

Towards understanding how young Japanese female college students pronounce the letters of the English alphabet - Part V: complementary results of fundamental frequency analysis

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Abstract

This work extends our previous examinations related to the pitch frequency analysis of voice sounds measured out of a group of young Japanese female students as they recited the English alphabet. Sub-groups of Japanese students were compared with groups of native speakers. Statistical testing procedures across the groups were carried out pair-wisely in order to verify the predominance of a variety of spoken English over the students. It turned out that the groups of students were more related to British than North American English.

Keywords

English alphabet pronunciation, English sounds, fundamental frequency analysis, percentiles of pitch frequencies

1 INTRODUCTION

Over the past decades, English language education in Japanese schools have shifted to a paradigm focused on the ‘English as a communication tool’, so that one of the main aims of English classes nowadays is to educate students to be able to carry out basic communication in English language by the time they get graduated from high school [1] [2].

In this scope, issues related to pronunciation that Japanese students face during their learning processes have been topics of intense investigations for

quite a long time, with the focus being centered at the hurdles in learning English language ([3]-[6]). Unlike the reasoning adopted in these investigations, Izuta ([7], [8]) considered this problem from the pitch frequency analysis standpoint. In fact, they reported some particular results of pitch frequency and pitch frequency percentile analyses which were obtained by performing acoustical comparisons between the English sounds made by Japanese learners and native speakers. Their main motivation was the current view that the sound feature expressed by the pitch frequencies F0 rules over the perception of the sounds [9]. As a matter of fact, Barreda and Nearey [10] examined the influence of pitch frequencies on the vowel perception, whereas Binns and Culling [11] studied the relationship between the external disturbances and the speech perception; Carrol et al [12] investigated the interference of the noise on the reading of sentences in the cochlear implant users; Sugimoto [13] explored the models of the accent perception; Hillenbrand and Clark [14] focused on the differences in the male and female voice recognition mechanisms. Yet, Grahan [15] examined Japanese-(American) English bilinguals and showed the existence of differences in variation of fundamental frequency range as far as the narrative language is concerned. Comparisons of Japanese language with other languages have also been carried out. For example, van Bezooijen [16] compared the pitch frequencies of the speeches made by Japanese and Dutch women, and suggested that Japanese women had higher values. Interestingly, most of the experiments so far handled prosody with the smallest utterance unit being word.

Thus, in this investigation, unlike the prosody paradigm, we are concerned with the sounds (not phonics) of the alphabet, in order to make an acoustical characterization from the pitch standpoint. This investigation complements our previous reports [6, 7, 17], which suggested that the groups of students modulates the pitch frequencies differently from the group of native speakers, in the sense that it gives the details of the analyses of pitch frequencies.

Finally, this paper is organized as follows: the procedures are given in section 2, the results are presented in section 3; final discussion in section 4.

2 EXPERIMENTAL PROCEDURE

The experimental setup used to carry out the investigations is essentially the same as described previously.

2.1 Subjects

The participants were female students aged 18 to 21. Hereafter, the group consisting of all these students is called group JP, and this group was split into three groups: the group S1 of first-year students studying social sciences with 9 students, and the groups E1 and E2 of nine first-year and eight second-year students enrolled in the course of English literature and language, respectively. In addition, sounds of ten female speakers of Received Pronunciation and twenty female individuals of Standard American English were recorded. These groups were named group UK and US, respectively. All native speakers were in age range between late 20s and 30s and allegedly college graduated healthy native speakers of English.

2.2 Data Processing

A personal computer powered by the operating system Microsoft windows 8.1 and running Pratt and Microsoft excel 2013 were used to carry out the data processing.

3 RESULTS

In this section we present the results of the analyses. Note that results of the pilot experiments were presented in [6], where some brief results of this general pitch frequency analysis were given, and in [7], where the analysis of pitch frequency percentiles were considered. Thus this report basically presents the details of the previous investigations.

Letter A

The means and averages were computed as JP (231, 20), S1(226, 17), E1(241, 17), E2 (225, 23), UK(224, 60), and US(213, 63). The results given in Fig. 1 show that JP, S1, and E2 were statistically not different from UK and US, whereas E1 only from UK when paired up for comparisons. Looking at the comparisons of the percentiles (Fig. 2), the pairs JP and UK, S1 and UK, S1 and US, E1 and UK, E2 and UK, and E2 and US are not statistically different at percentage points. Yet, JP and US were different at 25%, whereas E1 and UK at 0% to 25%. These indicate that the percentiles expresses pretty well the result comparisons along the whole utterance lengths.

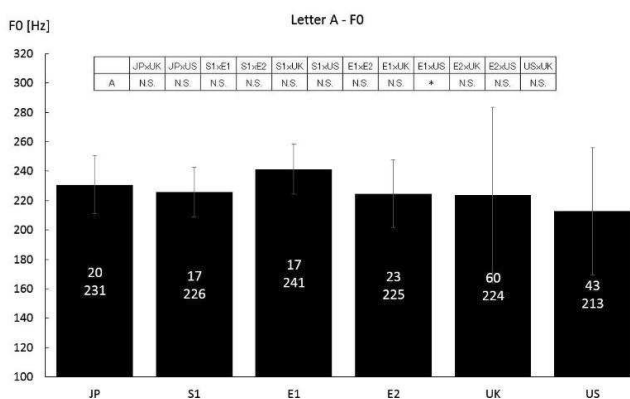


Fig. 1 Pitch frequency testing. Letter A.

A	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 2 Percentile testing. Letter A.

Letter B

Fig. 3 depicts the F0s, which had the means and standard deviations as JP (220, 21), S1(223, 12), E1(230, 17), E2 (204, 25), UK(218, 37), and US(202, 33). It tells us that the groups of students were statistically not different from UK. As for the comparisons with US, only the pair E2 and US came up ‘N.S.’ As far as the percentiles are concerned (Fig.4), the pairs JP and UK, S1 and UK, E1 and S1, E2 and UK, and E2 and US were all ‘N.S.’ at all percentage points. Note that the pairs JP and US, S1 and US, and E1 and UK were statistically different mostly at points in the first quartile of the sound lengths.

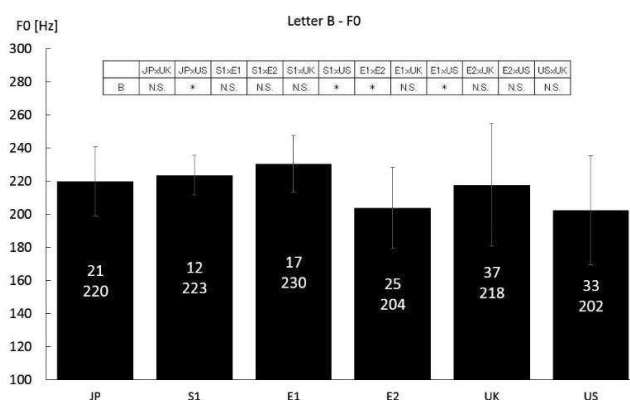


Fig. 3 Pitch frequency testing. Letter B.

B	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 4 Percentile testing. Letter B.

Letter C

Fig. 5 presents the comparison results for F0s across the groups, which were expressed in terms of averages and standard variations as JP (235, 29), S1(237, 22), E1(251, 28), E2 (215, 26), UK(232, 42), and US(205, 35). It turned out that the groups of students were all statistically not different from UK. Moreover, E2 and US were also ‘N.S.’ For the comparisons of the percentiles shown in Fig. 6, the pairs JP and UK, S1 and UK, and E1 and UK were all not different at all percentage points, whereas the pair E2 and UK failed only at 90%. The groups of students and US were different mainly at the first halves of the utterances.

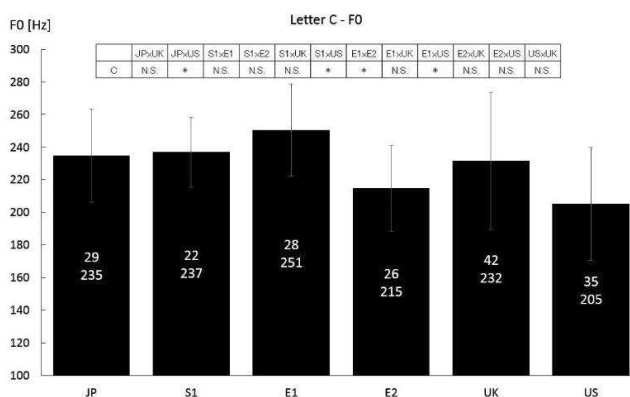


Fig. 5 Pitch frequency testing. Letter C.

C	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	*
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 6 Percentile testing. Letter C.

Letter D

The testing results of the F0s across the groups is shown in Fig. 7. There the values of the means and standard deviations were JP (223, 20), S1(228, 18), E1(230, 21), E2 (210, 18), UK(218, 50), and US(199, 28). All the groups of students paired up with UK as well as the pair of E2 and US were statistically not different. Moreover, the percentiles comparisons of these pairings shown in Fig.8 give that they were also ‘N.S.’ at all percentage points. The pairs of JP and US, S1 and US, and E1 and US differed from each other at 0%, 10%, and 25% suggesting that the students attempted to modulate the sounds as the utterances went on.

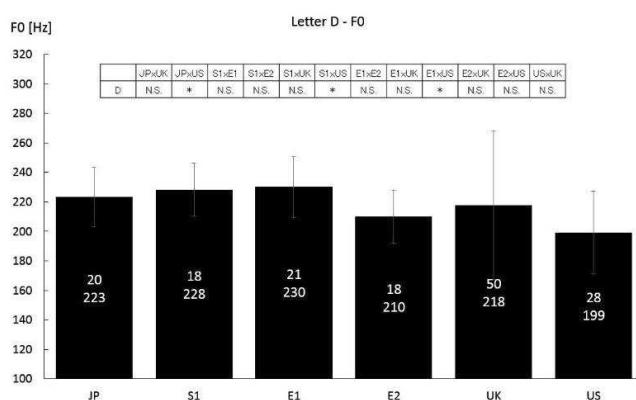


Fig. 7 Pitch frequency testing. Letter D.

D	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 8 Percentile testing. Letter D.

Letter D

The testing results of the F0s across the groups is shown in Fig. 7. There the values of the means and standard deviations were JP (223, 20), S1(228, 18), E1(230, 21), E2 (210, 18), UK(218, 50), and US(199, 28). All the groups of students paired up with UK as well as the pair of E2 and US were statistically not different. Moreover, the percentiles comparisons of these pairings shown in Fig.8 give that they were also ‘N.S.’ at all percentage points. The pairs of JP and US, S1 and US, and E1 and US differed from each other at 0%, 10%, and 25% suggesting that the students attempted to modulate the sounds as the utterances went on.

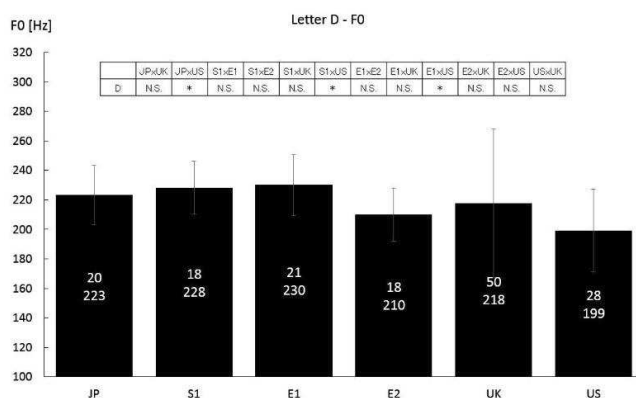


Fig. 7 Pitch frequency testing. Letter D.

D	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 8 Percentile testing. Letter D.

Letter F

The mean and standard deviation values of F0s characterized the groups as JP(251, 38), S1(267, 41), E1(253, 32), E2 (230, 33), UK(241, 37), and US(222, 45), and the statistical comparisons of the groups yielded the results as in Fig. 11. The pairs of JP and US, E1 and US, E2 and UK, and E2 and US were statistically not different. These results were also valid for the comparisons of the percentiles at almost all points (Fig. 12). Interestingly, nevertheless the pair of E1 and UK were different, their percentiles were not different at all percentage points.

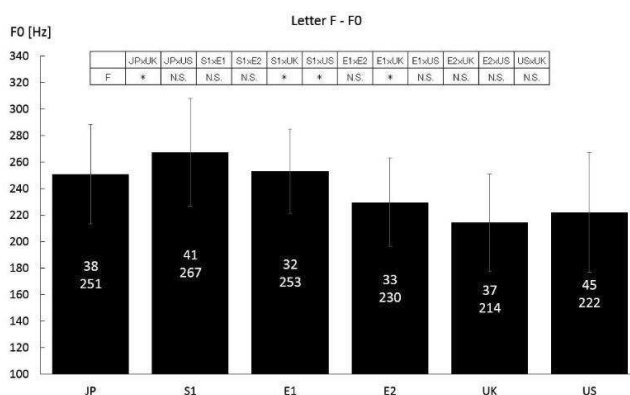


Fig. 11 Pitch frequency testing. Letter F.

F	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 12 Percentile testing. Letter F.

Letter G

The comparison graph of F0s is outlined in Fig. 13. The F0s representing the groups are written as JP(221, 21), S1(219, 16), E1(229, 25), E2 (214, 22), UK(204, 23), and US(200, 50). All the pairings of the groups of students with the groups of natives led to statistically not different groupings. As for the percentiles shown in Fig. 14, it yields a table with ‘N.S.’ values almost completely spread all over it; the exceptions were for the pair of JP and UK at 100%, and E1 and US at 25%. Note that the ‘N.S.’ resulting from the comparisons with US can be in part attributed to the large value of the standard deviation that the group US had.

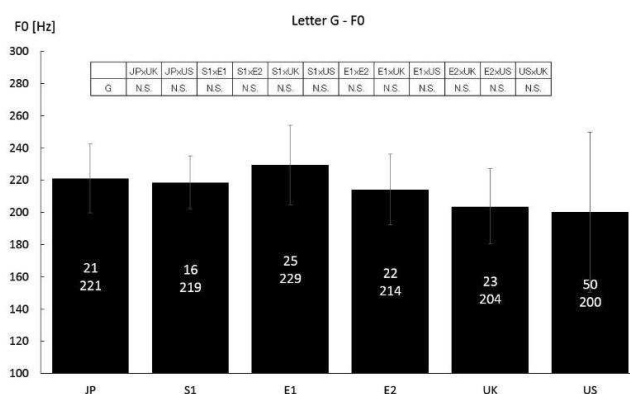


Fig. 13 Pitch frequency testing. Letter G.

G	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 14 Percentile testing. Letter G.

Letter H

Fig. 15 was accomplished by statistically comparing the groups specified by the means and standard deviations of F0s leading to the terminology JP(239, 34), S1(254, 39), E1(248, 27), E2 (212, 17), UK(225, 46), and US(212, 47). The pair of JP and UK, and the groups of S1, E1 and E2 paired up with UK and US were statistically not different. On the other hand, Fig. 16 shows that the pairs of JP and UK, E1 and UK, E2 and UK, and E2 and US were all not different at all points. The other combinations of groups were different at a few points, which was true even for the pair of JP and US.

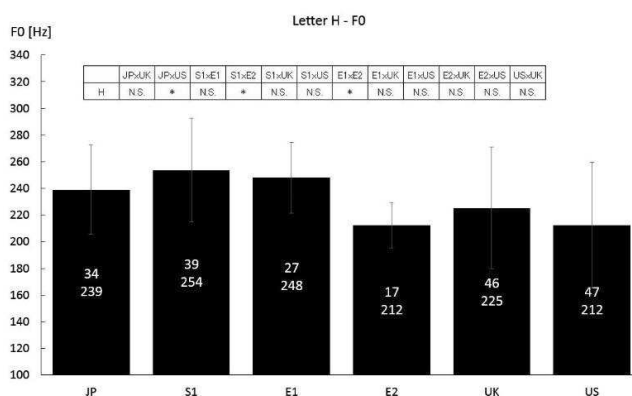


Fig. 15 Pitch frequency testing. Letter H.

H	JP×UK	JP×US	S1×E1	S1×E2	S1×UK	S1×US	E1×E2	E1×UK	E1×US	E2×UK	E2×US	US×UK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	*	N.S.	*	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 16 Percentile testing. Letter H.

Letter H

Fig. 15 was accomplished by statistically comparing the groups specified by the means and standard deviations of F0s leading to the terminology JP(239, 34), S1(254, 39), E1(248, 27), E2 (212, 17), UK(225, 46), and US(212, 47). The pair of JP and UK, and the groups of S1, E1 and E2 paired up with UK and US were statistically not different. On the other hand, Fig. 16 shows that the pairs of JP and UK, E1 and UK, E2 and UK, and E2 and US were all not different at all points. The other combinations of groups were different at a few points, which was true even for the pair of JP and US.

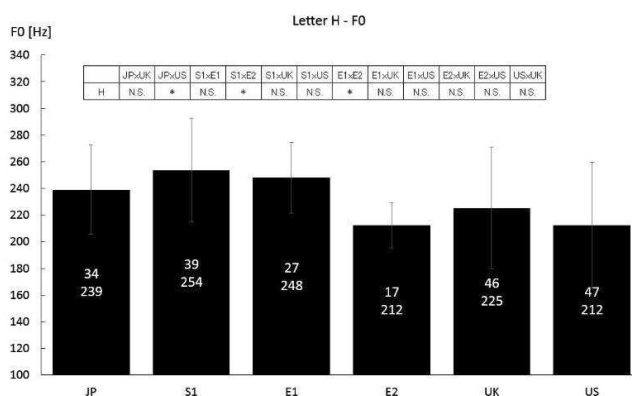


Fig. 15 Pitch frequency testing. Letter H.

H	JP×UK	JP×US	S1×E1	S1×E2	S1×UK	S1×US	E1×E2	E1×UK	E1×US	E2×UK	E2×US	US×UK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	*	N.S.	*	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 16 Percentile testing. Letter H.

Letter I

Considering that the mean and standard deviation values of F0s were JP (220, 19), S1(225, 16), E1(228, 17), E2 (207, 18), UK(189, 53), and US(191, 28), and performing the statistical comparisons we get Fig. 17. It shows that the groups of students paired up with UK as well as the pair of E2 and US were statistically not different. The comparisons of the percentiles given in Fig. 18 tell us that ruling out the pair of JP and UK, which were different at 100%, these pairs were not different at all percentage points. Moreover, JP and US as well as E1 and US were different at 0% to 50% whereas S1 and US at the second quarter.

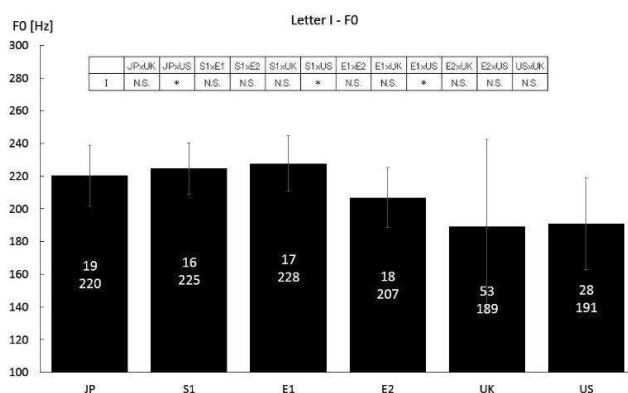


Fig. 17 Pitch frequency testing. Letter I.

I	JP×UK	JP×US	S1×E1	S1×E2	S1×UK	S1×US	E1×E2	E1×UK	E1×US	E2×UK	E2×US	US×UK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 18 Percentile testing. Letter I.

Letter J

Comparisons of the F0s gave Fig. 19. The mean and standard deviation values considered to perform them were JP(220, 23), S1(228, 26), E1(227, 21), E2 (203, 14), UK(208, 40), and US(192, 31). Benchmarking the groups of students against the groups of natives yielded the groups of students being statistically not different from UK. Actually, this evaluation result was also true for the pair of E2 and US. The results of the percentile comparisons were all not different for these pairs at all percentage points as verified in Fig. 20. As for the pairs of JP and US, as well as E1 and US, the differences were seen on the first half whereas S1 and US at middle points.

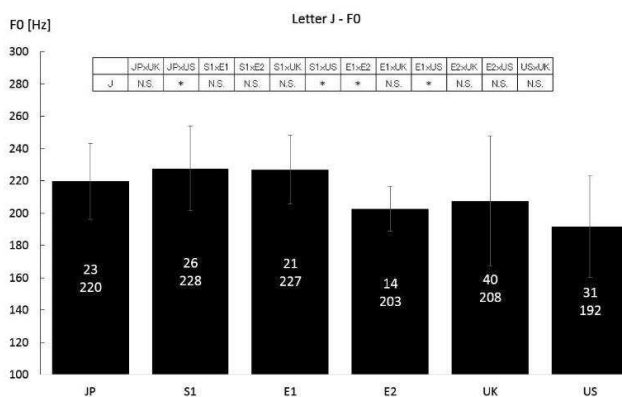


Fig. 19 Pitch frequency testing. Letter J.

J	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 20 Percentile testing. Letter J.

Letter K

Fig. 21 shows the points of the groups defined by JP(227, 20), S1(231, 20), E1(234, 14), E2 (217, 23), UK(215, 26), and US(198, 33), in which the first number of the duo stand for the averages and the second one standard deviations. In addition to the pairings of the groups of students with UK, the pair of groups E2 and US came up statistically ‘not different’. In fact, the groups of students paired with UK had the percentiles leading to ‘N.S.’ at all points whereas E2 and US differed only at 0%. Moreover, S1 and E1 differed from US at percentage values lower than 50% whereas JP was not only in this interval but also at higher values.

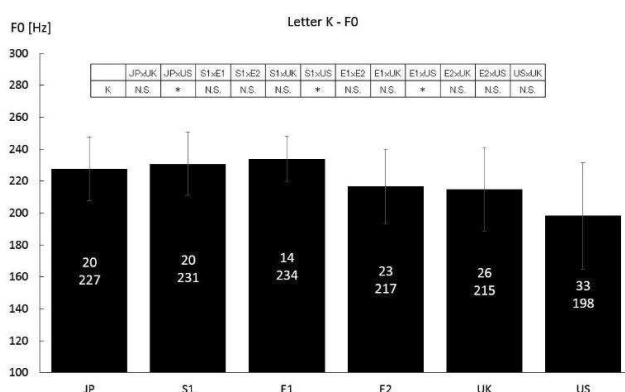


Fig. 21 Pitch frequency testing. Letter K.

K	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	*	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 22 Percentile testing. Letter K.

Letter M

Fig. 25 shows the graph of comparisons for the groups featured by JP(224, 28), S1(230, 33), E1(226, 18), E2 (215, 32), UK(201, 43), and US(197, 31), in which the first numbers mean the averages and the second ones the deviations. The comparisons of the groups of students with UK yielded the groups being statistically not different from each other. In addition to these pairs, the group E2 was not different from US. From Fig. 26, we have that the pairs mentioned so far were also ‘N.S.’ at all percentage points. Despite the limited number of points at which the pairs of JP and US, and S1 and US, these pairs were not similar when their utterances were compared.

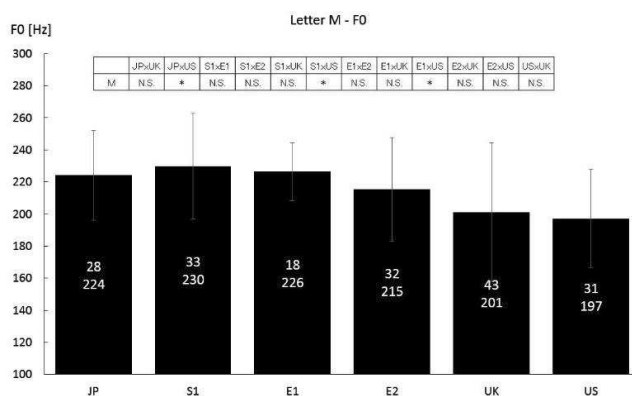


Fig. 25 Pitch frequency testing. Letter M.

M	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 26 Percentile testing. Letter M.

Letter N

The statistical comparisons of F0s for the letter N are given in Fig. 27. For this, the values of the means and deviations were JP(227, 34), S1(231, 37), E1(226, 20), E2 (224, 45), UK(196, 49), and US(199, 31). These show that the pairs of S1 and UK, E1 and UK, E2 and UK, and E2 and US were statistically not different. As for the percentiles (Fig. 28), though JP and UK were different from each, their percentiles were not different at all points. This kind of statistical indifference was also seen in the pairs above mentioned. JP and US as well as E1 and US were different from each other at 0% and 25% only; however they were not similar when the whole utterances were considered.

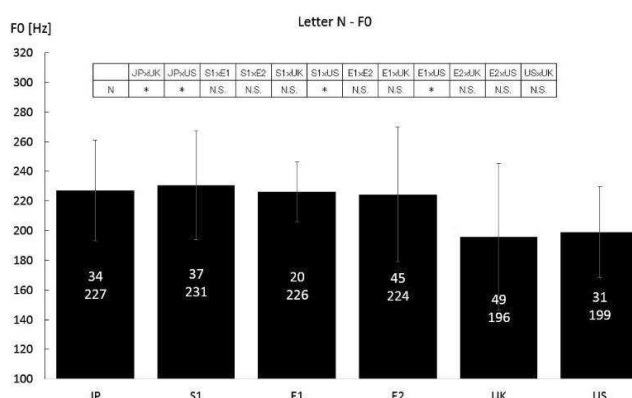


Fig. 27 Pitch frequency testing. Letter N.

N	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 28 Percentile testing. Letter N.

Letter O

The points JP(216, 19), S1(222, 16), E1(224, 15), E2 (202, 21), UK(196, 46), and US(193, 25) were compared across the groups and the results are placed on the graph in Fig. 29. Comparisons of the groups of students with the group UK led to ‘N.S.’ for all the pairings. Still, the pair of groups E2 and US also were statistically not different. Looking at the percentile comparisons of these pairings, we have that apart from the pair of JP and UK, which differed at 100%, the other pairs were all not different from each other at all points. JP and US differed at 25% and 100%, whereas S1 and US as well as E1 and US both differed at 25% and 50%.

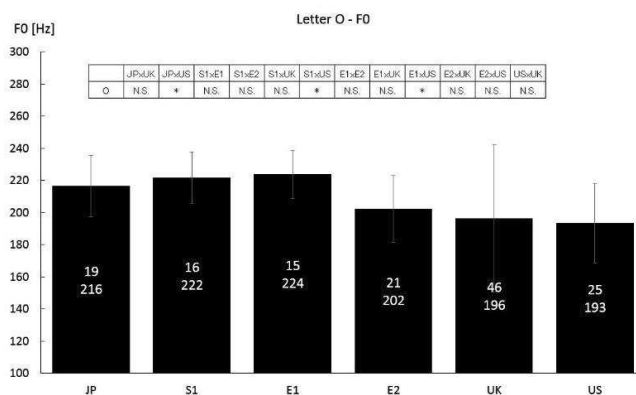


Fig. 29 Pitch frequency testing. Letter O.

O	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 30 Percentile testing. Letter O.

Letter O

The points JP(216, 19), S1(222, 16), E1(224, 15), E2 (202, 21), UK(196, 46), and US(193, 25) were compared across the groups and the results are placed on the graph in Fig. 29. Comparisons of the groups of students with the group UK led to ‘N.S.’ for all the pairings. Still, the pair of groups E2 and US also were statistically not different. Looking at the percentile comparisons of these pairings, we have that apart from the pair of JP and UK, which differed at 100%, the other pairs were all not different from each other at all points. JP and US differed at 25% and 100%, whereas S1 and US as well as E1 and US both differed at 25% and 50%.

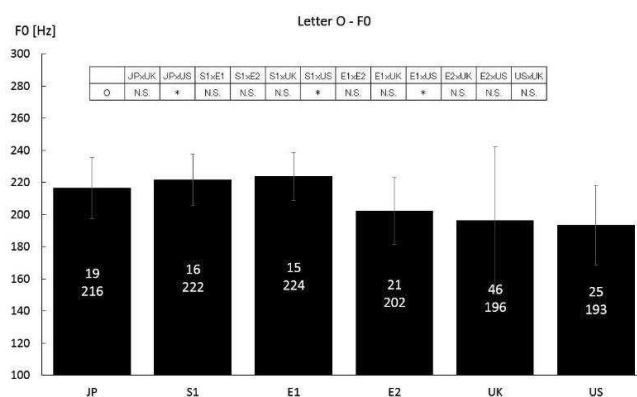


Fig. 29 Pitch frequency testing. Letter O.

O	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 30 Percentile testing. Letter O.

Letter P

Fig. 31 gives the results of the F0 comparisons for means and standard deviations characterizing the groups as JP (226, 22), S1(233, 19), E1(227, 30), E2 (217, 12), UK(223, 30), and US(214, 35). It shows that all the possible combinations of the groups of students with the groups of native speakers lead to the groups of the pairs being statistically not different from each other. Fig. 32 shows the percentiles comparisons, which yielded ‘N.S.’ at all points for the pairs JP and UK, S1 and UK, E1 and UK, and E2 and UK. As for the pairs consisting of groups of students and US, there were points at which the groups were statistically different from each other.

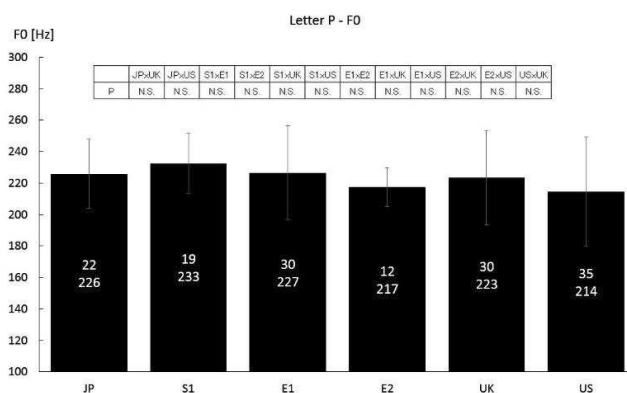


Fig. 31 Pitch frequency testing. Letter P.

P	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	*	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 32 Percentile testing. Letter P.

Letter Q

Fig.33 shows that the results of the statistical testing of the formants F0s. The values expressed as (mean, standard deviation) were JP (227, 18), S1(231, 11), E1(234, 16), E2 (215, 21), UK(227, 49), and US(217, 37). As in the letter P case, all the pairings of the groups of students with the groups of native speakers rendered ‘N.S.’. For the comparisons of the percentiles shown in Fig. 34, the pairs of groups of JP and UK, S1 and UK, E1 and UK, E2 and UK, and E2 and US came ‘N.S.’ at all points. On the other hand, the pairs of JP and US, S1 and US, and E1 and US were statistically different at 25%.

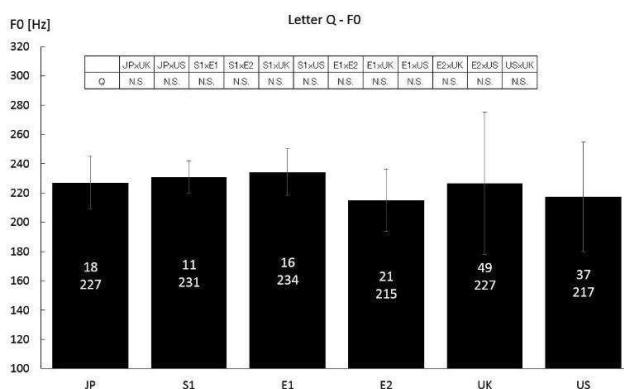


Fig. 33 Pitch frequency testing. Letter Q.

Q	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 34 Percentile testing. Letter Q.

Letter R

The plots of the comparison results for F0s are displayed in Fig. 35. The values of the pairs were JP (216, 16), S1(219, 9), E1(224, 15), E2 (204, 15), UK(201, 44), and US(191, 43). Consequently, the groups of students were not statistically different from the group UK just as were not the pairs of groups of JP and US, as well as E2 and US. Fig. 36 shows the results of the percentile comparisons. From it, we have that indeed the pairings of the groups of students and UK were all statistically not different at all points whereas JP and US at 25%, 50%, and 100%; S1 and US as well as E1 and US, at 25% and 50%; E2 and US, at 25%.

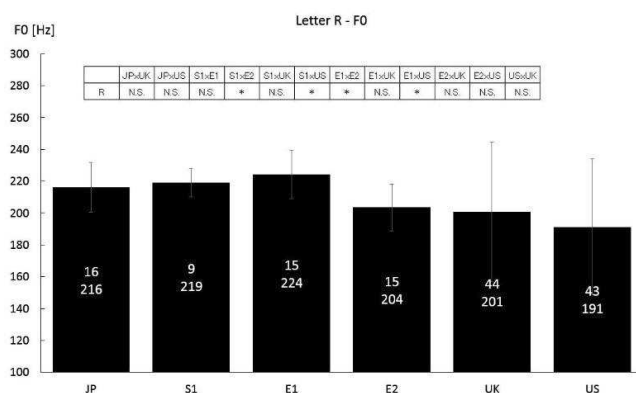


Fig. 35 Pitch frequency testing. Letter R.

R	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	*	N.S.
50%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 36 Percentile testing. Letter R.

Letter T

Fig. 39 gives the comparison results for the means and deviations of F0 computed as JP (229, 22), S1(236, 16), E1(231, 26), E2 (219, 22), UK(232, 42), and US(209, 26). For this letter, the groups of JP and US along with S1 and US were statistically different, and all other pairings resulted in the groups being not different from each other. Fig. 40 says that we had ‘N.S.’ at all points for the pairs of JP and UK, S1 and UK, E1 and UK, E1 and US, E2 and UK, and E2 and US. For the combinations yielding different groups, the group JP differed from US at 0% to 25%, S1 and US at 10% and 25%. Note that they were different at points in the first half of the utterance lengths.

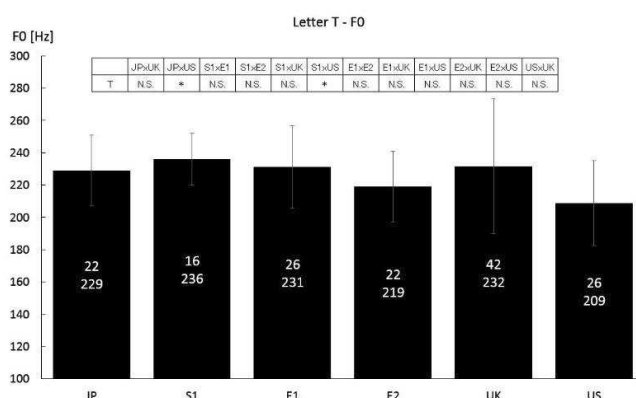


Fig. 39 Pitch frequency testing. Letter T.

T	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 40 Percentile testing. Letter T.

Letter U

The statistical comparisons of the pitch frequencies F0s (Fig. 41), whose means and standard deviations were JP (222, 22), S1(227, 14), E1(228, 17), E2 (207, 29), UK(222, 43), and US(196, 26), show that all the pairings of the groups of the students and UK were statistically not different. The same result was obtained for the pair E2 and US. As for the comparisons of the percentiles, Fig. 42 tells us that these pairs were also not different statistically for percentage points. Furthermore, JP differed from US at 10% and 25%; S1 and US as well as E1 and US at 10% to 50%.

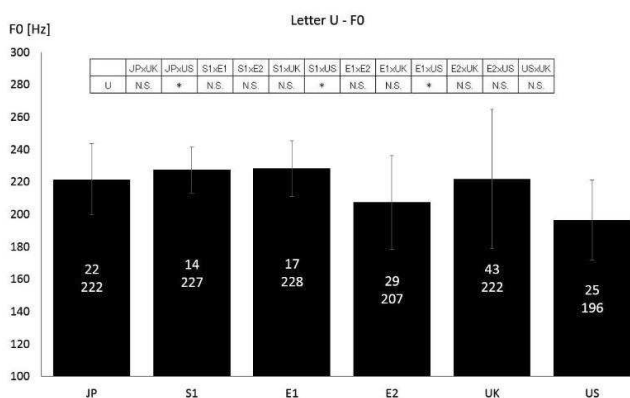


Fig. 41 Pitch frequency testing. Letter U.

U	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 42 Percentile testing. Letter U.

Letter V

The statistical comparisons of the F0s are given in Fig. 43, in which the means and standard deviations were JP (222, 21), S1(230, 18), E1(226, 18), E2 (210, 23), UK(217, 49), and US(195, 27). The outcomes of the comparisons between the groups of students and native speakers were similar to the letter U case. As far as the percentiles are concerned (Fig. 44), the comparisons of the groups of students with the group UK rendered all statistical similarity between the groups taken in pairs. In contrast, the group JP differed from the group US at 0% and 25%; S1 from US at 0% to 50%; E1 from US at 0%, 25% and 50%; E2 from US at 0%.

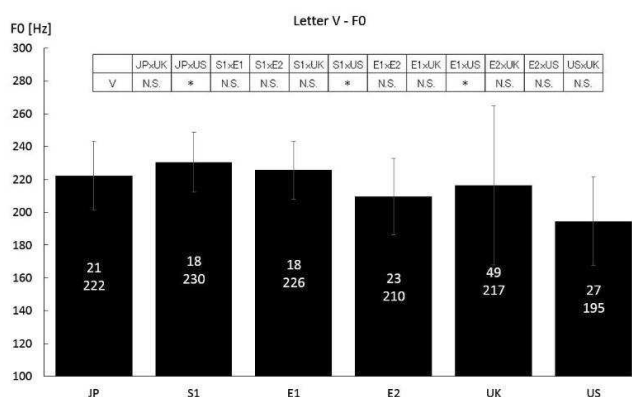


Fig. 43 Pitch frequency testing. Letter V.

V	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	*	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 44 Percentile testing. Letter V.

Letter V

The statistical comparisons of the F0s are given in Fig. 43, in which the means and standard deviations were JP (222, 21), S1(230, 18), E1(226, 18), E2 (210, 23), UK(217, 49), and US(195, 27). The outcomes of the comparisons between the groups of students and native speakers were similar to the letter U case. As far as the percentiles are concerned (Fig. 44), the comparisons of the groups of students with the group UK rendered all statistical similarity between the groups taken in pairs. In contrast, the group JP differed from the group US at 0% and 25%; S1 from US at 0% to 50%; E1 from US at 0%, 25% and 50%; E2 from US at 0%.

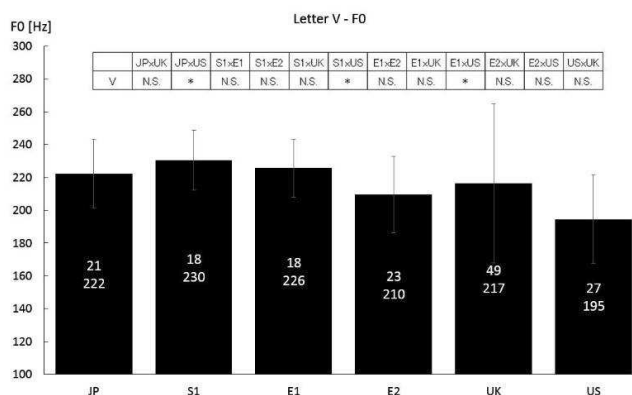


Fig. 43 Pitch frequency testing. Letter V.

V	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	*	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	*	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 44 Percentile testing. Letter V.

Letter W

Fig. 45 shows that the statistical testing of the pitch frequencies F0s with the means and standard deviations described by JP (213, 22), S1(221, 15), E1(222, 15), E2 (194, 24), UK(203, 48), US(202, 34) led to the pairs of groups of students and natives speakers being statistically not different for all possible combinations. From the analysis of the percentiles shown in Fig. 46, it is straightforward that among these pairings, only the pair of groups E1 and US did not have ‘N.S.’ at all points considered for comparisons. Actually, E1 differed from US at 0% and 25%.

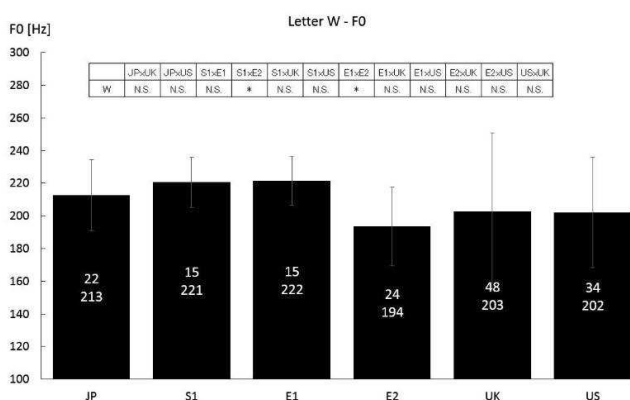


Fig. 45 Pitch frequency testing. Letter W.

W	JP×UK	JP×US	S1×E1	S1×E2	S1×UK	S1×US	E1×E2	E1×UK	E1×US	E2×UK	E2×US	US×UK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 46 Percentile testing. Letter W.

Letter X

Focusing on F0 comparisons for the letter X (Fig. 47), which had the mean and standard deviation values expressed by JP (246, 37), S1(266, 35), E1(255, 34), E2 (214, 19), UK(227, 45), and US(218, 55), we realize that all the pairings of the groups of students and natives speakers give the groups in the pairs being statistically not different from each other. Moreover, from Fig. 48, the comparisons of the percentiles resulted in the pairs E1 and UK, E2 and UK, and E2 and US being not different from each other. The pairs JP and UK as well as S1 and UK were different at 90%, whereas JP and US, at 75% and 90%; and E1 and US, at 25% to 75%.

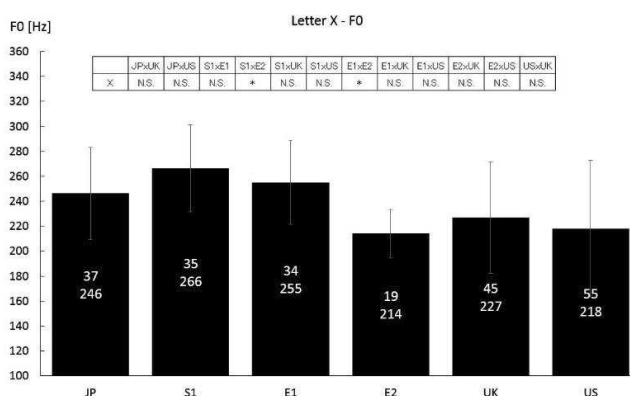


Fig. 47 Pitch frequency testing. Letter X.

X	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
10%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	N.S.	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
50%	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	*	N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	N.S.
90%	*	*	N.S.	*	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	N.S.	N.S.	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 48 Percentile testing. Letter X.

Letter Y

For the letter Y (Fig. 49), whose values of the means and standard deviations were JP (217, 19), S1(219, 13), E1(221, 18), E2 (210, 26), UK(193, 45), and US(188, 21), the comparisons showed that none of the groups of students paired up with US were statistically not different. On the contrary, these groups were all not different from UK. Fig. 50 shows that the pairs S1 and UK, E1 and UK, and E2 and UK were all not different at all points. Now, JP differed from UK at 100%; JP from US, at 0%, 25%, 50%, and 100%; S1 from US, as well as E1 from US, at 50%; and E2 from US, at 0%.

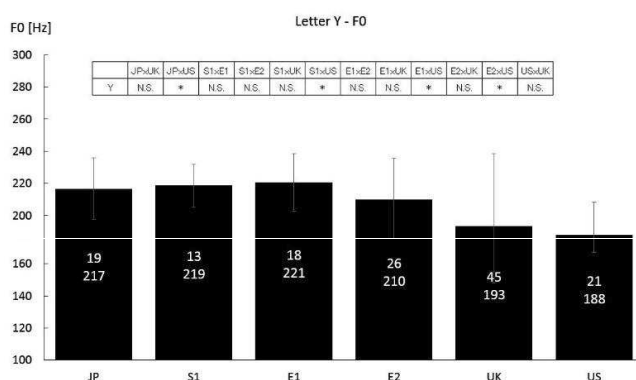


Fig. 49 Pitch frequency testing. Letter Y.

Y	JPxUK	JPxUS	S1xE1	S1xE2	S1xUK	S1xUS	E1xE2	E1xUK	E1xUS	E2xUK	E2xUS	USxUK
0%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.
10%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25%	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
50%	N.S.	*	N.S.	*	N.S.	*	*	N.S.	*	N.S.	N.S.	N.S.
75%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
90%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
100%	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig. 50 Percentile testing. Letter Y.

statistically similar, JP and US were not. It turns out that, in a comparative study as presented in this work, one should focus on the variety of the spoken English sounds and compare as much as possible with other varieties, and make it clear the scope of the study, in particular, in what refers to the choice of set of words and/or sentences.

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REFERENCES

- [1] Ministry of Education, Culture, Sports, Science, and Technology of Japan, Mext (accessed 2015/10/01). http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo3/015/siryo/05112901/009.htm (in Japanese).
- [2] Benesse. , <http://benesse.jp/blog/20141204/p1.html>.
- [3] K. Ohata, "Phonological differences between Japanese and English: Several potentially problematic areas of pronunciation for Japanese ESL/EFL learners," Asian EFL Journal, 6 (4), pp. 1-19, 2004.
- [4] B. Smith, "Pronunciation Patterns of Japanese Learners and their Implications or Teaching", Polyglossia, Vol. 23, pp. 199-206, October 2012.
- [5] T. Riney and J. Anderson-Hsieh, "Japanese pronunciation of English," Vol. 15, No.1, pp. 21-36, 1993.
- [6] Izuta, G. (2015b). On How Young Japanese Female College Students Say the English Alphabet: A Comparison of the Fundamental Frequencies F0s with Native Speakers of English Language, Proceedings of The Asian Conference on Second Language

- Acquisition and Teacher Education, , SLATE 2015/8/2-4 Hiroshima, digital format, ISSN: 2189-2164, 6 pages.
- [7] Izuta, G. (2015c). A Study on How Young Japanese Female College Students Say the English Alphabet: Comparison of the Fundamental Frequencies F0s across the Sub-Groups and Along Different Percentiles, Proceedings of The Asian Conference on Second Language Acquisition and Teacher Education, SLATE 2015/8/2-4 Hiroshima, digital format, ISSN: 2189-2164, 8 pages.
- [8] Y. Tsubota, M. Dantsuji and T. Kawahara, “English Pronunciation Instruction System for Japanese using Formant Structure Estimation,” Spoken Language Information Processing of Information Processing Society of Japan, 99(64):77-84, 1999 (in Japanese).
- [9] H. Fujisaki and T. Kawashima, “The roles of pitch and higher formants in the perception of vowels,” *IEEE Trans. Audio Electroacoust.*, AU-16, pp. 73–77, 1968.
- [10] S. Barreda and T. M. Nearey, “The direct and indirect roles of fundamental frequency in vowel perception,” *J. Acoust. Soc. Am.*, 131(1), pp.466-477, 2012.
- [11] C. Binns and J. F. Culling, “The role of fundamental frequency contours in the perception of speech against interfering speech,” *J. Acoust. Soc. Am.*, 122(3), pp.1765–1776, 2007.
- [12] J. Carrol, S. Tiaden and F. G. Zeng, “Fundamental frequency is critical to speech perception in noise in combined acoustic and electric hearing,” *J. Acoust. Soc. Am.*, 130(4), pp.2054-2062, 2012.
- [13] M. Sugimoto, “Word Accent in Japanese and English - What Are the Differences?” Hitsuji Shobou, 2014, Japan.
- [14] J. M. Hillenbrand and M. J. Clark, “The role of f0 and formant frequencies in distinguishing the voices of men and women. Attention,” *Perception, & Psychophysics*, 71 (5), pp.1150-1166, 2009.
- [15] Graham C., "Fundamental Frequency Range in Japanese and English: The Case of Simultaneous Bilinguals," *Phonetica*, v.71, pp.271-295, 2014.

- [16] R. van Bezooijen, "Sociocultural Aspects of Pitch Differences between Japanese and Dutch Women," *Language and Speech*, v.38, pp.253-265, 1995.
- [17] G. Izuta, "Towards understanding how young Japanese female college students pronounce the letters of English alphabet - Part II: analysis of the pitch frequency modulation", *Reports of The Institute for Culture in Life of Yonezawa Women's Junior College*, Vol. 42, pp.17-74, 2015.