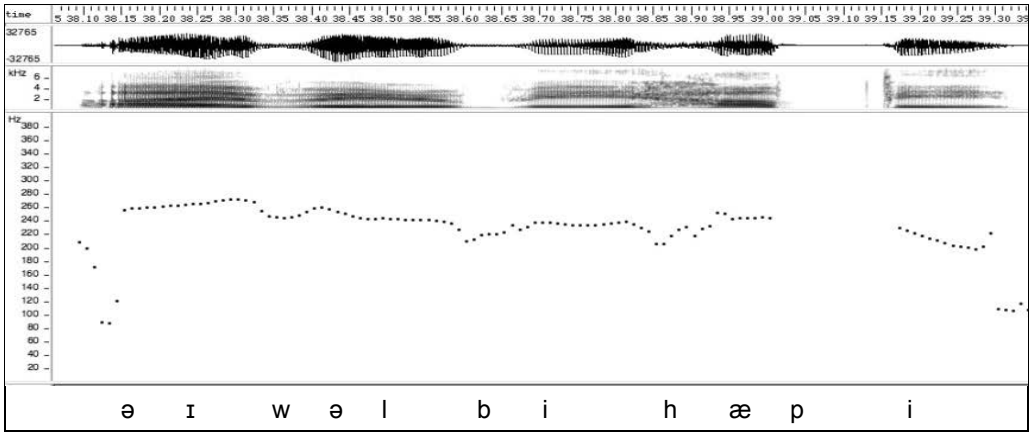


Figure 11： Japanese Student's (JS4) Pitch Contour of " I will be happy "

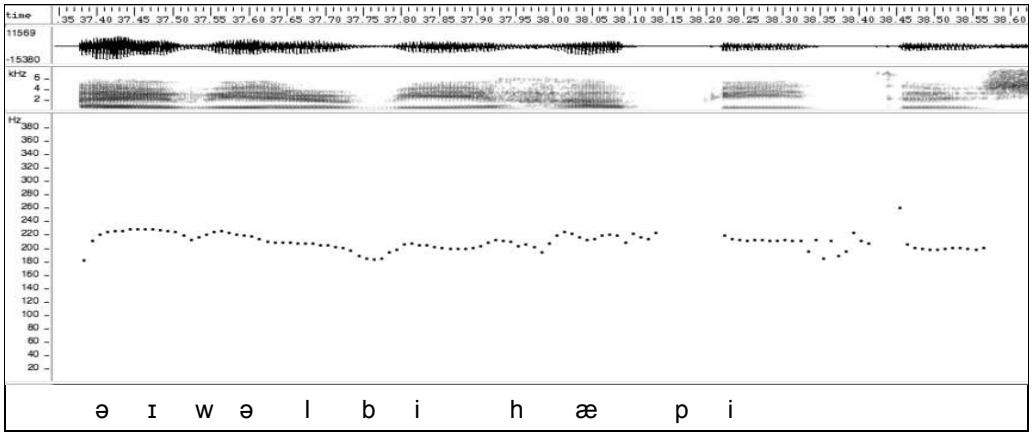


Figure 12： Japanese Student's (JS1) Pitch Contour of " I will be happy "