

# **Towards understanding how young Japanese female college students pronounce the letters of the English alphabet - Part IV: further analysis of formants**

Guido Izuta

## **Abstract**

This report complements our previous investigations on formants. Here, the utterances of three groups (26 Japanese female students, 10 British and 20 American women) were analyzed, and statistically compared not only for the formants, but also their percentiles. It turned out that only a few letters had both F2 and F1 statistically similar to those of the natives; and preference to a specific variety of English sound pattern was not statistically established.

## **Keywords**

English alphabet pronunciation, English sounds, formant analysis, percentiles of formants

## **1 INTRODUCTION**

In general, pronunciation has been one of the main curricular elements in the English language learning and teaching programs towards nonnative speakers of English, so that many different frameworks have been developed and introduced in school classes in order to help students improve their speaking skills [1].

In the Japanese educational environment context, the English language learning and teaching in Japanese schools witnessed a major shift in the teaching paradigm from ‘yakudoku’ – basically emphasizing English text translation - to an approach focusing also on ‘the speaking and listening to be

able to communicate in English language' with the establishment of the Japan Exchange and Teaching (JET) program in 1987 by the Japanese government in cooperation with local administrations and contracting organizations. Briefly speaking, this program has recruited qualified native speakers of English as ALTs (assistant language teachers) to assist in English classes at each and every school throughout the country from the elementary to high school levels. Nevertheless, there are a number of reports related to the investigations targeting Japanese college students, which have suggested that a great deal of individuals struggle to distinguish as well as utter some of the English sounds [2] [3] [4].

In fact, these issues can be interpreted in the scope of the investigations made by Derwing and Munro [5], who pointed out that the teaching of English pronunciation has faced many problems as lack of a systematic teaching pronunciation methodology leading, most of the time, the instructors to do it on a trial and error basis; not to mention that there is even a reluctance by the part of the teachers themselves to teach this topic. Yet, this happens due to the fact that there is still a lot of research to be carried out on pronunciation. Indeed, in regard to the case of the English language learning by Japanese students, our knowledge on what the patterns of the speaking sounds look like as well as how they are characterized in relation to the sounds made by the native speakers is still very limited; and, consequently, resources that can be used by the teachers as references to correct or improve the pronunciation skills of the learners in classes are neither enough nor abundantly available yet.

As far as the formant analysis is concerned, it has been used in a variety of branches of linguistics and phonology, and techniques to analyze the human voice sounds have been well established based on the physiological characteristics of the mouth and physical acoustic features of the sounds [7] [8]. In a few words, the formant frequencies F2 and F1 are associated respectively with the positioning of the tongue and rounding of the lips during the utterances [8]. Thus, these acoustical characteristics allow us to infer, to some extent, the differences in the mouth movement and opening of the lips between two

groups one relatively to the other in contrastive analyses. Incidentally, recently Izuta [9] [10] presented some brief and preliminary investigations on the formants and the percentiles of the sounds produced by Japanese students.

Thus, on taking these facts into consideration, the purpose of this investigation is two-fold: (1) to make it clear how young Japanese female college students say the letters of the English alphabet by comparing them with the voicing of North American as well as British English speakers; (2) understand the phonation strategy bearing on the analyses of the formants and their percentiles.

## **2 EXPERIMENTAL PROCEDURE**

The experimental setup was basically the same as reported in our previous papers. Briefly speaking, Twenty six female college students aged 19 to 20 years old were grouped as JP (all students), S1(nine first-year students studying social sciences), E1 (nine first graders of English department) and E2 (eight second-graders of English department), as previously described. In addition, sounds of ten female speakers of British English (group UK) and twenty female individuals of Standard American English (group US) were measured. The native speakers were women in the age range between late 20s and 30s and allegedly healthy native speakers of English.

For the data acquisition and processing, the digital sounds were pre-processed for noise filtering and analyzed with freeware “Praat”. The percentiles at 0%, 10%, 25%, 50%, 75%, 90%, and 100% of the data sets for each letter and each group were computed.

## **3 RESULTS**

In this section we present the results. It is worth noting that preliminary results were presented somewhere else (Izuta [9] [10]). The novelty here is the detailed analyses and discussions focusing on the sub-groups of Japanese students.

## Letter A

Fig.1 shows the plots of the formants F1 and F2 with F1 expressing the vertical axis and F2 the horizontal one. Writing the points on the graph as the pair (value of F2, and value of F1), these points read: JP (2058, 766), S1(2063, 789), E1(1999, 735), E2 (2117, 774), UK(2341, 632), US(2161, 638). Interpreting them in terms of the movements of the mouth, it is straightforward that the opening of the mouth, which related to the formant F1, from closed to open position was (UK, US, E1, JP, E2, S1) with the leftmost group (UK) being relatively closed whereas the rightmost was open. As for the tongue positioning, which is associated with the formant F2, the order was (E1, JP, S1, E2, US, UK) with the leftmost group (E1) having the most backward position, and the rightmost group (UK) having the tongue in a forward position.

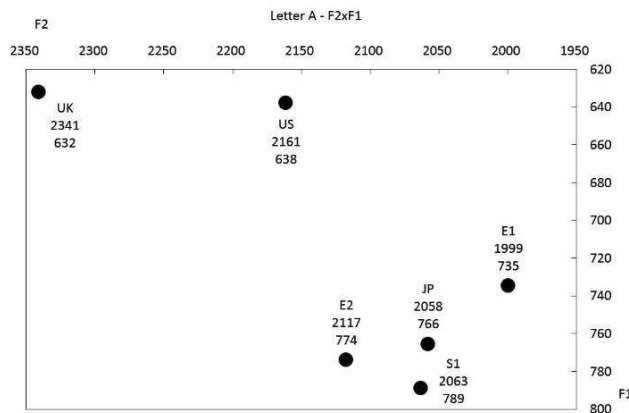


Fig. 1 F2 x F1 Graph. Letter A.

Fig.2 shows that the results of the statistical testing of the formants F1s. The values expressed as (mean, standard deviation) were JP (765, 50), S1(789, 30), E1(735, 44), E2 (774, 61), UK(632, 69), and US(638, 81). Fig. 2 (left) gives the comparison of the utterances as whole, whereas Fig. 2 (right) is the comparison results of the utterances at their percentiles. As a whole the groups of students JP, S1, E1, and E2 were statistically different from the groups of

native speakers. As for the percentiles, the groups JP, S1 and E1 correlated positively with the groups of the natives in the last part of the sounds, suggesting that the students tried to modulate their utterances to sound native-like. Even though not true when compared to the group UK, the group E2 correlated to the group US in most of the percentiles.

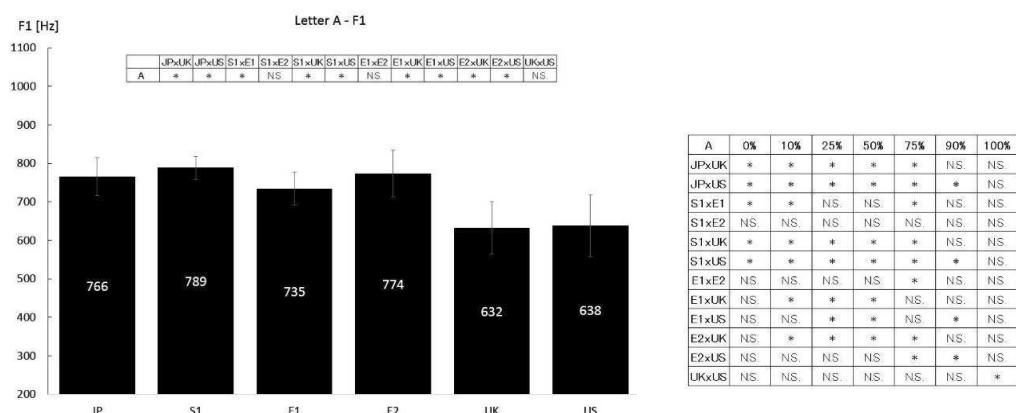


Fig. 2 Testing of F1. Left: whole utterance. Right: percentiles. Letter A.

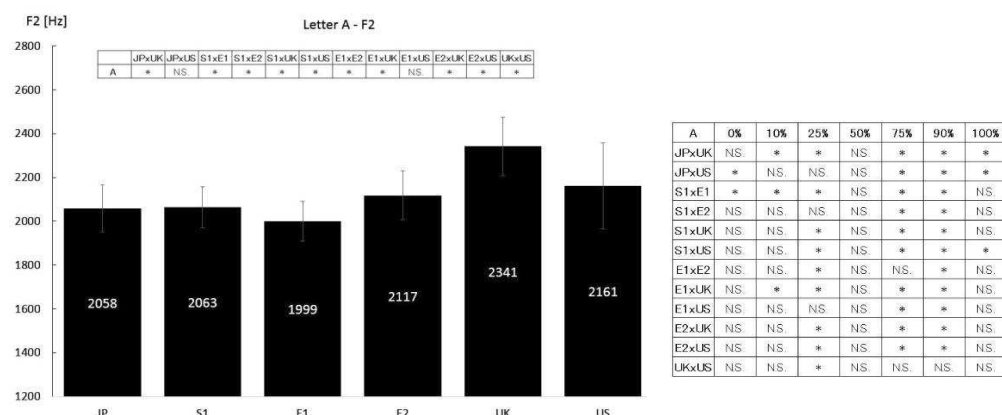


Fig. 3 Testing of F2. Left: whole utterance. Right: percentiles. Letter A.

The results of the statistical comparison for the formants F2s are given in Fig. 3. The mean values and the standard deviations were JP (2058, 106), S1(2063, 94), E1(1999, 91), E2 (2117, 112), UK(2341, 135), and US(2161, 196). The groups JP and E1 were not statistically different from the group US for the

sound as a whole (Fig. 3 - left). However, the comparison of the percentiles shows that the group JP was correlated to US at 10%, 25%, and 50% only, whereas E1 was in most of the percentiles (Fig. 3 - right). Note also that the other groups of the students were partially correlated to the natives.

## Letter B

The plots of the formants F1 and F2 as F2 x F1 are displayed in Fig.4. The values of the pairs were JP (2095, 678), S1(2098, 687), E1(2051, 618), E2 (2142, 736), UK(2467, 501), and US(2271, 484). Thus, the lips rounding of the speakers expressed by F1 were from a relatively closed to open position given by (US, UK, E1, JP, S1, E2). This order says that the groups of the students opened (rounded) the lips wider than the groups of the native speakers. Focusing on the tongue positioning, the order of the groups from back to forward position was (E1, JP, S1, E2, US, UK), which shows that the students produced the sounds positioning the tongue in the far back of the mouth then the native speakers.

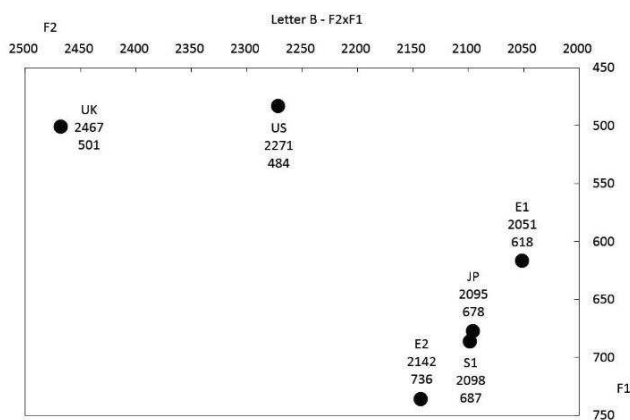


Fig. 4 F2 x F1 Graph. Letter B.

Fig.5 (left) illustrates the results of the statistical comparison of the formants F1 for the sounds. The values of the means and standard deviations of F1s were JP (678, 82), S1(687, 57), E1(618, 65), E2 (736, 84), UK(501, 116), and US(484, 84). The comparison of the groups showed that none of the groups of

the students correlated positively with the groups of the native speakers. Looking at the percentiles of the sounds and carrying out the statistical comparisons (Fig. 5 – right), we see that the group JP correlated to UK at 0%, 75%, and 75%; and to US only at 100%. For the other groups of the students, S1 and UK correlated at 0%, 75%, 90%, and 100%; S1 and US, at 100%; E1 and UK, at 0%, 75%, 90%, and 100%; E1 and US, at 0%, 90%, and 100%; E2 and UK at 0%, 90%, 100%; E2 and US, at 0% and 100%.

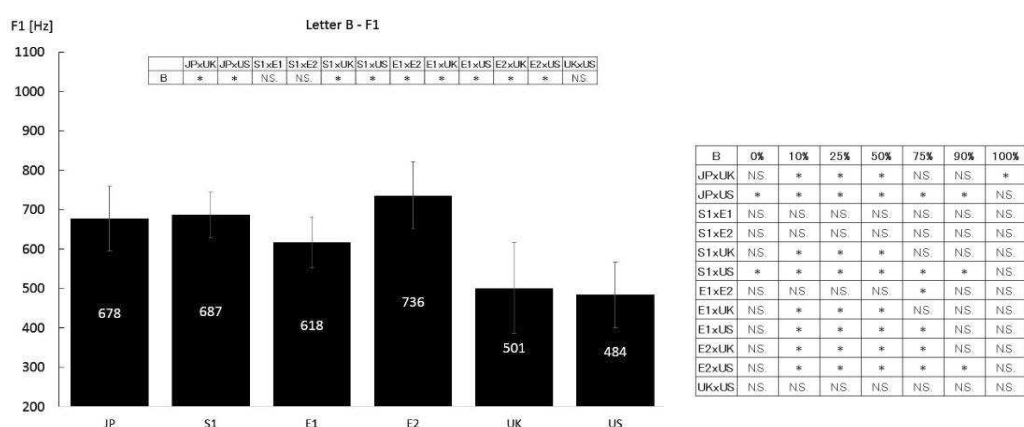


Fig. 5 Testing of F1. Left: whole utterance. Right: percentiles. Letter B.

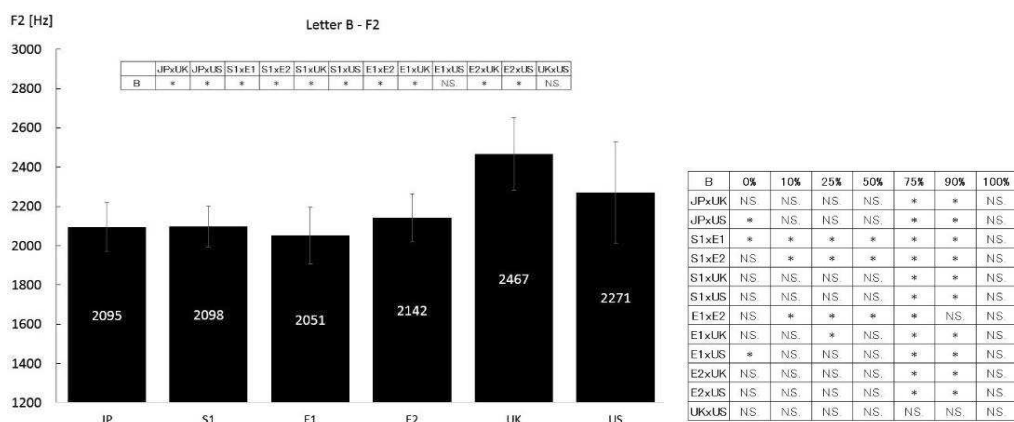


Fig. 6 Testing of F2. Left: whole utterance. Right: percentiles. Letter B.

Fig. 6 (left) gives the comparison results for the means and deviations of F2 computed as JP (2095, 125), S1(2098, 103), E1(2051, 143), E2 (2142, 122),

UK(2467, 184), and US(2271, 260). It shows that amongst the groups of the students, only the group E1 was positively correlated to the group of natives, namely US. Nevertheless, the comparison of the percentiles indicates that the group JP and UK were statistically similar at 0%, 10%, 25%, 50%, and 100%; JP and US at 10%, 25%, 50%, and 100%; S1 and UK as well as S1 and US, at 0%, 10%, 25%, 50%, and 100%; E1 and UK at 0%, 10%, 50%, and 100%; E1 and US, at 10%, 25%, 50%, and 100%; E2 and UK as well as E2 and US, at 0%, 10%, 25%, 50%, and 100%.

### Letter C

The formants F1 and F2 as the graph F2xF1 are plotted on Fig. 7. In fact, the average values of F2s and F1s were JP (2133, 789), S1(2145, 808), E1(2096, 760), E2 (2160, 801), UK(2492, 781), and US(2251, 663). Hence, the movements of the lips as opening and rounding are, from closed to open position, given by the following order (US, E1, UK, JP, E2, S1), which means that in general the Japanese students opened their mouths wider than the native speakers. As for the tongue positioning from back to forward position, they are ordered as (E1, JP, S1, E2, US, UK), which suggests that the students placed their tongues in the back of their mouths whereas the natives in relatively forward positions. In summary, the students made the sounds with their mouths open and the tongues pulled back.

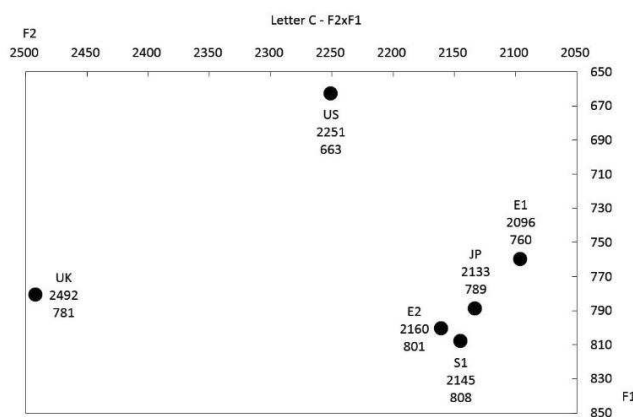


Fig. 7 F2 x F1 Graph. Letter C.



Interestingly, the statistical comparisons of the formants F1s (Fig. 8 - left), whose means and standard deviations were JP (789, 59), S1(808, 64), E1(760, 50), E2 (801, 58), UK(781, 198), and US(663, 93), show that all the groups of the students – JP, S1, E1, and E2 – were statistically similar to the group UK, but not to the group US. Yet, the comparisons of the percentiles in Fig. 8 (right) tells us that the formants F1 of JP and UK were statistically similar at 0%, 50%, 75%, 90%, and 100%; JP and US for percentiles from 75% to 100%; S1 and UK as well as E1 and UK, and E2 and UK, at 0%, 50%, 75%, 90%, and 100%; S1 and US, at 90% and 100%; E1 and US, at 50%, 75%, 90%, and 100%; E2 and US, at 75%, 90%, and 100%.

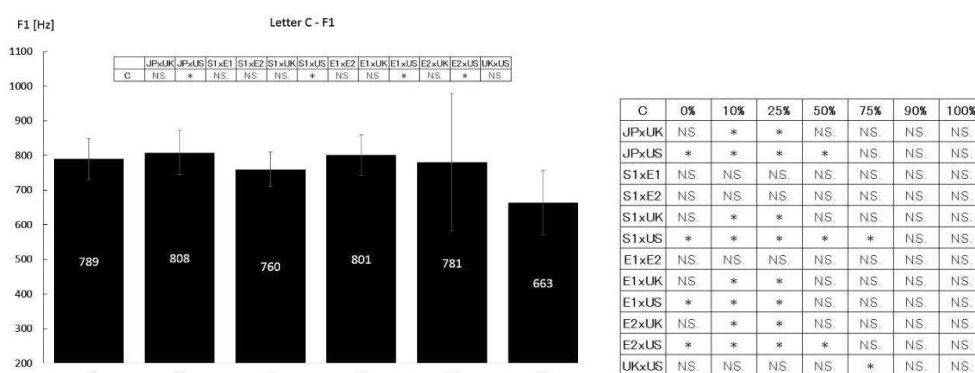


Fig. 8 Testing of F1. Left: whole utterance. Right: percentiles. Letter C.

As for the statistical comparisons of the formants F2s depicted in Fig. 9 (left) and given by the mean and standard variation values JP (2133, 60), S1(2145, 14), E1(2096, 76), E2 (2160, 55), UK(2492, 158), and US(2251, 223), the students had the group JP similar to US. All the other pairings of the groups of students and native speakers led to statistical difference between the groups. Considering the comparisons of the percentiles (Fig. 9 – right), we see that JP and UK were statistically similar at 0% and 50%, JP and US, at 10%, 25%, and 50%; S1 and UK, at 0%, 50%, and 100%; S1 and US, at 0% and 50%; E1 and UK, at 0%, 50%, and 100%; E1 and US, in the first half of the utterance – namely at 0%, 10%, 25%, and 100% - E2 and UK as well as E2 and US at 0%,

50%, and 100%.

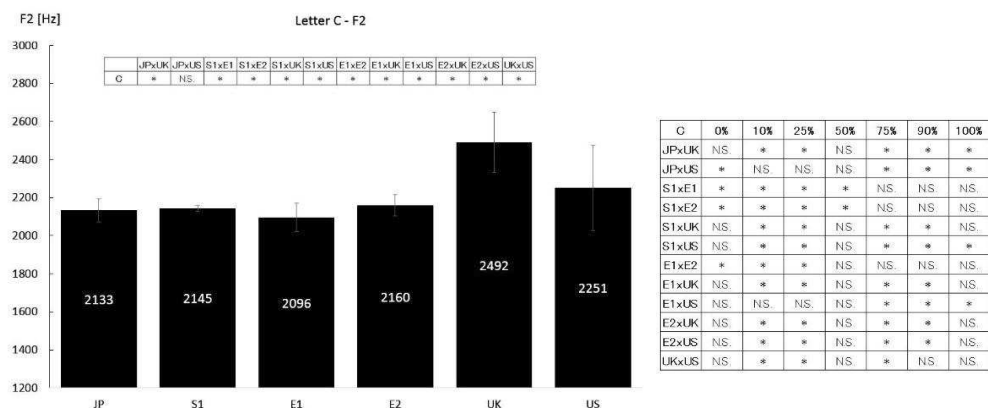


Fig. 9 Testing of F2. Left: whole utterance. Right: percentiles. Letter C.

## Letter D

Fig. 10 shows the graphs of the formants F1 and F2 paired as F2 x F1. The values of F2s and F1s were JP (2100, 696), S1(2115, 715), E1(2050, 647), E2 (2138, 729), UK(2504, 556), US(2267, 510). Interpreting these plots in terms of the movements of the lips as opening and rounding, they show that the native speakers made the sounds with their lips in a slightly closed position. In fact, ordering the groups according to the closed/open position of the lips we obtain the ordering (US, UK, E1, JP, S1, E2) from closed to open.

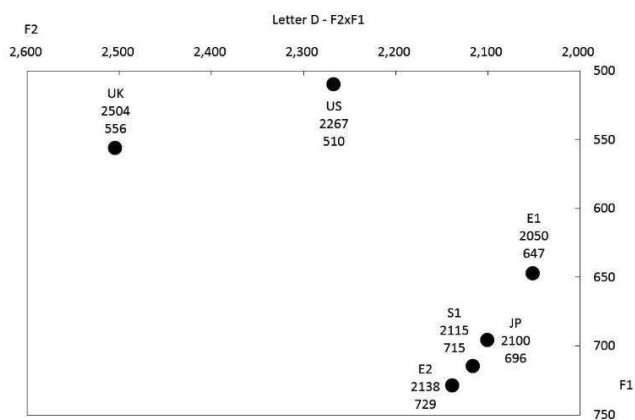


Fig. 10 F2 x F1 Graph. Letter D.

As far as the tongue positioning is concerned, the ordering of the groups was (E1, JP, S1, E2, US, UK) from back to forward. These indicate that the students opened their mouths wider and placed the tongues in the back than their native peers.

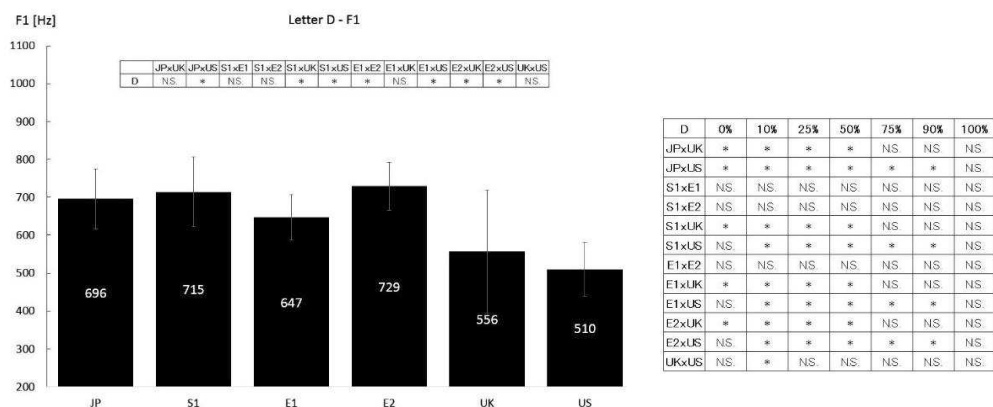


Fig. 11 Testing of F1. Left: whole utterance. Right: percentiles. Letter D.

The statistical comparisons of the formants F1s are given in Fig. 11 (left), in which the means and standard deviations were JP (696, 79), S1(715, 92), E1(647, 59), E2 (729, 63), UK(556, 163), and US(510, 72). The take away was that the pairs JP and UK as well as E1 and UK showed statistical similarity, and none of the combinations of the groups of students with the groups of native speakers were similar. On the other hand, the testing results of the percentiles given in Fig. 11 (right) say that JP and UK were statistically similar at 75%, 90%, and 100%; JP and US, at 100%; S1 and UK, at 75%, 90%, and 100%; S1 and US, at 0%, and 100%; E1 and UK, at 75%, 90%, and 100%; E1 and US, at 0% and 100%; E2 and UK, at 75%, 90%, and 100%; E2 and US, at 0% and 100%. Note that the groups of students tended to correlate positively to US at 0% and 100%, and to the group UK at percentiles in the last half of the utterances. Note that the groups of students were statistically similar to the group UK at percentiles in the last half of the utterance, and similarities with the group US at some sporadic percentiles.

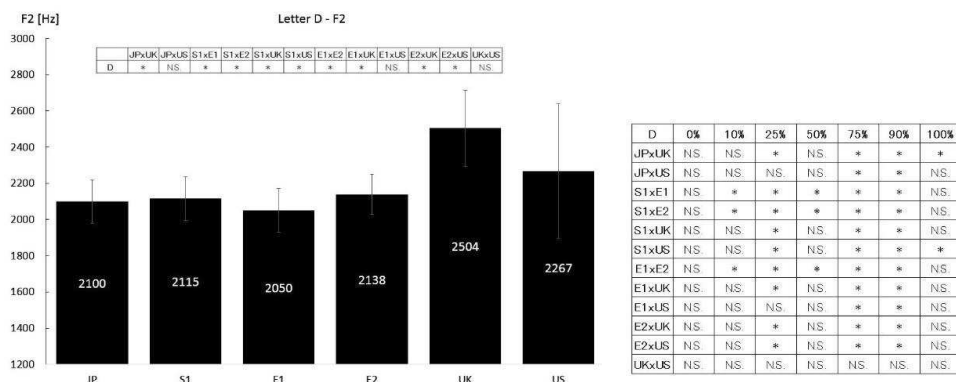


Fig. 12 Testing of F2. Left: whole utterance. Right: percentiles. Letter D.

As for the statistical comparisons of the formants F2s (Fig. 12 - left), which considered the averages and standard deviations given by JP (2100, 120), S1(2115, 122), E1(2050, 120), E2 (2138, 113), UK(2504, 210), and US(2267, 372), led to statistical similarity between JP and US, and E1 and US. Indeed, the details are presented in Fig. 12 (right). From this table, we see that JP and UK are similar at 0%, 10%, 50%; JP and US, at 0%, 10%, 25%, 50%, and 100%; S1 and UK, at 0%, 10%, 50%, and 100%; S1 and US, at 0%, 10%, and 50%; E1 and UK, at 0%, 10%, 50%, and 100%; E1 and US, at 0%, 10%, 25%, 50%, and 100%; E2 and UK as well as E2 and US, at 0%, 10%, 50%, and 100%. A characteristic of these percentile comparisons is that the groups of students were statistically similar to the groups of natives mainly in the first half of the utterances.

Taking into account these results, the percentiles suggest that the students have distinct strategy for producing the formants F1 and F2.

## Letter E

Fig. 13 yields the graphs of F2 x F1. The pairs of F2 and F1 points plotted are JP (2117, 659), S1(2106, 671), E1(2074, 619), E2 (2178, 691), UK(2610, 562), and US(2275, 487). The F1 formants gave the group ordering (US, UK, E1, JP, S1, E2) for the movements of the lips from closed to open positions. It

shows that the native speakers had their lips (mouths) in a relatively closed position compared to the students. Now the F2 formants teach us about the tongue positioning, and the ordering of the groups based on the positioning of the tongue from back to forward positions is (E1, S1, JP, E2, US, UK), which implies that the natives placed their tongues in a point more forward than the students.

Nevertheless, Fig. 14 (left) shows that the statistical testing of the F1 formants with the means and standard deviations described by JP (659, 77), S1(671, 77), E1(619, 51), E2 (691, 89), UK(562, 192), US(487, 84) led to statistical similarities between the groups of JP and UK, S1 and UK, E1 and UK, and E2 and UK. In other words, though all the groups of students were similar to the group UK, none of them correlated positively to the group US. Moreover, Fig. 14 (right) indicated that JP and UK were statistically similar at the percentiles of 75%, 90%, and 100%; JP and US only at 100%; S1 and UK, at 75% and 90%; S1 and US, at 50% and 100%; E1 and UK, at 0%, 75%, 90%, and 100%; E1 and US at 0% and 100%; E2 and UK, at 75% and 90%. Thus the correlations of students and natives were seen at higher percentiles.

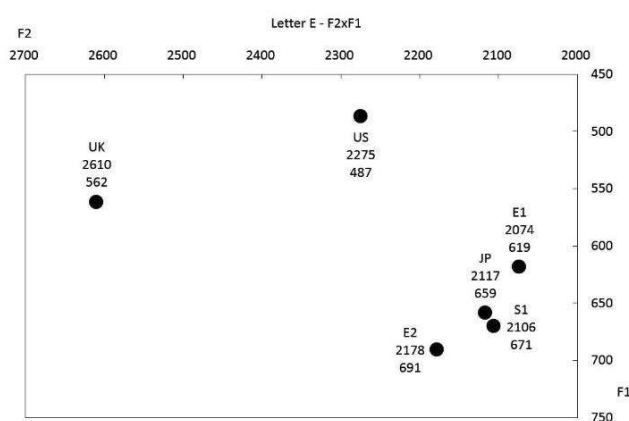


Fig. 13 F2 x F1 Graph. Letter E.

On the other hand, as presented in Fig. 15 (left), the comparisons of F2 formants for the average and standard deviations values computed as JP (2117, 144), S1(2016, 140), E1(2074, 128), E2 (2178, 163), UK(2610, 174), and

US(2275, 336), brought up statistical similarities for the pairs JP and US, and E1 and US. The detailed results of the percentile comparisons are shown in Fig. 15 (right). From these, we notice that JP and UK were similar at 0%, 10%, and 50%; JP and UK, at 10%, 25%, and 50%; S1 and UK as well as S1 and US, at 0%, 10%, and 50%; E1 and UK, at 0%, 10%, 50%; E1 and US, at 10%, 25%, and 50%; E2 and UK as well as E2 and US, at 0%, 10%, and 50%. Note, that these similarities were at lower values of percentiles.

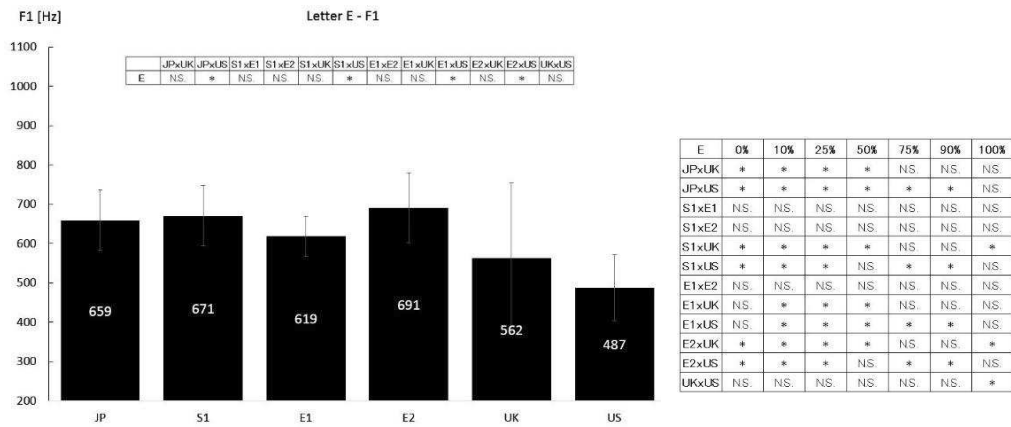


Fig. 14 Testing of F1. Left: whole utterance. Right: percentiles. Letter E.

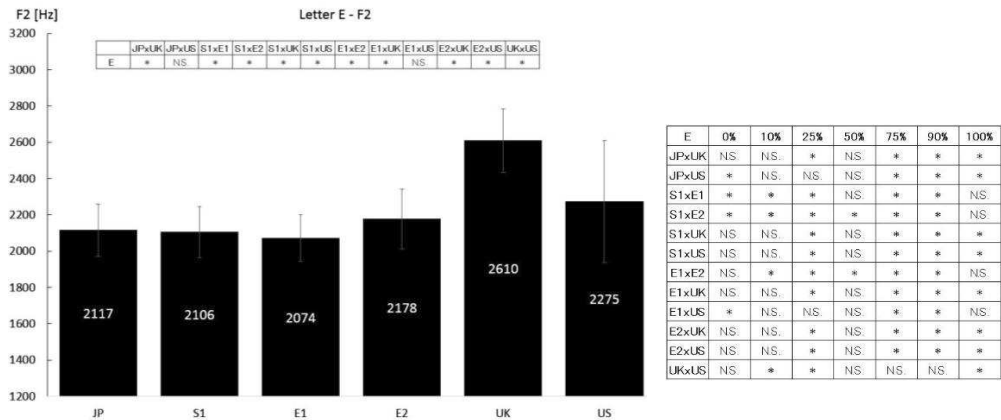


Fig. 15 Testing of F2. Left: whole utterance. Right: percentiles. Letter E.

## Letter F

The graphs of F2 x F1 are shown in Fig. 16. The values of F2 and F1 were JP (2033, 974), S1(2032, 950), E1(2038, 971), E2 (2028, 1005), UK(2171, 1157), and US(1957, 934). Ordering the F1s, which stand for the rounding/opening of the lips, we have (US, S1, E1, JP, E2, UK) with t US being the group with the lips/mouth in the least open position and UK in the most open position. Thus, the groups of students located in-between these two extremes. Now, ordering the groups according to the values of F2s sorted in an increasing fashion leads to (US, S1, E2, JP, E1, UK). Again, the groups of students situated in-between US, which was had the tongue in the far back position, and UK, which placed forwardly the tongue.

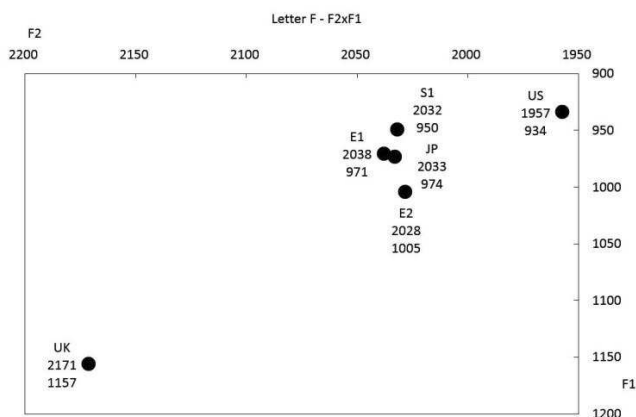


Fig. 16 F2 x F1 Graph. Letter F.

Focusing on F1s (Fig. 17, left), which had the mean and standard deviation values expressed by JP (974, 112), S1(950, 117), E1(971, 141), E2 (1005, 68), UK(1157, 220), and US(934, 98), we realize that regardless the fact that the native groups UK and US were not statistically similar, the groups JP, E1 and E2 were all similar to both UK and US groups. In contrast, the group S1 was statistically similar to US only. In addition, as detailed in Fig. 17 (right), the comparisons of the percentiles show that JP and UK were similar at 0%, 90%, and 100%; JP and US, at 0%, 10%, 50%, 75%, and 100%; S1 and UK, at 0%, 75%, 90%, and 100%; S1 and US, at 0%, 10%, 50%, 50%, 75%, and 90%; E1 and UK, at 0%, 10%, 50%, 75%, 90%, and 100%; E1 and US, at all

percentiles; E2 and UK, at 0%, 50%, 75%, 90%, and 100%; E2 and US, at 0%, 10%, 25%, 75%, 90%, and 100%. The groups of students were highly correlated to the groups of natives at relatively higher values of percentiles suggesting a kind of a strategy to adjust the opening of the mouth in order to obtain a utterance sounding native-like.

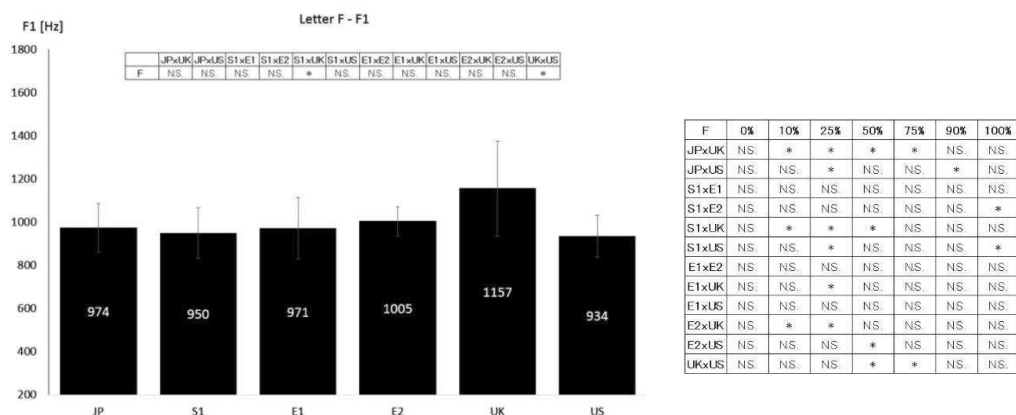


Fig. 17 Testing of F1. Left: whole utterance. Right: percentiles. Letter F.

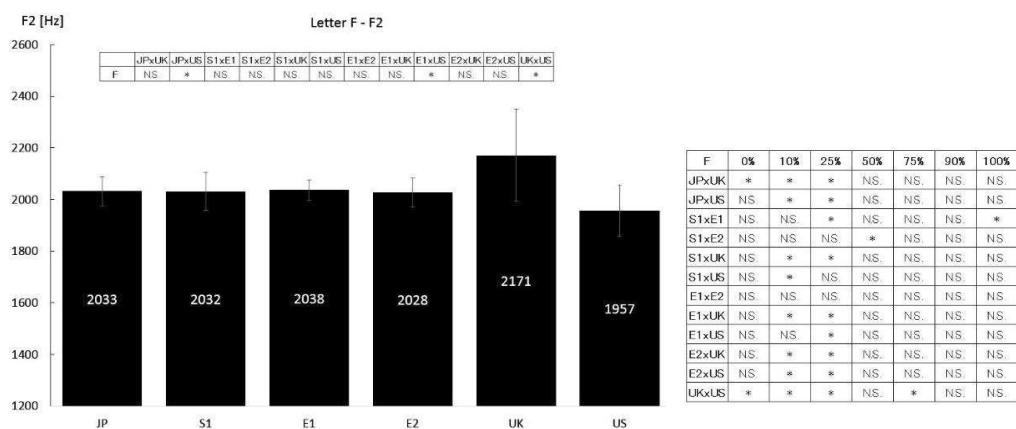


Fig. 18 Testing of F2. Left: whole utterance. Right: percentiles. Letter F.

Looking at the F2 formants (Fig. 18, left), which had the mean and standard deviation values written as JP (2033, 56), S1(2032, 73), E1(2038, 39), E2 (2028, 56), UK(2171, 179), and US(1957, 98), we get statistical similarity for the pairs of JP and UK, S1 and UK, S1 and US, E1 and UK, E2 and UK, and



E2 and US. It is worth noting that as in the previous case, UK and US were not statistically similar to each other. From the statistical testing of the F2 percentiles (Fig. 18, right), it was found that JP and UK were statistically similar at 50%, 75%, 90%, and 100%; JP and US, at 0%, 50%, 75%, 90%, and 100%; S1 and UK, at 0%, 50%, 75%, 90%, and 100%; S1 and US along all the percentiles except at 10%; E1 and UK, at 0%, 50%, 75%, 90%, and 100%; E1 and US, at the same values as E1 and UK and at 10%; E2 and UK as well as E2 and US, at 10%, 50%, 75%, 90%, and 100%. As in the case of the F1 percentiles, the statistical similarities were verified mainly in the last half of the utterances. In other words, it is likely that the students moved their tongues forward and backward in an attempt to reproduce the native sounds.

## Letter G

The F2 and F1 points represented by JP (2125, 709), S1(2133, 713), E1(2091, 677), E2 (2155,741), UK(2512, 668), and US(2465, 652) are placed in the F2 x F1 graph shown in Fig. 19.

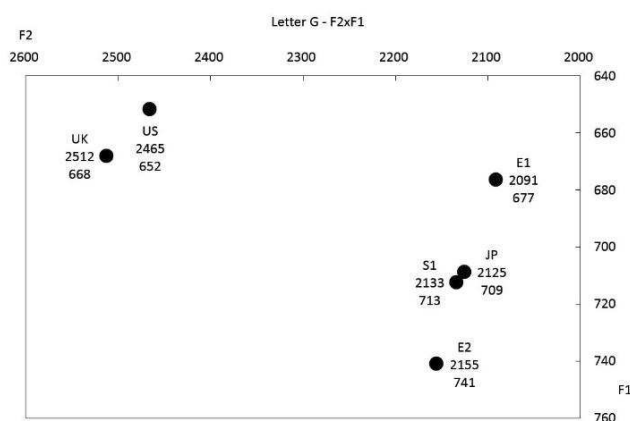


Fig. 19 F2 x F1 Graph. Letter G.

The F1 formants show that the ordering of the groups as (US, UK, E1, JP, S1, E2) holds as long as rounding of the lips from closed to open positions are taken as the sorting key. This ordering means that the students opened their

mouths wider than the native speakers. Still, considering the tongue positioning associated to the formant F2 and ordering the groups from back to forward positions, we have (E1, JP, S1, E2, US, UK), which means that the students placed their tongues in the back of their mouths relatively to the native speakers.

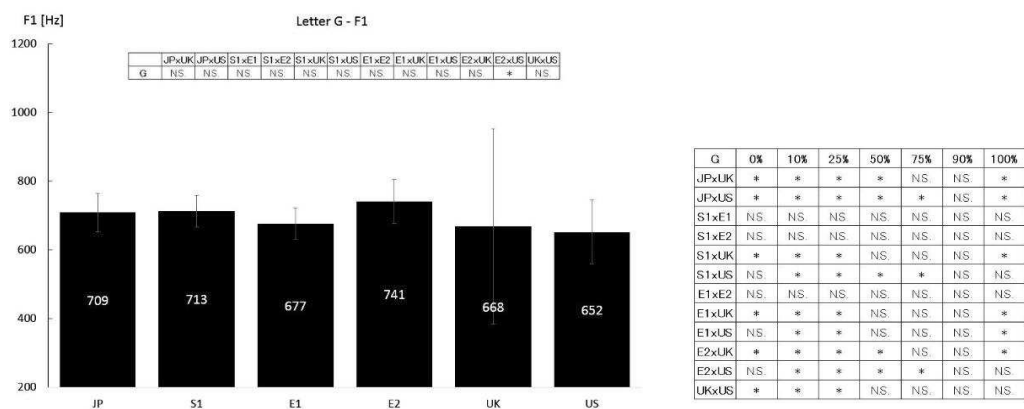


Fig. 20 Testing of F1. Left: whole utterance. Right: percentiles. Letter G.

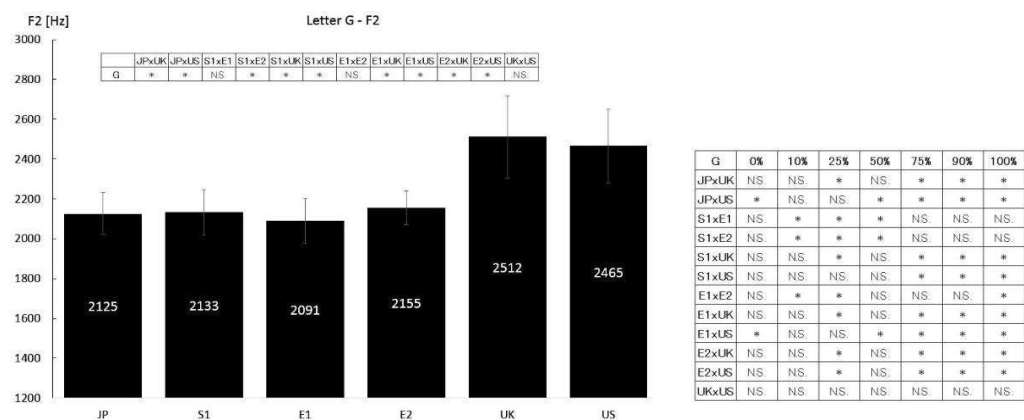


Fig. 21 Testing of F2. Left: whole utterance. Right: percentiles. Letter G.

The results of the statistical comparisons of F1s, which read JP (709, 56), S1(713, 46), E1(677, 45), E2 (741, 64), UK(668, 284), and US(652, 93), are presented in Fig. 20 (left). Leaving out the pair E2 and US, which were statistically different, the other pairings of the groups of students with the

groups of natives turned out to be statistically similar. Despite these results, the comparisons of the percentiles showed that similarities were not verified along all the percentiles. In fact, Fig. 20 (right) tells us that JP and UK were statistically similar at 75% and 90%; JP and US, at only 90%; S1 and UK, at 50%, 75%, and 90%; S1 and US, at 0%, 90%, and 100%; E1 and UK, at 50%, 75%, and 90%; E1 and US, at 0%, 50%, 75%, and 90%; E1 and UK, at 75%, and 90%; E2 and US, at 0%, 90%, and 100%. In contrast, Fig. 21 (left) shows that the comparison results for the F2 formants, whose mean and standard deviation values were JP (2125, 102), S1(2133, 114), E1(2091, 113), E2 (2155, 85), UK(2512, 207), and US(2465, 186), were such that none of the groups of students were statistically similar to the groups of natives. Still, Fig. 21 (right) shows that JP and UK were not different at 0%, 10%, and 50%; JP and US, at 10%, and 25%; S1 and UK, at 0%, 10%, and 50%; S1 and US, at 0%, 10%, 25%, and 50%; E1 and UK, at 0%, 10%, and 50%; E1 and US, at 10% and 25%; E2 and UK, at 0%, 10%, and 50%; E2 and US, at 0%, 10%, and 50%.

## Letter H

Fig. 22 is regarded to the graph of F2 x F1, in which the values of the F2s and F1s were JP (2094, 903), S1(2113, 902), E1(2044, 900), E2 (2129, 906), UK(2544, 1182), and US(2356, 922). The F1 formants indicate that ordering groups according to the movement of the lips and from closed to open, the sequence (E1, S1, JP, E2, US, UK) holds.

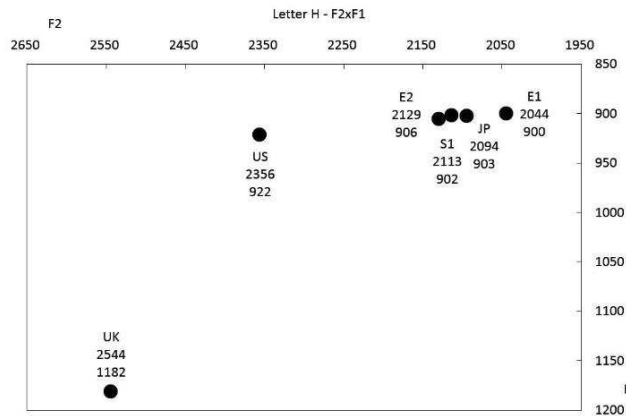


Fig. 22 F2 x F1 Graph. Letter H.

This translates into a less open mouth for the group of students. As for the F2 formants, which are associated to the positions of the tongue, the sequence (E1, JP, S1, E2, US, UK) is established if back-to-forward sorting is adopted. Thus, we see that the students kept their tongues in a deeper back position than the native speakers.

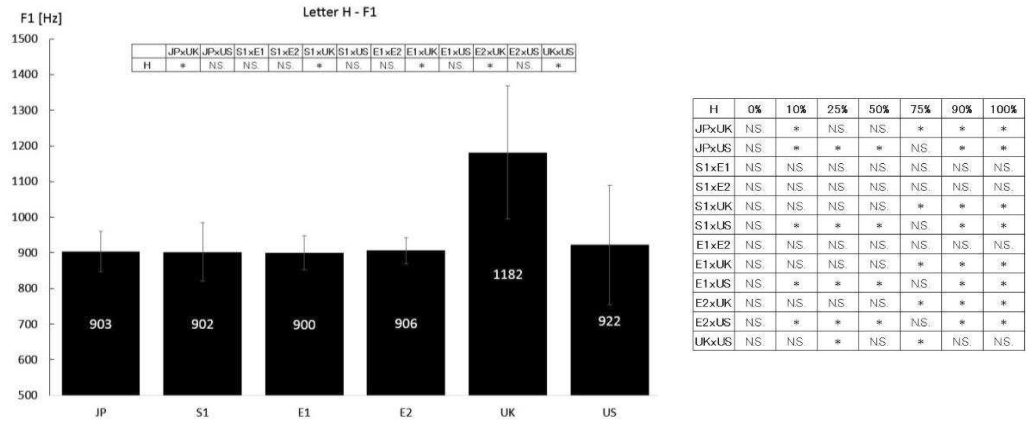


Fig. 23 Testing of F1. Left: whole utterance. Right: percentiles. Letter H.

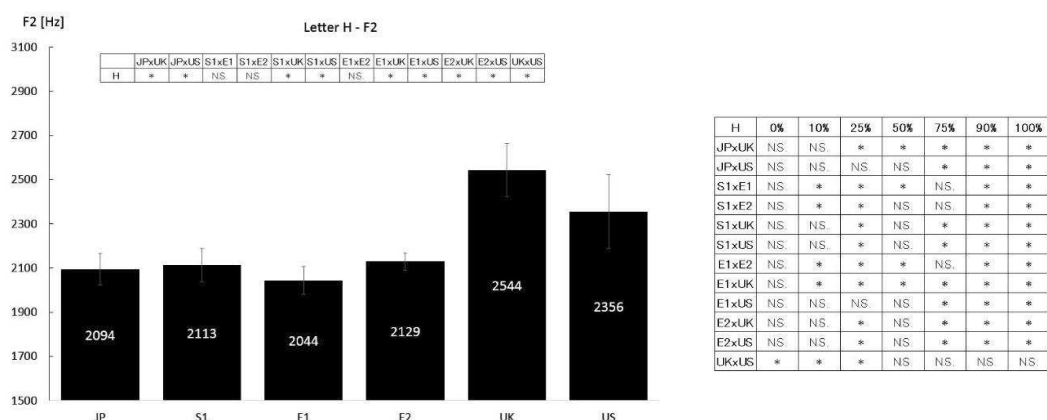


Fig. 24 Testing of F2. Left: whole utterance. Right: percentiles. Letter H.

Fig. 23 (left) shows the results of the comparisons between the F1s, which were calculated as JP (903, 57), S1(902, 82), E1(900, 48), E2 (906, 36), UK(1182, 186), and US(922, 168). It says that the groups of students were all not statistically different to the group US, and were indeed different to the group UK. Now, the comparisons of the percentiles are given in Fig. 23 (right). The groups JP and UK were not statically different at 0%, 25%, and 50%; JP and US, at 0%, and 75%; S1 and UK, at 0%, 10%, 25%, and 50%; S1 and US, at 0%, and 75%; E1 and UK, at 0%, 10%, 25%,and 50%; E1 and US, at 50%; E2 and UK, at 0%, 10%, 25%, and 50%; E2 and US, at 0% and 75%. Interestingly, considering the utterance as a whole, the group of students were statistically similar to US; however, the percentiles show that the students were more correlated to UK than the group US. Yet this correlation was mainly in the first half of the sound length.

For the F2 formants (Fig. 24), whose values of the means and standard deviations were JP (2094, 71), S1(2113, 76), E1(2044, 64), E2 (2129, 39), UK(2544, 119), and US(2356, 168), the comparisons showed that none of the groups of students were statistically similar to the groups of natives. As for the comparisons of the percentiles, JP and UK were statistically similar at 0%, and 10%; JP and US, at 0%, 10%, 25%, and 50%; S1 and UK as well as S1 and US, at 0%, 10%, and 50%; E1 and UK, at 0% only; E1 and US, at 0%, 10%, 25%, and 50%; E2 and UK as well as E2 and US, at 0%, 10%, and 50%.

## Letter I

The pairs consisting of F1 and F2 formants for the groups given by JP (1875, 880), S1(1904, 848), E1(1853, 897), E2 (1867, 895), UK(1805, 863), US(1835, 836) had the graph F2 x F1 depicted in Fig.25. Sorting the groups in increasing order from small to large values of F1 - rounding of lips from closed to open positions - yielded the sequence (US, S1, UK, JP, E2, E1). Ruling out the group S1, the groups of students produced the sounds with their mouths open wider than the groups of natives. As for the sorting of F2 formants also in increasing order from small to large values; i.e., tongue positioning from back to forward position, led to (UK, US, E1, E2, JP, S1). This sequence means that the students placed their tongues relatively forward when compared with the natives. Note that the number of pairs showing similarities along the percentiles is relatively high.

Yet, the mean and standard deviation values of the F1 formants given by JP (880, 50), S1(848, 40), E1(897, 48), E2 (895, 50), UK(863, 185), and US(836, 103) rendered statistically similarities between the groups of natives, for every single combination between the groups of students and that of natives taken pair-wisely (Fig. 26 - left). The comparisons of the groups at different percentiles gave statistically similar JP and UK at 0%, 25%, 50%, 75%, 90%, and 100%; JP and US, at 50%, 75%, 90%, and 100%; S1 and UK as well S1 and US at all percentiles, but at 0%; E1 and UK at all values of percentiles; E1 and US at all percentiles, but 25%; E2 and UK as well E2 and US, at 0%, 50%, 75%, 90%, and 100% (Fig. 26 - right). A relevant characteristic observed in the comparisons of the percentiles is that the groups of students were statistically not different to the groups of natives mainly in the second half of the utterance length.

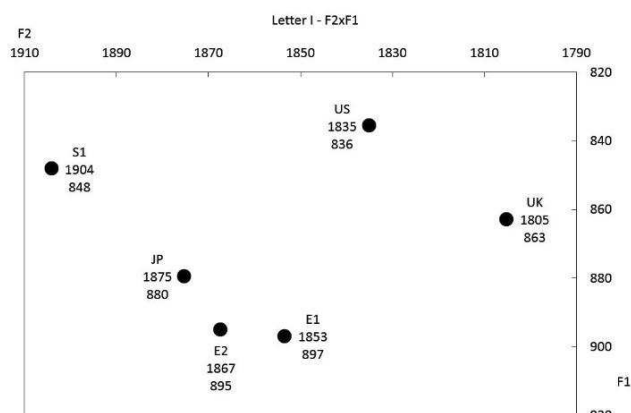


Fig. 25 F2 x F1 Graph. Letter I.

Analogously, looking at the comparisons of the F2 formants, Fig. 27 (left) gives positive statistical similarities for all the combinations of the groups of students and speakers when taken in pairs. The values of the averages and standard deviations of F2s considered in the statistical comparisons were JP (1875, 68), S1(1904, 68), E1(1853, 61), E2 (1867, 73), UK(1805, 141), and US(1835, 187). Fig. 27 (right) presents the results of the comparisons carried out on the percentiles. JP and UK were not statistically different at 100% only, JP and US at 50%, 75%, and 100%. S1 and UK, at 0% and 100%; S1 and US, at 0% and 75%; E1 and UK, at 0%, 50%, and 100%; E1 and US, at 25%, 50%, 75%, 90%, and 100%; E2 and UK as well as E2 and US, at 0% and 100%. Unlike the pairs JP and US, and E1 and US, which were similar in most part of the second half of the utterance, the other pairs consisting of groups of students and natives did not showed a clear pattern where the percentiles are statistically similar. Yet, despite the similarities seen in Fig. 27 (left), the number of percentiles, at which the groups were similar, is not so high.

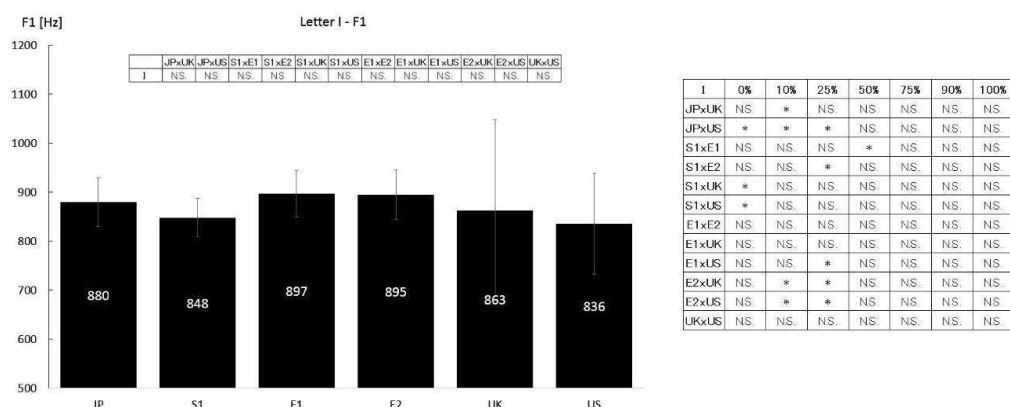


Fig. 26 Testing of F1. Left: whole utterance. Right: percentiles. Letter I.

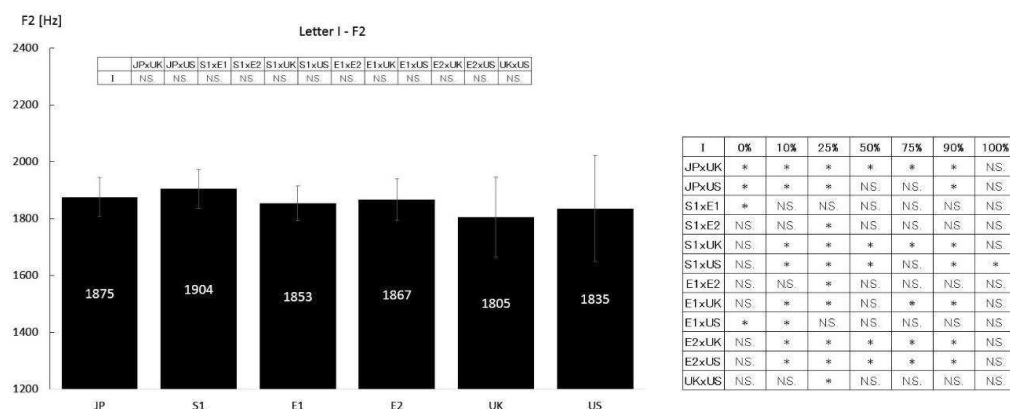


Fig. 27 Testing of F2. Left: whole utterance. Right: percentiles. Letter I.

## Letter J

Let us now consider the sound of the letter J characterized by the formants F2 and F1 describing the groups as JP (2091, 791), S1(2101, 802), E1(2068, 763), E2 (2107, 810), UK(2350, 778), and US(2254, 717) and plotted on the graph in Fig. 28. Sorting the F1 formants in increasing order of values produced the sequence (US, E1, UK, JP, S1, E2), which, apart from the group E1, indicates that the groups of natives made the utterances keeping their lips in a more closed position than the students. On the other hand, aligning the



F2s in increasing order of their values led to the sequence (E1, JP, S1, E2, US, UK), which means that tongue positioning of the natives were more forward than the students.

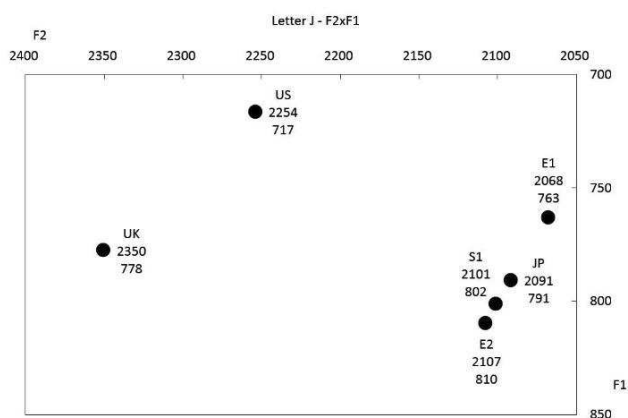


Fig. 28 F2 x F1 Graph. Letter J.

Nevertheless, the statistical comparisons of the F1 formants, which had the mean and standard deviation values given by JP (791, 48), S1(802, 43), E1(763, 52), E2 (810, 42), UK(778, 291), and US(717, 169), provided positive statistical similarities for all the comparisons between the groups of students and natives (Fig. 30 - left). However that did not mean that the comparisons of the percentiles were positives for most of the percentile values. In fact, Fig. 30 (right) says that JP and UK were not statistically different at 50%, 75%, and 90%; JP and US, at 50%, and 90%; S1 and UK, at 50%, 75%, and 90%; S1 and US, at 50, 90%, and 100%; E1 and UK, at 50%, 75%, and 90%; E1 and US, at 0%, 50%, 75%, and 90%; E2 and UK, at 50%, 75%, and 90%; E2 and US, at 50%, and 90%. These values mean that the groups of natives had a tendency to mimic, to some extent, the acoustical properties of the sounds generated by the natives in the last half of the sound length.

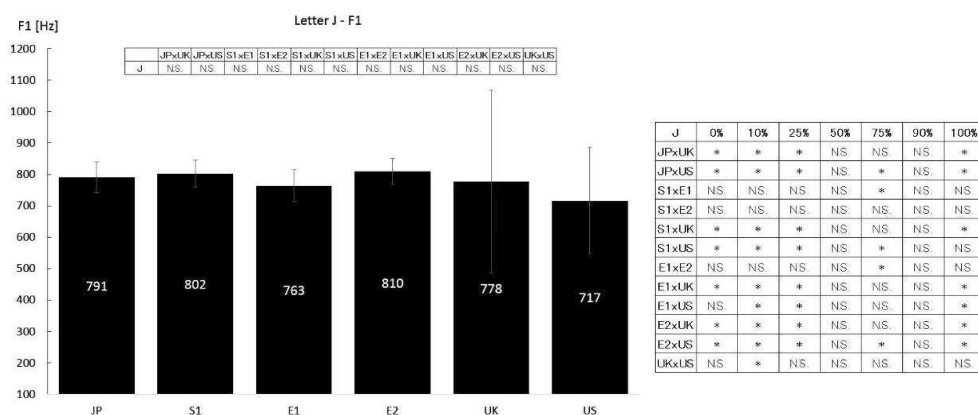


Fig. 29 Testing of F1. Left: whole utterance. Right: percentiles. Letter J.

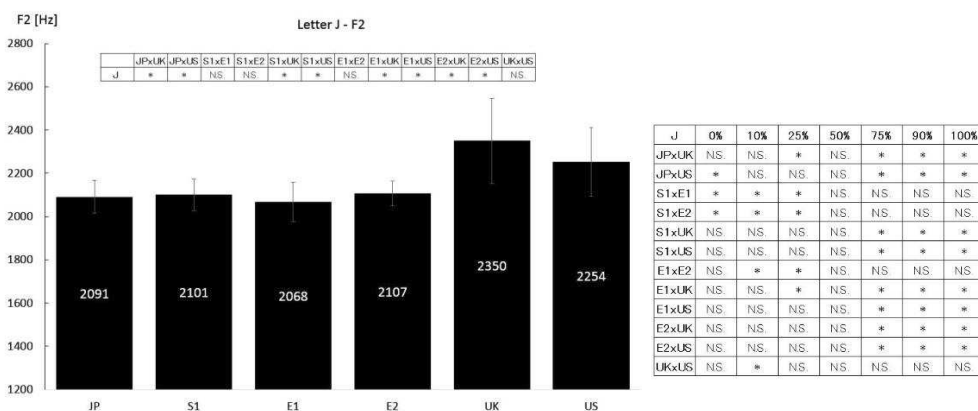


Fig. 30 Testing of F2. Left: whole utterance. Right: percentiles. Letter J.

As far as the comparisons of F2s are concerned, the results are pictured in Fig. 30 (left). The average and standard deviation values of F2 were JP (2091, 75), S1(2101, 73), E1(2068, 92), E2 (2107, 56), UK(2350, 197), and US(2254, 159). Benchmarking the groups of students against the groups of natives led to none of the groups of students being statistically similar to the groups of natives. Moreover, the comparisons of the percentiles (Fig. 30 - right) show that JP and UK were not statistically different at 0%, 10%, and 50%; JP and US, at 10%, 25%, and 50%; S1 and UK as well as S1 and US, at 0% through 50%; E1 and UK, at 0%, 10%, and 50%; E1 and US, at 0% through 50%; E2 and UK as well as US were also at 0%, 10%, 25%, and 50%. Clearly, the

positive similarities between these groups took part in the first half of the utterances.

## Letter K

The graph of F2 x F1 is given in Fig. 31. The groups had the points defined the duo consisting of F2 and F1 values and described as JP (2104, 785), S1(2095, 785), E1(2079, 757), E2 (2143, 818), UK(2375, 784), and US(2246, 676). The values of F1 mean that the group US had the smallest opening of the mouth whereas the group E2 the greatest. As a matter the fact, lining the groups from the smallest to widest opening, it became (US, E1, UK, S1, JP, E2). For the tongue positioning described by the F2 formants, the groups were aligned as (E1, S1, JP, E2, US, UK) in order of positioning in the back to forward places. This sequence shows that the groups of natives had the tongues positioned at points located in the front region of the mouth.

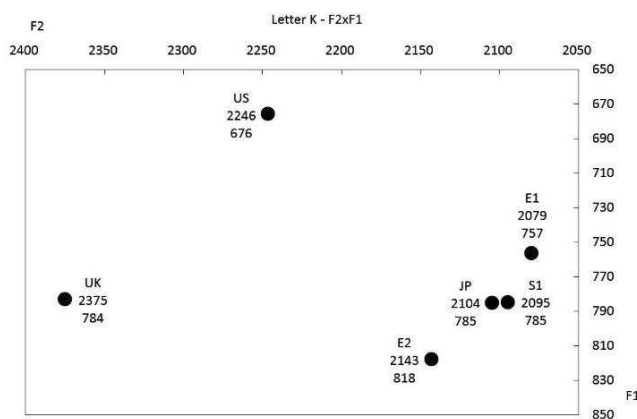


Fig. 31 F2 x F1 Graph. Letter K.

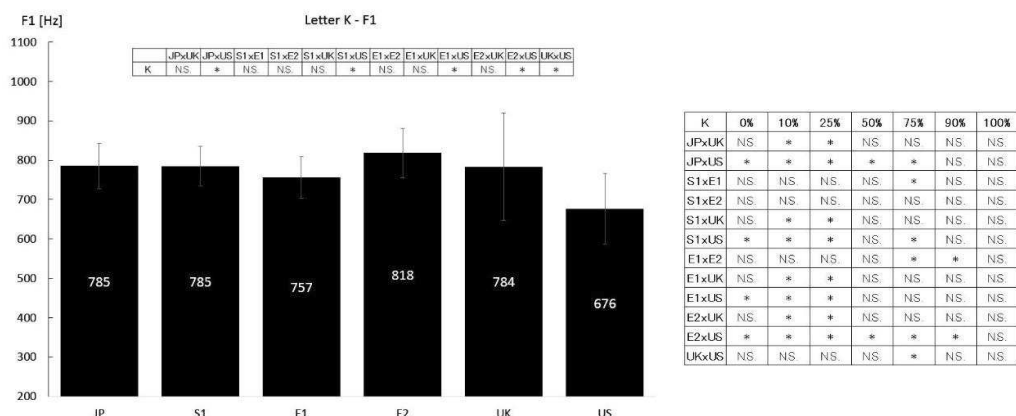


Fig. 32 Testing of F1. Left: whole utterance. Right: percentiles. Letter K.

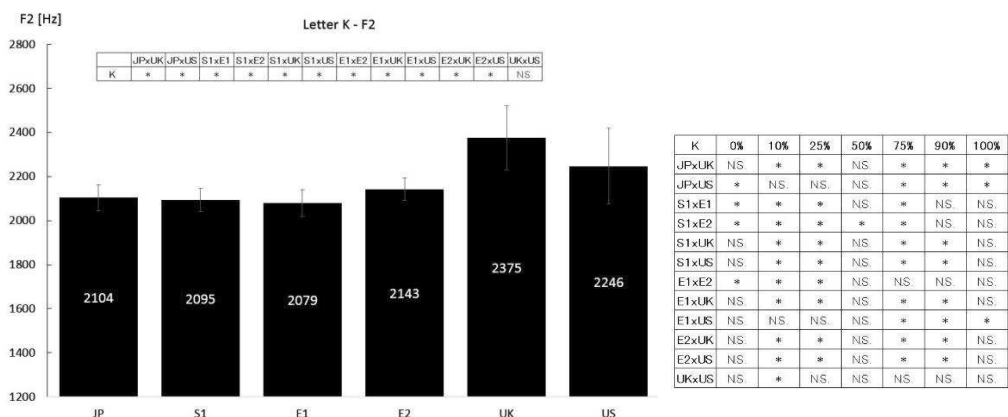


Fig. 33 Testing of F2. Left: whole utterance. Right: percentiles. Letter K.

Comparing the groups for F1s (Fig. 32, left), whose means and standard deviations of the groups were JP (785, 59), S1(785, 50), E1(757, 52), E2 (818, 63), UK(784, 136), and US(676, 90), showed that the groups of students were all not statistically different to the group UK. Yet, none of them was statistically similar to the group US. Note that UK and US were not similar. Fig. 32 (right) shows comparison results of the percentiles across the groups. In fact, JP and UK were statistically similar at 0%, 50%, 75%, 90%, and 100%; JP and US, at 90% and 100%; S1 and UK, at 0%, 50%, 75%, 90%, and 100%; S1 and US, at 50%, 90%, and 100%; E1 and UK, at 0%, 50% through 100%; E1 and US, at 50% to 100%; E2 and UK, at 0% and 50% to 100%; E2

and US, at 100% only. These similarities were verified mainly in the last half of the utterances.

As far as the comparisons of F2 are concerned, Fig. 33 (left) shows that these were carried out for the groups defined by JP (2104, 59), S1(2095, 53), E1(2079, 61), E2 (2143, 50), UK(2375, 146), and US(2246, 172), in which the first values stand for the means and the latter for the standard deviations. Now, the comparisons provided statistical similarities for none of the combinations of groups of students and natives. As for the comparisons of the percentiles, Fig. 33 (right) shows that JP and UK were statistically similar at 0% and 50%; JP and US, at 10%, 25%, and 50%; S1 and UK as well as S1 and US, at 0%, 50%, and 100%; E1 and UK, at 0%, 50%, and 100%; E1 and US, at 0%, 10%, 25%, and 50%; E2 and UK as well as E2 and US, at 0%, 50%, and 100%.

## Letter L

The points of UK and US on the graph F2 x F1 as shown in Fig. 34 were located in the right region whereas the groups of students were placed in the lower left part of the graph. Indeed, the values of F2 and F1 formants for the groups were JP (1944, 804), S1(1999, 798), E1(1917, 795), E2 (1914, 821), UK(1626, 795), and US(1568, 741).

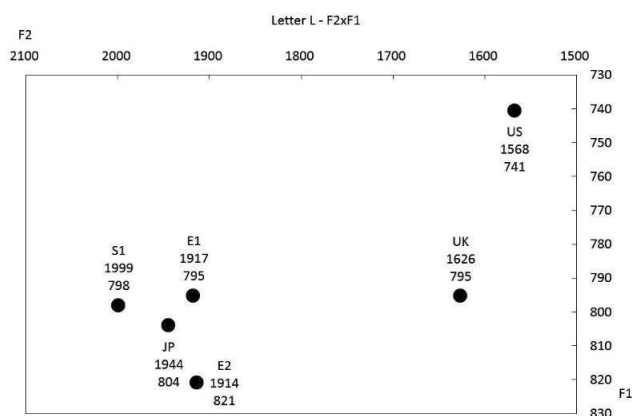


Fig. 34 F2 x F1 Graph. Letter L.

Ordering the F1s according to their values in increasing order, we had the sequence (US, UK, E1, S1, JP, E2), which means that the students opened their mouths wider than the natives. As for the F2s, the ordering sequence was (US, UK, E2, E1, JP, S1) with the native speakers placing their tongues in the frontal part of the mouth.

Fig 35 (left) depicts the results of the F1 statistical comparisons for the groups characterized by the averages and standard deviations as JP (804, 51), S1(798, 50), E1(795, 55), E2 (821, 50), UK(795, 87), and US(741, 65). It says that the groups of students were all not statistically different to the groups of natives. Furthermore, the groups S1 and E1 were also statistically similar to the group US. Actually, UK and US were also not different from each other. Focusing on the comparisons of the percentiles, Fig 35 (right) shows that JP and UK were not statistically different at 25%, 75%, 90%, and 100%; JP and US, at 10%, 25%, 50%, and 100%; S1 and UK, at all percentages but 0%; S1 and US, at 10%, 25%, 50%, and 100%; E1 and UK, at all percentages but 10%; E1 and US, at all percentages; E2 and UK, at all percentages but 10%; E2 and US, at 0%, 10%, 25%, 50%, and 100%.

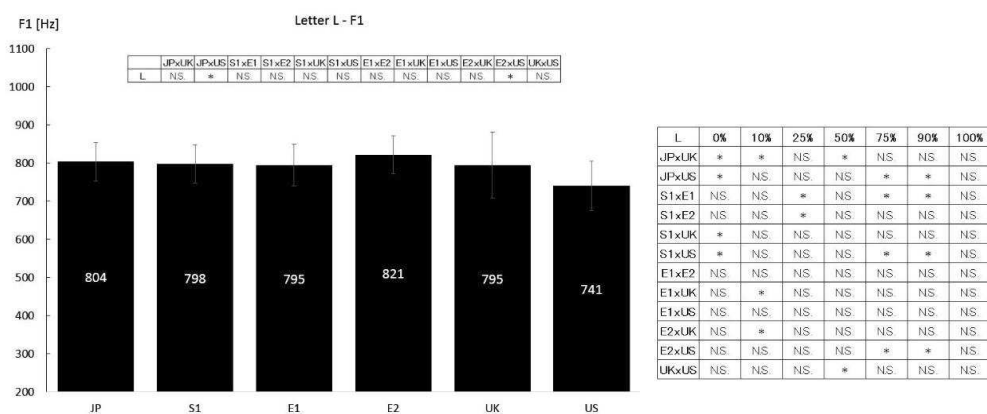


Fig. 35 Testing of F1. Left: whole utterance. Right: percentiles. Letter L.

The comparisons of F2s are given in Fig. 36. The groups had the means and deviations described by JP (1944, 133), S1(1999, 121), E1(1917, 127), E2 (1914, 149), UK(1626, 127), and US(1568, 107). Fig. 36 (left) indicates that

none of the groups of students were statistically similar to the groups of native speakers. As a matter of fact, Fig. 36 (right) shows that JP and UK were not statistically different at 90%, and 100%; JP and US, at 100%; S1 and UK, at 75%, 90%, and 100%; S1 and US, at 90%, and 100%; E1 and UK, at 0%, 50% through 100%; E1 and US, at 50%, and 100%; E2 and UK as well as E2 and US, at 75%, 90% and 100%.

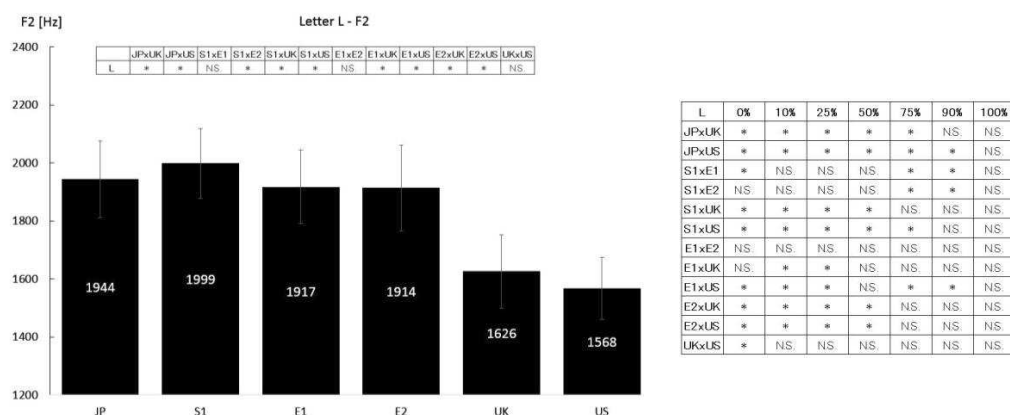


Fig. 36 Testing of F2. Left: whole utterance. Right: percentiles. Letter L.

## Letter M

Fig.37 gives the graph of F2 x F1, in which the groups had F2 and F1 formants expressed by JP (1992, 820), S1(1979, 778), E1(1971, 805), E2 (2030, 885), UK(1880, 681), and US(1779, 648). Sorting the groups from those with the smallest value (smallest aperture of the mouth) to the largest value (widest opening) led to the sequence (US, UK, S1, E1, JP, E2), which tells us that the groups of students made the utterances by opening their mouths wider than their native peers. As for F2, the sequence became (US, UK, E1, S1, JP, E2) with the groups of natives having the tongues in the back position compared to the students. The comparisons of F1s were carried out with the means and averages computed as JP (820, 98), S1(778, 52), E1(805, 101), E2 (885, 110), UK(681, 96), and US(648, 97).

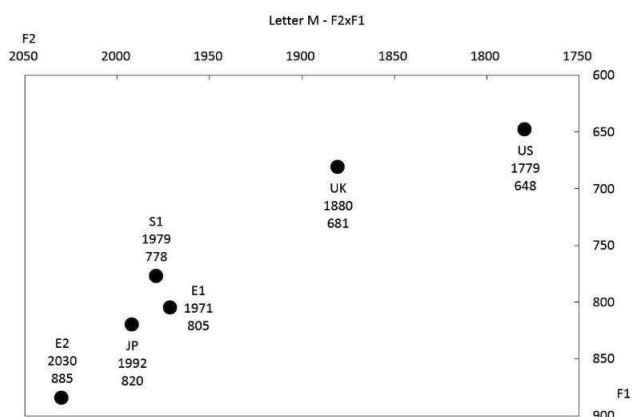


Fig. 37 F2 x F1 Graph. Letter M.

The results given in Fig. 38 (left) say that none of the groups of students were all statistically different from the groups of natives when paired for comparisons. Looking at the comparisons of the percentiles (Fig. 38 – right), we have that JP and UK are not statistically different at 0%, 50%, 75%, 90%, and 100%; JP and US, at 0% only; S1 and UK, at 0%, 50% to 100%; S1 and US, at 0%, 50%, 90%, and 100%; E1 and UK, at 0%, 50% to 100%; E1 and US, at 0%, 10%, 50%, 75%, and 100%; E2 and UK, at 0%, 50% to 100%; E2 and US, at 0% only. These positive correlations were seen mainly in the last half of the sound production.

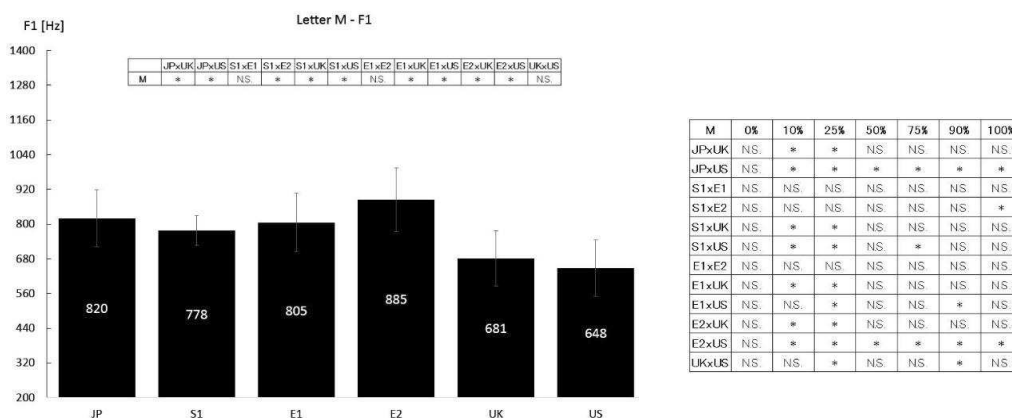


Fig. 38 Testing of F1. Left: whole utterance. Right: percentiles. Letter M.



For the F2 formants, the averages and deviations of the groups were JP (1992, 99), S1(1979, 91), E1(1971, 99), E2 (2030, 108), UK(1880, 152), and US(1779, 115). Fig. 39 (left) gives illustrates the statistical comparisons across the groups of students and natives. Statistical similarities were computed for the pairs S1 and UK, S1 and US, E1 and UK, and E2 and US. Fig. 39 (right) shows that nevertheless JP and UK were not statistically similar, the comparisons of the percentiles went positive for all values of percentages. JP and US were similar at 100%; S1 and UK as well as S1 and US, E1 and UK, E2 and UK, E2 and US were similar at all values of percentages. E1 and US, at 0%, 50%, and 100%. Thus, most of these comparisons turned out to be statistically similar.

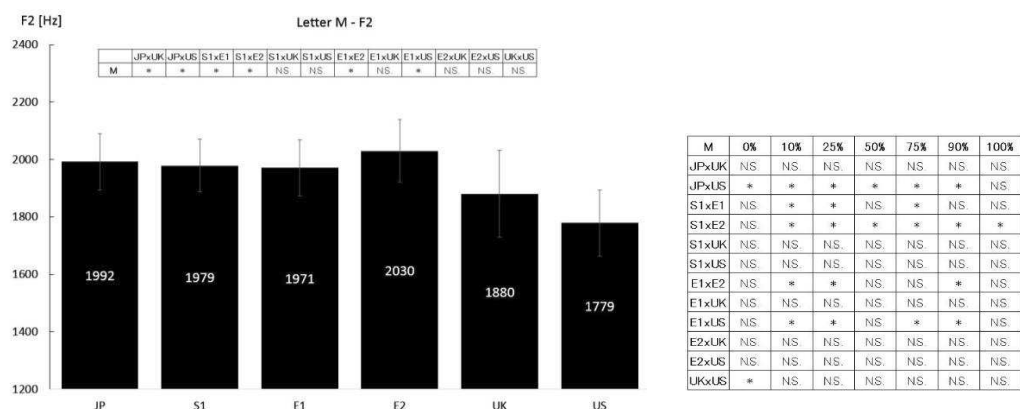


Fig. 39 Testing of F2. Left: whole utterance. Right: percentiles. Letter M.

## Letter N

Fig. 40 depicts the points of the F2 and F1 formants expressed as the graph F2 x F1. Actually, the values of F2 and F1 characterizing the groups were JP(1996, 789), S1(1997, 765), E1(1958, 757), E2(2039, 851), UK(1888, 749), and US(1853, 623). The sequence (US, UK, E1, S1, JP, E2) gives the groups ordered by the values of F1 formants from the smallest to the largest, so that the groups of students opened their mouth wider than the natives. Moreover, ordering the groups in increasing order of the values of F2, the sequence

became (US, E1, UK, JP, S1, E2) with the group US placing the tongue in the back deeper than the others whereas the group E2 placed somewhere more forwardly than the others.

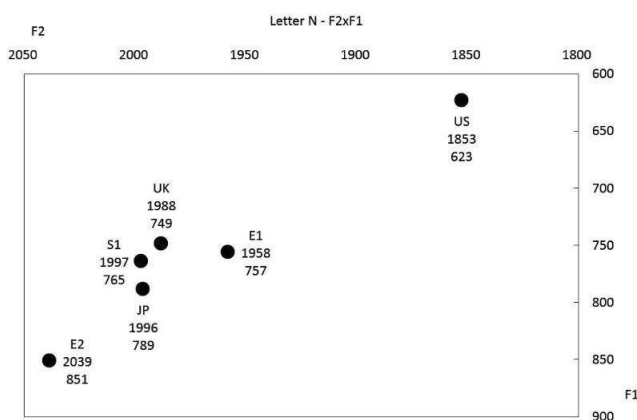


Fig. 40 F2 x F1 Graph. Letter N.

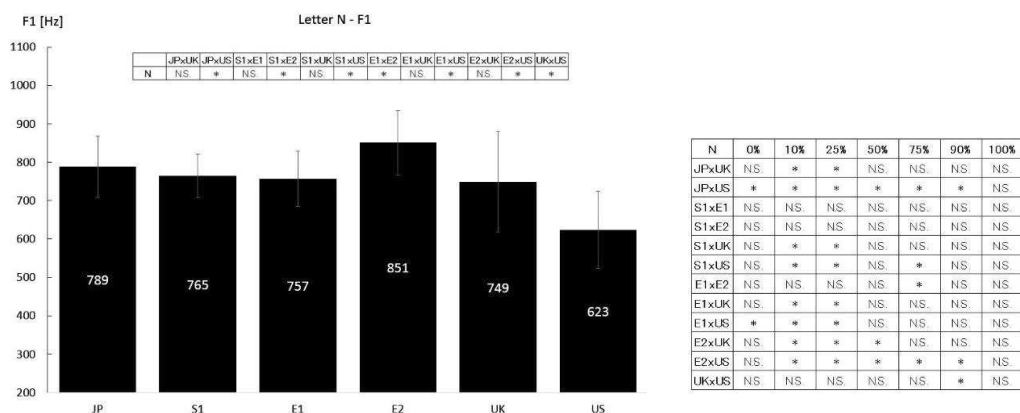


Fig. 41 Testing of F1. Left: whole utterance. Right: percentiles. Letter N.

Fig. 41 (left) depicts the comparison results of the F1s. The values of the means and variations were JP (789, 81), S1(765, 56), E1(757, 72), E2 (851, 84), UK(749, 131), and US(623, 101). It tells us that the groups of students were all statistically similar to the group UK, but none of them to the group US. Furthermore, Fig. 41 (right) shows that JP and UK were not statistically different at 0%, 50% to 100%; JP and US, at 100% only; S1 and UK, at 0%,

50% to 100%; S1 and US, at 0%, 50%, 90%, and 100%; E1 and UK, at 0%, 50% to 100%; E1 to US, at 50% to 100%; E2 and UK, at 0%, 75% to 100%; E2 and US, at 0% and 100%. It is clear that these positive correlations held primarily in the last half of the utterance generation.

Now, the comparison results of F2 formants with means and standard variations of the groups given by JP (1996, 82), S1(1997, 50), E1(1958, 101), E2 (2039, 75), UK(1988, 197), US(1853, 170) are given in Fig. 42 (left). In addition the pair S1 and US, all the groups of students were not statistically different from the group UK. Fig. 42 (right) figures the results of the percentile comparisons. From it, all the groups of students were statistically similar to the group UK for all values of percentages. As for the comparisons with US, JP and US were similar at 50% to 100%; S1 and US, at all percentages; E1 and US at 25% to 100%; E2 and US at all percentage values.

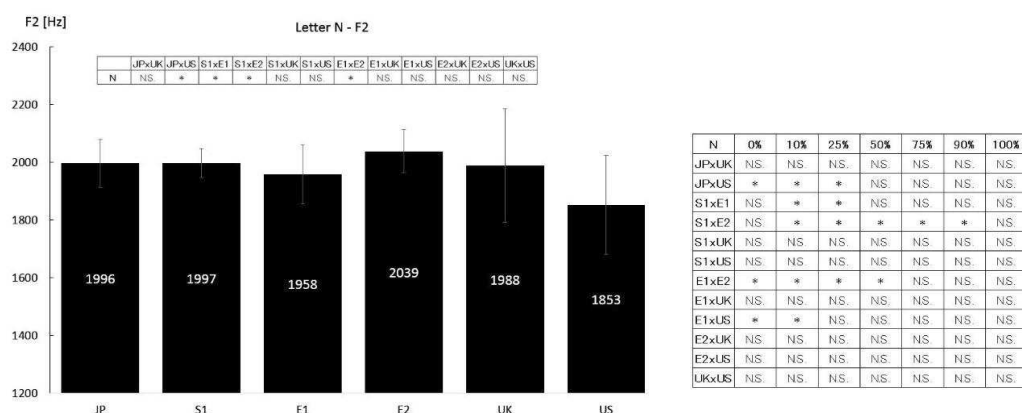


Fig. 42 Testing of F2. Left: whole utterance. Right: percentiles. Letter N.

## Letter O

Consider the groups be given by their F2 and F1 formants as JP (1557, 795), S1(1549, 807), E1(1522, 772), E2 (1606, 806), UK(1739, 635), and US(1313, 633) then the graph F2 x F1 is given by Fig. 43. Aligning the groups according to the values of F1 leads to (US, UK, E1, JP, E2, S1) with the leftmost representing the group with the closest position and the rightmost the widest open mouth. So, it shows that the groups of students showed their mouths

open wider than the natives. As for the sequencing of the groups according to the values of F2 formants, we have the ordering (US, E1, S1, JP, E2, UK) with the leftmost group having the tongue placed innermost and the rightmost group having the tongue in a outermost position.

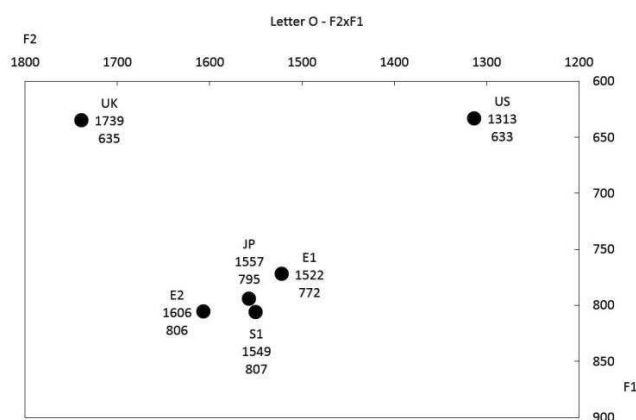


Fig. 43 F2 x F1 Graph. Letter O.

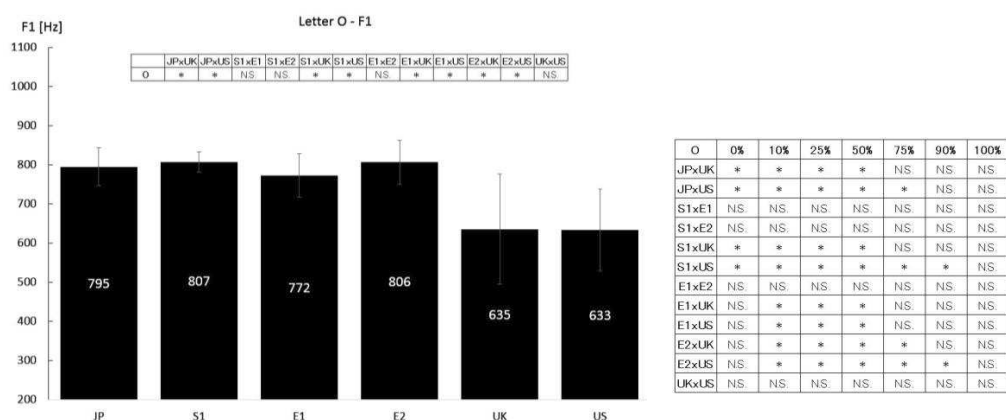


Fig. 44 Testing of F1. Left: whole utterance. Right: percentiles. Letter O.

Fig. 44 (left) depicts the statistical comparisons of the F1s across the groups, which were characterized by the means and standard variations as JP (795, 49), S1(807, 26), E1(772, 55), E2 (806, 57), UK(635, 141), and US(633, 104). The graph shows that there were no groups of students, which were statistically similar to the groups of natives. As for the comparisons of the percentiles are

given in Fig. 44 (right). JP and UK were statistically similar at 75%, 90% and 100%; JP and US, at 90% and 100%; S1 and UK, at 75%, 90%, and 100%; S1 and US, at only 100%; E1 and UK as well E1 and US, at 0%, 75%, 90%, and 100%; E2 and UK, at 0%, 90%, and 100%; E2 and US, at 0%, and 90%. Despite the fact that the groups of students were statistically different from the groups of natives, the comparisons of the percentiles came up with statistical similarities at a number of percentages. Yet, these correlations were seen mostly in the last half of the utterance generation.

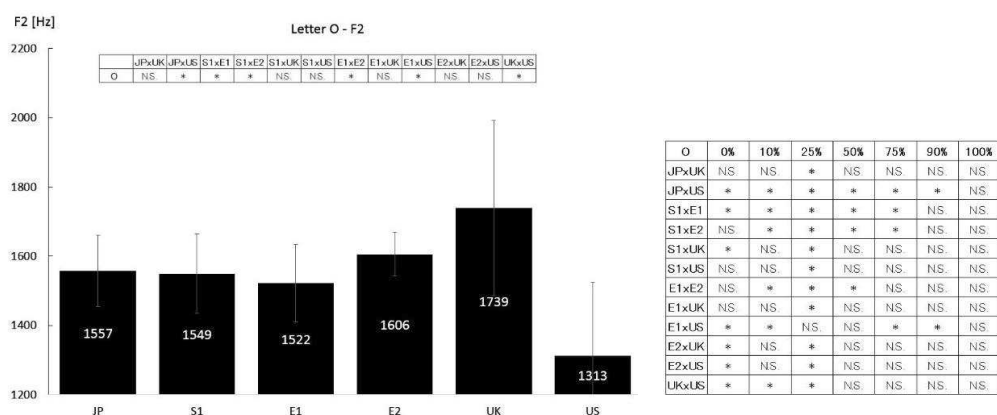


Fig. 45 Testing of F2. Left: whole utterance. Right: percentiles. Letter O.

Fig. 45 (left) presents the comparison results for F2 formants across the groups, which were expressed in terms of averages and standard variations as JP (1557, 103), S1(1549, 114), E1(1522, 112), E2 (1606, 63), UK(1739, 253), and US(1313, 212). It tells us that all the groups of students were not statistically different from the groups of natives. Furthermore, Fig. 45 (left) yields the results of the percentiles comparisons which say that JP and UK were statistically similar at all percentages but 25%; JP and US, at 100% only; S1 and UK at 10%, 50% to 100%; S1 and US as well E1 and UK, at all percentages but 25%; E1 and US, at 25%, 50%, and 100%; E2 and UK as well as E2 and US, at 10%, 50% to 100%.

## Letter P

The sounds of this letter had F2 and F1 formants characterizing the groups as JP(2127, 693), S1(2076, 693), E1(2115, 654), E2 (2197, 737), UK(2540, 653), and US(2322, 589). These points are plotted on the graph F2 x F1 depicted in Fig. 46. Sorting the groups following the values of F1 from the smallest to the largest allows us to write the sequence (US, UK, E1, S1, JP, E2), in which the group US is the component with less mouth opening whereas E2 the largest. Now, the sorting of the group based on F2 values led to the sequence (S1, E1, JP, E2, US, UK) meaning that the UK was the group with the tongue placed at an outermost point of the mouth.

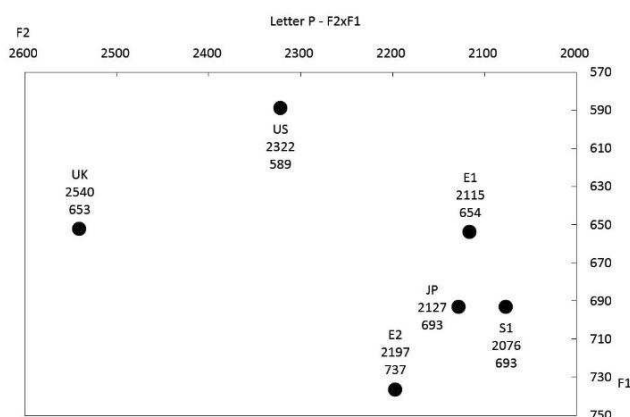


Fig. 46 F2 x F1 Graph. Letter P.

The testing of the F1s across the groups is shown in Fig. 47 (left). There the values of the means and standard deviations were JP (693, 60), S1(693, 38), E1(654, 53), E2 (737, 62), UK(653, 186), and US(589, 125). Not only were the groups of students all statistically similar to the groups of natives, but also was the group E1 similar to US. Still, Fig. 47 (right) shows that JP and UK were similar at 0%, 75% to 100%; JP and US, at 0%, 50%, and 100%; S1 and UK, at 0%, 75% to 100%; S1 and US, at all percentages but 75%; E1 and UK, at 0%, 75% to 100%; E1 and US, at 0%, 50% to 100%; E2 and UK, at 0%, 75%

to 100%; E2 and US, at 0%, 25%, 50%, and 100%.

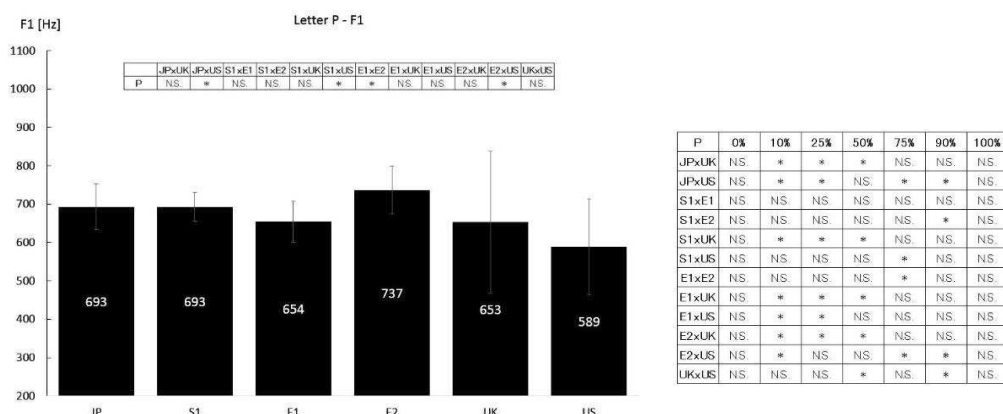


Fig. 47 Testing of F1. Left: whole utterance. Right: percentiles. Letter P.

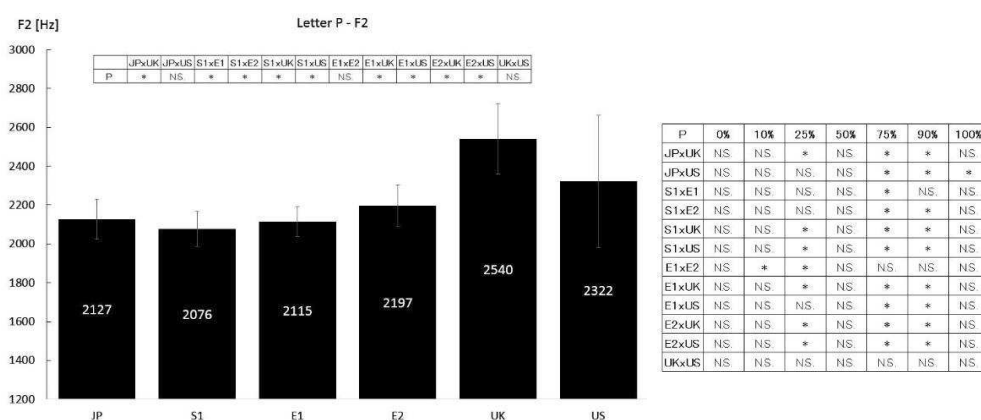


Fig. 48 Testing of F2. Left: whole utterance. Right: percentiles. Letter P.

On the other hand, the comparisons of F2 led to Fig. 48 (left), in which the groups had the mean and standard deviation values given by JP (2127,102 ), S1(2076, 91), E1(2115, 77), E2 (2197, 107), UK(2540, 182), and US(2322, 341). Here, amongst the groups of students, only the group JP was statistically similar to the group US. Fig. 48 (right) presents the comparison results of the percentiles. JP and UK were statistically not different from each other at 0%, 10%, 50%, and 100%; JP and US, at 0% to 50%; S1 and UK as well as S1 and US, at 0%, 10%, 50%, and 100%; E1 and UK, at 0%, 10%, 50%, and 100%; E1 and US, at 0% to 50%, and 100%; E2 and UK as well as E2 and US, at 0%,

10%, 50%, and 100%.

### Letter Q

Fig. 49 depicts the graph of F2 x F1, whose points were JP (1999, 731), S1(1974, 737), E1(2032, 696), E2 (1990, 763), UK(2076, 785), and US(1967, 648) with the first values in the duplex standing for F2s and the second for F1s. Sorting the groups from smaller to larger values of F1s led to the sequence (US, E1, JP, S1, E2, UK), in which the group US had the smallest mouth opening and UK the widest. In addition, the ordering according to the values of F2 rendered (US, S1, E2, JP, E1, UK), which has US with the tongue back in the mouth and UK forwardly placed. The results mean that the group US located in the upper right region whereas UK in the lower left plane.

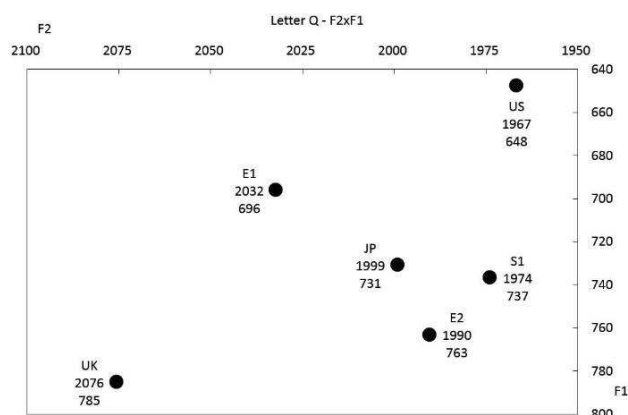


Fig. 49 F2 x F1 Graph. Letter Q.

Fig. 50 (left) provides the comparison results for the F1 formants. The values of the means and standard deviations compared were JP (731, 59), S1(737, 43), E1(696, 46), E2 (763, 73), UK(785, 176), and US(648, 148). For this letter, all the groups of students were statistically similar to the groups of natives when compared in pairs. From Fig. 50 (right), JP and UK were similar at 0% and 75%; JP and US at 50% to 100%; S1 and UK, at 0% and 75%; S1 and US, at all percentages but 10%; E1 and UK, at 0%, and 75%; E1 and US, at 25% to 100%; E2 and UK, at 0%, and 75%; E2 and US, at 0%, 25%, 90%, and 100%.



Note that the similarities were seen more frequently in the last part of the utterance. Also, the number of points, at which the groups of students and natives are similar, are greater when comparing the groups of students and US, than the students and UK.

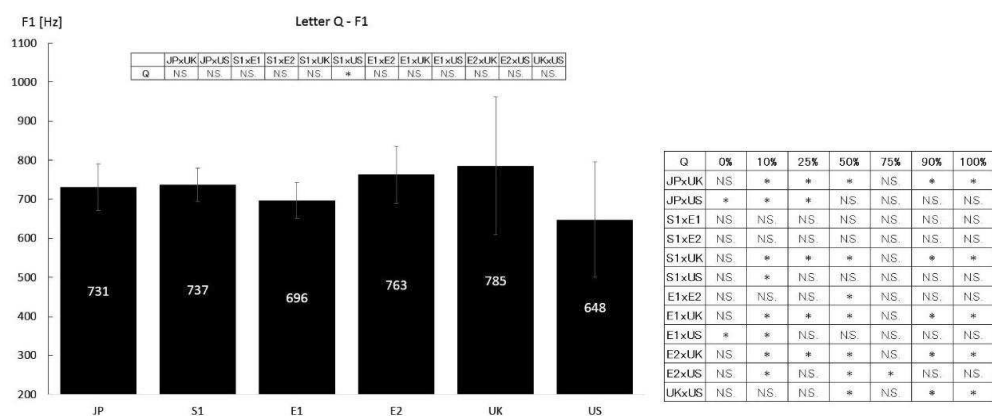


Fig. 50 Testing of F1. Left: whole utterance. Right: percentiles. Letter Q.

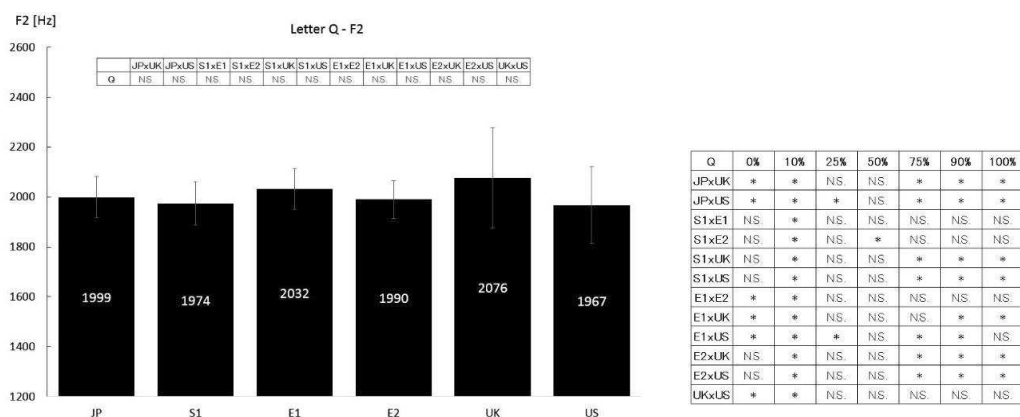


Fig. 51 Testing of F2. Left: whole utterance. Right: percentiles. Letter Q.

For the mean and standard deviation values of F2 and the groups characterized by JP (1999, 82), S1(1974, 87), E1(2032, 81), E2 (1990, 76), UK(2076, 202), and US(1967, 154), Fig. 51 (left) shows that the groups of students were all similar to the groups of natives when the contrastive analysis was carried out. Moreover, from Fig. 51 (right), JP and US were similar at

25% and 50%; JP and US, at 50%; S1 and UK as well as S1 and US, at 0%, 25% and 50%; E1 and UK, at 25% to 75%; E1 and US, at 50% and 100%; E2 and UK as well as E2 and US, at 0%, 25% and 50%. Unlike in the case of F1s, the number of percentage points, at which the groups of students and either UK or US are similar, is approximately the same.

## Letter R

Fig. 52 gives the graph of F2 x F1, whose points were JP(1681, 874), S1(1729, 843), E1(1652, 874), E2 (1660, 910), UK(1425, 848), and US(1542, 787) with the first value in the parenthesis standing for the F2 and the second one for F1. The sequence (US, S1, UK, E1, JP, E2) is obtained by putting the groups in ascending order of F1 values; thus US is the group having the smallest mouth opening whereas E2 the greatest. Analogously, the sequence (UK, US, E1, E2, JP, S1) is established by aligning the groups in increasing order of F2 values. This sequence means that UK hold the tongue in the inner back part of the mouth whereas S1 in the outer most part.

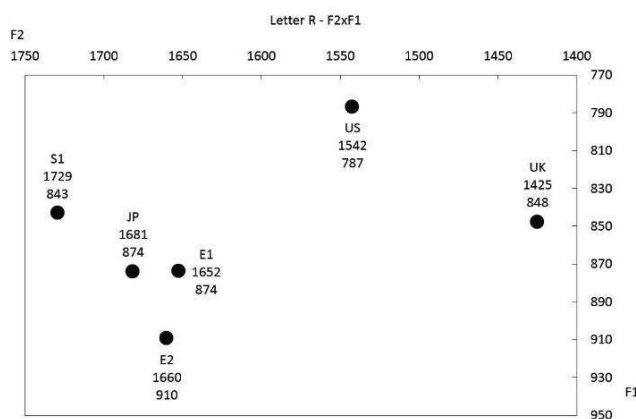


Fig. 52 F2 x F1 Graph. Letter R.

The mean and standard deviation values of F1 characterized the groups as JP(874, 56), S1(843, 54), E1(874, 56), E2 (910, 42), UK(848, 117), and US(787, 99), and the statistical comparisons of the groups yielded the results

as in Fig. 53 (left). In fact, it shows that the groups of students were statistically not different from the groups of natives for all the combinations possible. In addition, the group S1 and US were also statistically similar to each other. From Fig. 53 (right), the groups JP and UK as well as S1 and JP, E1 and UK, and E2 and UK were all statistically similar at all percentage points. JP and US were similar at 0%, 10%, and 100%; S1 and US, at all percentage points but 75%; E1 and US, at 0%, 10%, 90%, and 100%; E2 and US, at 0%, 50%, 90%, and 100%.

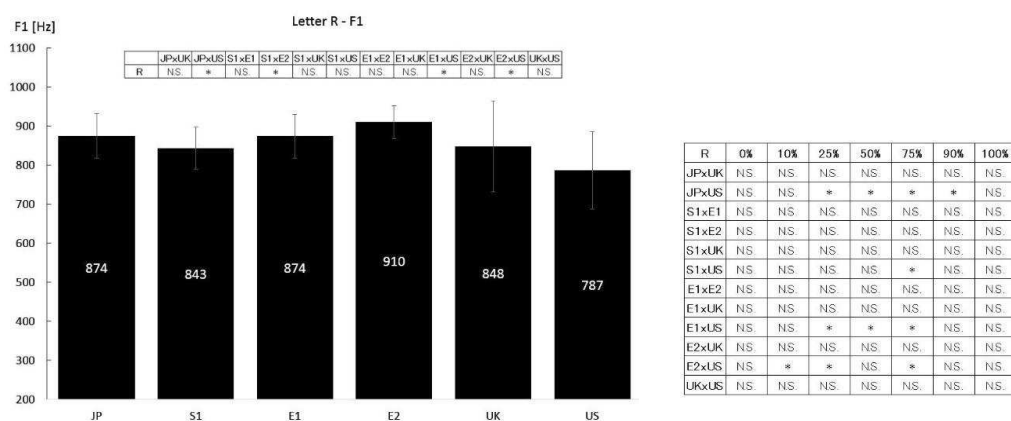


Fig. 53 Testing of F1. Left: whole utterance. Right: percentiles. Letter R.

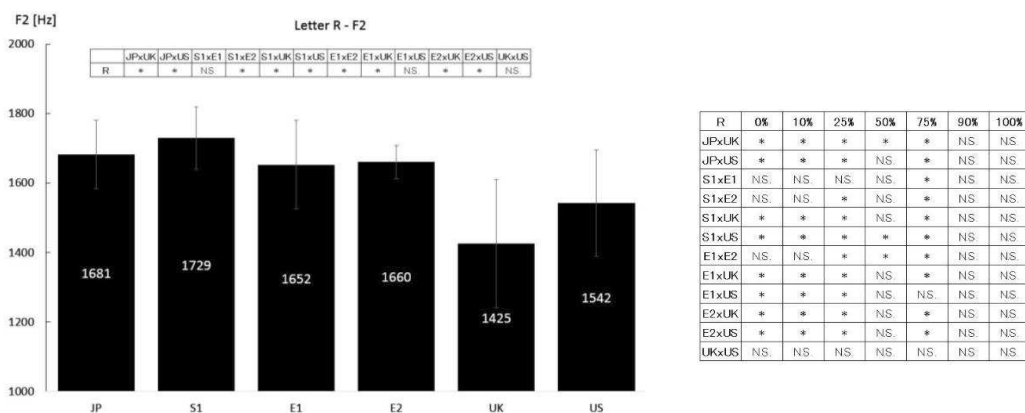


Fig. 54 Testing of F2. Left: whole utterance. Right: percentiles. Letter R.

As far as the comparisons of F2 are concerned, the mean and standard

variations values typifying the groups were JP (1681, 98), S1(1729, 89), E1(1652, 127), E2 (1660, 47), UK(1452, 185), and US(1542, 153). The statistical comparisons are as portrayed in Fig. 54 (left), which shows that none of the groups of students was statistically similar to the groups of natives. Furthermore, from Fig. 54 (right), the groups JP and UK were similar at 90% and 100%; JP and US, at 50%, 90%, and 100%; S1 and UK, at 50%, 90%, and 100%; S1 and US, at 90% and 100%; E1 and UK, at 50%, 90% and 100%; E1 and US, at 50% to 100%; E2 and UK as well as E2 and US, at 50%, 90%, and 100%.

## Letter S

The graph of F2 x F1 is outlined in Fig. 55. The F2 and F1 formants representing the groups are written as JP(2042, 958), S1(2041, 916), E1(2061, 1014), E2 (2020, 943), UK(2219, 1174), and US(2006, 921). By ordering the groups according to their F1 values taken from the smallest to the largest defined the sequence (S1, US, E2, JP, E1, UK) with the leftmost group S1 having the smallest mouth aperture, and the rightmost group UK having the largest one. On the other hand, taking into account the values of F2 determined the sequence (US, E2, S1, JP, E1, UK), which means that the group US had the tongue back inside the mouth and UK hold it in a forward position.

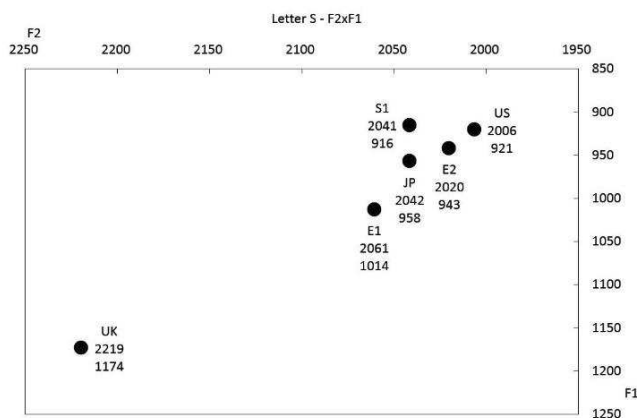


Fig. 55 F2 x F1 Graph. Letter S.

Fig. 56 (left) was accomplished by statistically comparing the groups specified by the means and standard deviations of F1s leading to the nomenclature JP(958, 89), S1(916, 60), E1(1014, 115), E2 (943, 51), UK(1174, 245), and US(921, 133). The groups of students were all statistically similar to the group US. Moreover, the groups JP and UK as well as E1 and UK were not statistically different. Fig. 56 (right) allows us to assert that JP and US as well as S1 and US, E1 and UK, E1 and US, E2 and US were not different from the statistical point of view. As for the groups JP and UK as well as S1 and UK, E2 and UK, they were not different at 0%, 50% to 100%.

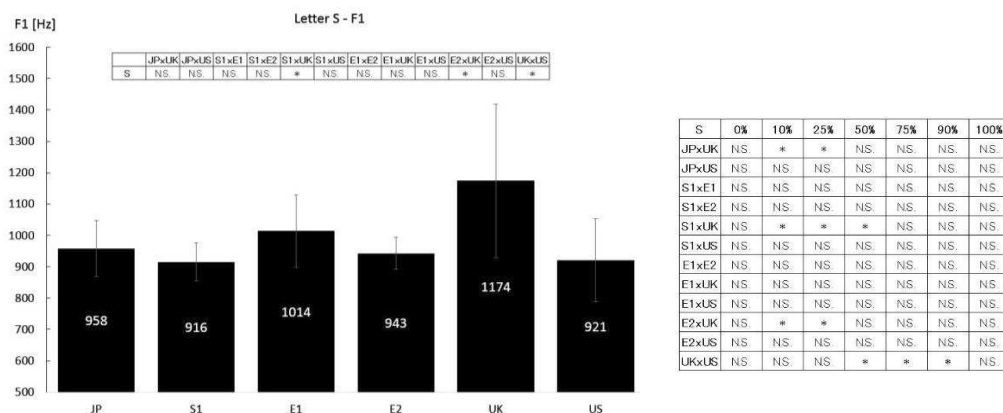


Fig. 56 Testing of F1. Left: whole utterance. Right: percentiles. Letter S.

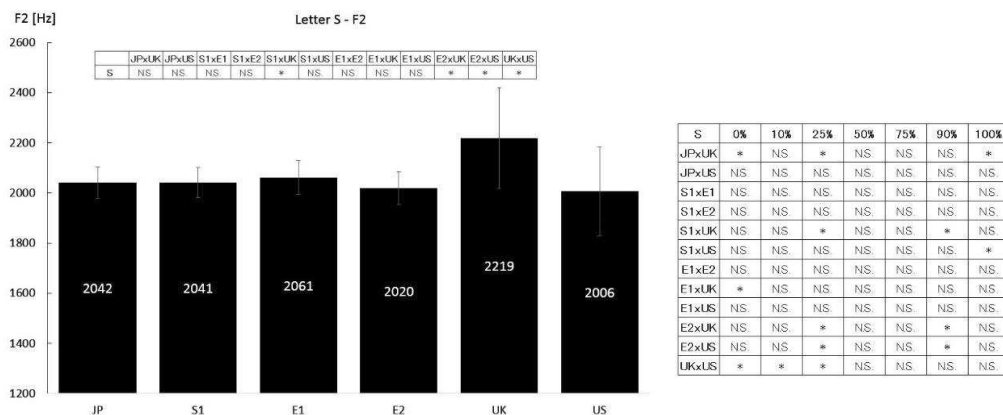


Fig. 57 Testing of F2. Left: whole utterance. Right: percentiles. Letter S.

Fig. 57 (left) is regarded to the comparisons of F2s across the groups. As a matter of fact, the averages and standard deviations featured the groups as JP(2042, 64), S1(2041, 60), E1(2061, 67), E2 (2020, 66), UK(2219, 201), and US(2006, 177). It is seen that JP and UK, JP and US, S1 and US, E1 and UK, and E1 and US were not statistically different from the group US. What is more, from Fig. 57 (right), JP and US as well as S1 and US, E1 and US were not different from the group US at all percentage points. JP and UK were similar to each other at 10%, 50% to 90%; S1 and UK, at 0, 10%, 50%, 75%, 90%, and 100%; E1 and UK, at 10% to 100%; E2 and UK, at 0%, 10%, 50%, 75%, and 100%.

## Letter T

Fig. 58 shows the points F2 and F1 plotted as the graph F2xF1. These points represent the groups, which had the following values: JP(2116, 719), S1(2097, 705), E1(2101, 662), E2 (2155, 799), UK(2511, 623), and US(2351, 605). Focusing on the rounding of the lips (opening of the mouth), the groups were aligned as (US, UK, E1, S1, JP, E2) in increasing order of F1. This sequencing means that the students opened their mouths more than the native speakers during the sound production. From the tongue positioning standpoint, the sequence became (S1, E1, JP, E2, US, UK) as we considered the values of F2 in increasing order. Thus, the groups of students can be considered as ‘back positioning’ strategy for moving their tongues in oppose to ‘forward positioning’ of the groups of natives. Taking into account that the mean and standard deviation values of F1 for the groups were JP (719, 78), S1(705, 59), E1(662, 50), E2 (799, 55), UK(623, 196), and US(605, 77), and performing the statistical comparisons we get Fig. 59 (left). It shows that the groups of students were all statistically similar to the groups of natives. Still, E1 was also similar to US. Spot lighting Fig. 59 (right), we see that JP and UK were similar at 0%, 75% to 100%; JP and US, at 0%, 90%, and 100%; S1 and UK as well as S1 and US, and E1 and UK, at 0%, 75% to 100%; E1 and US, at 0%,

50% to 100%; E2 and UK, at 0%, 75% to 100%; E2 and US, at 0% and 100%. Thus, the comparisons of the percentiles indicate that the similarities were present mainly in the last half of the utterances.

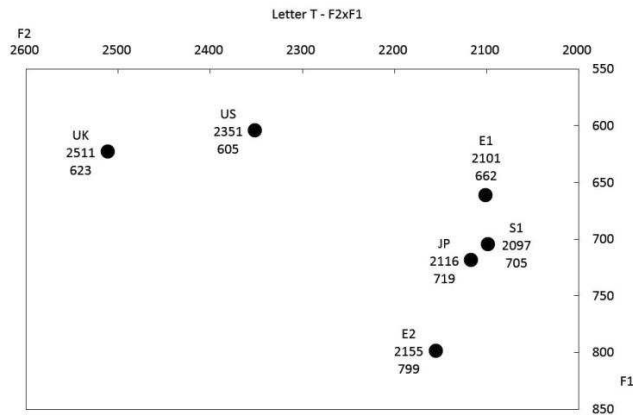


Fig. 58 F2 x F1 Graph. Letter T.

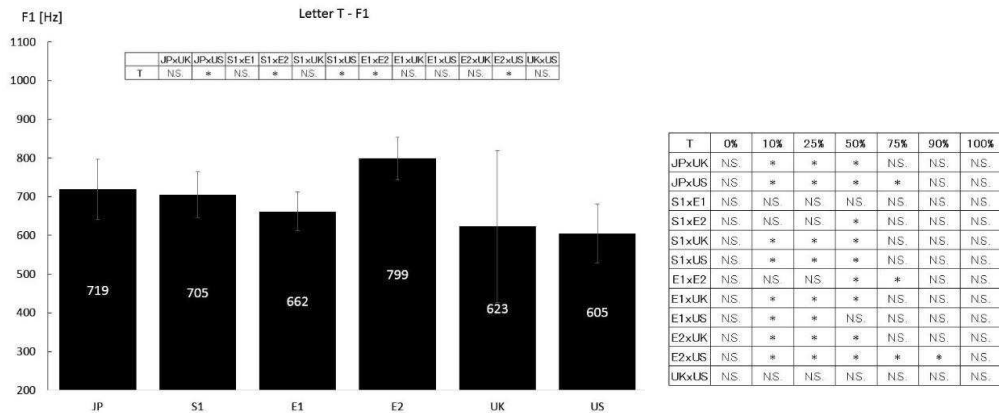


Fig. 59 Testing of F1. Left: whole utterance. Right: percentiles. Letter T.

The comparison results of F2s across the groups are depicted in Fig. 60 (left). The numerical values of the groups were JP(2116, 125), S1(2097, 129), E1(2101, 137), E2 (2155, 113), UK(2511, 163), and US(2351, 302). In this case, the comparisons of the groups of students with the groups the natives led to the group E1 being not different from US. Furthermore, Fig. 60 (right) says that the pairs JP and UK as well as S1 and UK, E1 and UK, and E2 and UK

were not different at 0%, 50%, and 100%; JP and US as well as E1 and US, at 0% to 50%, and 100%; S1 and US as well as E2 and US, at 0%, 50%, and 100%. Hence, the ‘NS’ pairs were mainly seen in the first half of the sounds.

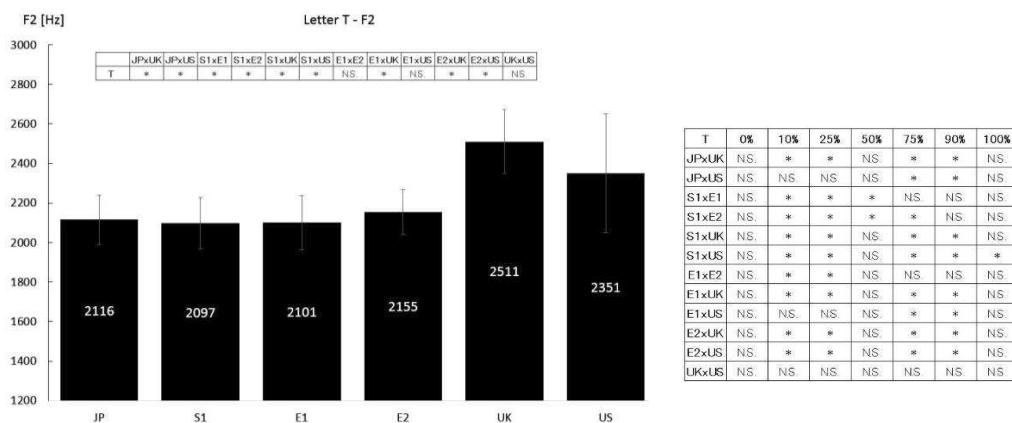


Fig. 60 Testing of F2. Left: whole utterance. Right: percentiles. Letter T.

## Letter U

The points of F2 and F1 formants of the groups characterized by JP(1985, 640), S1(1975, 656), E1(2006, 596), E2 (1971, 670), UK(1968, 433), and US(1887, 500) are placed on the graph F2 x F1 in Fig. 61. Thus, the sequence (UK, US, E1, JP, S1, E2) representing the openness of the mouth is obtained by ordering the F1s in increasing order of their values.

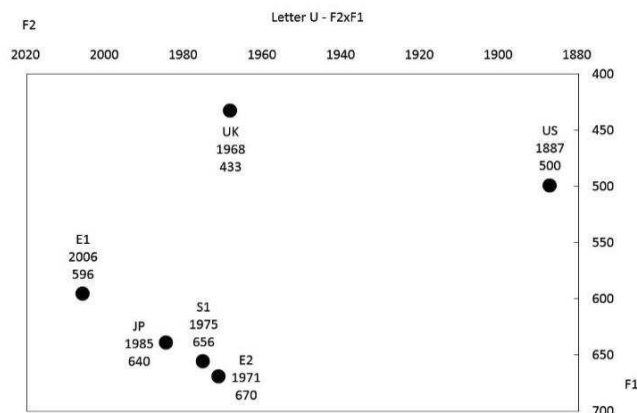


Fig. 61 F2 x F1 Graph. Letter U.



From this, we see that the groups of students opened their mouths wider than the groups of natives. Now considering the F2s to sequence the groups leads to (US, UK, E2, S1, JP, E1), which means that groups of students moved their tongues forward during the sound generation process.

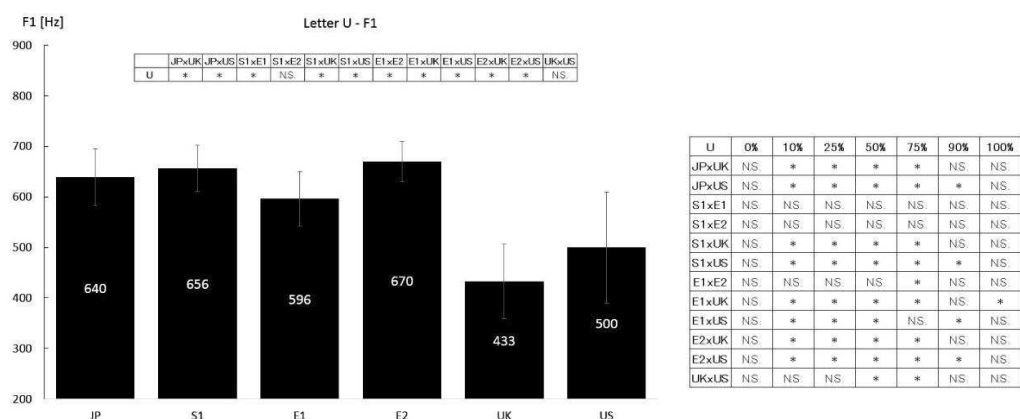


Fig. 62 Testing of F1. Left: whole utterance. Right: percentiles. Letter U.

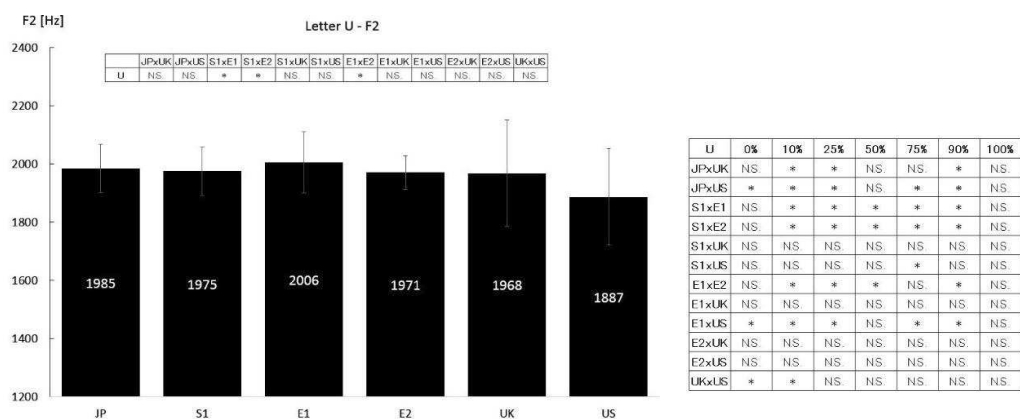


Fig. 63 Testing of F2. Left: whole utterance. Right: percentiles. Letter U.

Comparisons of the F1s gave Fig. 62 (left). The mean and standard deviation values considered to perform them were JP(640, 56), S1(656, 46), E1(596, 54), E2 (670, 39), UK(433, 74), and US(500, 110). Benchmarking the groups of students against the groups of natives did not give similar pairs. From Fig. 62

(right), JP and UK were not different at 0%, 90% and 100%; JP and US, at 0%, and 100%; S1 and UK, at 0%, 90%, and 100%; S1 and US, at 0%, and 100%; E1 and UK, at 0%, and 90%; E1 and US, at 0%, 75%, and 100%; E2 and UK, at 0%, 90%, and 100%; E2 and US, at 0%, and 100%.

For the comparisons of F2s (Fig. 63 - left), the values of the groups were JP (1985, 83), S1(1975, 83), E1(2006, 104), E2 (1971, 58), UK(1968, 183), and US(1887, 167). Unlike the F1 case, here the groups of students were all not different from the groups of natives. In addition, the comparisons of the percentiles shown in Fig. 63 (right) allow us to state that JP and UK were not different at 0%, 50%, 75%, and 100%; JP and US, at 50%, and 100%; S1 and UK as well as E1 and UK, E2 and UK, and E2 and US, at all the percentage points; S1 and US, at all the points but 75%; E1 and US, at 50%, and 100%. We that that the comparisons of the percentiles also provide a great deal of pairs being not statistically different.

## Letter V

Fig. 64 shows the points of the groups defined by JP(2060, 714), S1(2022, 731), E1(2042, 667), E2 (2121, 747), UK(2411, 582), and US(2220, 502), in which the first number of the duo means F2 formants and the second one F1s.

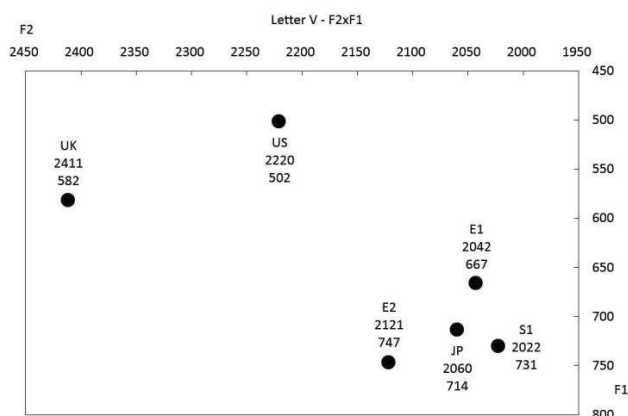


Fig. 64 F2 x F1 Graph. Letter V.

Taking the groups in order of increasing values of F1, we have (US, UK, E1, JP, S1, E2), which means that the groups of students had their mouths open wider than the groups of natives. In the same way, considering F2s, the sequence translates into (S1, E1, JP, E2, US, UK) with the groups of the students having their tongues in the back part of the mouth and the natives leaving them forward in their mouths.

The results of the F1 comparisons are given in Fig. 65 (left). Here the mean and standard deviation values of the groups read JP (714, 78), S1(731, 86), E1(667, 83), E2 (747, 28), UK(582, 205), and US(502, 124). Statistically speaking, the groups of students were all not different from the group UK when compared pair-wisely. Fig. 65 (right) says that the group JP and UK were not statistically different from each other at 0%, 75% to 100%; JP and US, at 90% and 100%; S1 and UK, at 0%, 75% to 100%; S1 and US, at 90% and 100%; E1 and UK, at 75% to 100%; E1 and US, at 90%, and 100%; E2 and UK, at 0%, 75% to 100%; E2 and US, at 0%, and 100%. It is clear that these ‘NS’s were mostly observed at percentage points greater than 50%.

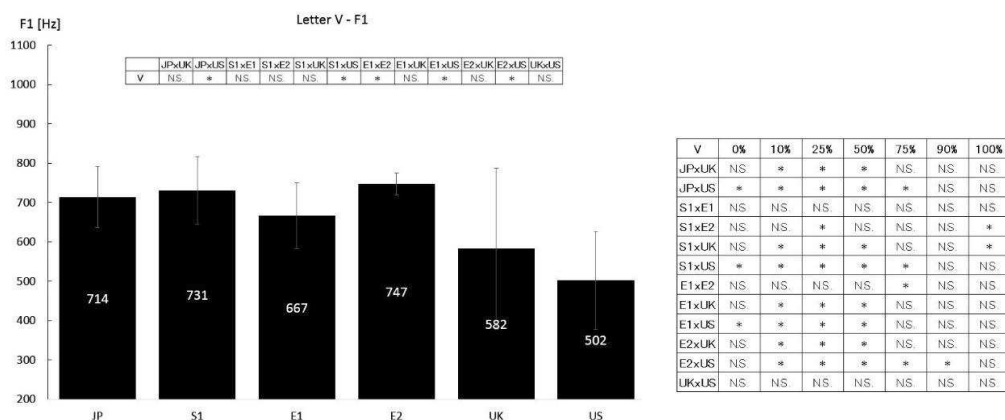


Fig. 65 Testing of F1. Left: whole utterance. Right: percentiles. Letter V.

The comparisons of F2s were performed taking into account the F2s and F1s of the groups given by JP(2060, 75), S1(2022, 52), E1(2042, 50), E2 (2121, 86), UK(2411, 231), and US(2220, 332). As shown in Fig. 66 (left) the comparisons turned out to be ‘NS’ for the couples JP and US, and E1 and US.

Now, going through the comparisons of percentiles Fig. 66 (right), we have that JP and UK were not statistically difference from each other at , 0% to 50%; JP and US, at 0% to 50%, and 100%; S1 and UK, at 0% to 50%, and 100%; S1 and US, at 0% to 50%; E1 and UK, at 0%, 10%, and 50%; E1 and US, at 0% to 50%, and 100%; E2 and UK as well as E2 and US, at 0% to 50%, and 100%. The point is that these ‘NS’ came up at percentage values smaller than 50%.

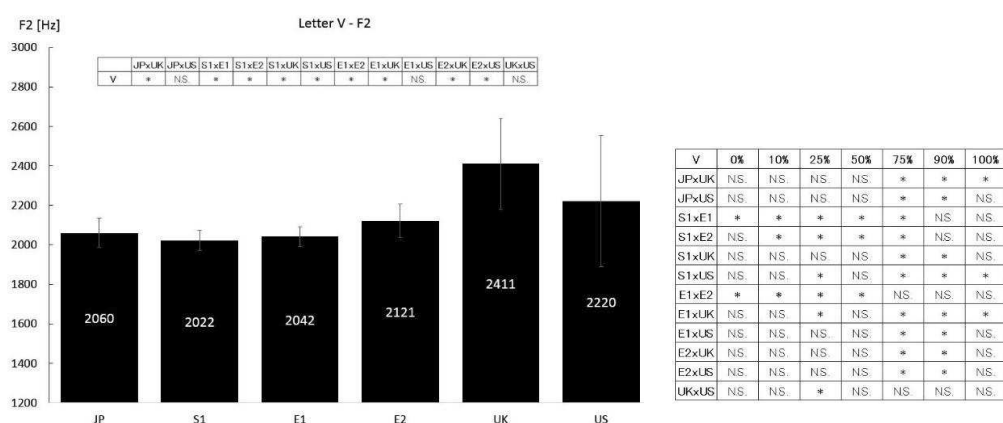


Fig. 66 Testing of F2. Left: whole utterance. Right: percentiles. Letter V.

## Letter W

Fig. 67 shows the graph of F2 x F1 for the groups featured by JP(1923, 684), S1(1897, 675), E1(1934, 668), E2 (1940, 713), UK(1844, 526), and US(1734, 562), in which the first numbers mean F2s and the second ones F1s. Sorting the groups on the basis of the F1 values yields (UK, US, E1, S1, JP, E2) whereas F2 values renders (US, UK, S1, JP, E1, E2). The former means that the groups of students had the mouth opening bigger than the natives, whereas the latter implies that the groups of students laid their tongues not as back as the natives.

The statistical comparisons of F1s are given in Fig. 68 (left). For this, the values of the means and deviations were JP(684, 66), S1(675, 65), E1(668, 66), E2 (713, 66), UK(526, 121), and US(562, 64). Comparisons of the groups of

students with the groups of natives did not gave ‘NS’ in none of cases. The comparison results of the percentiles are given in Fig. 68 (right). JP and UK were not statistically different from each other at 0%, 90%, and 100%; JP and US, at 0%, 25%, and 100%; S1 and UK, at 0%, 90%, and 100%; S1 and US, at 0%, 25%, 90%, and 100%; E1 and UK, at 0%, 90%, and 100%; E1 and US, at 0% to 50%, 90%, and 100%; E2 and UK, at 0%, 90%, 100%; E2 and US, at 0% to 25%, and 100%. Nevertheless, the groups were different from each other in Fig. 68 (left), the percentiles show that there are many points at which the groups of students and natives were not different from each other.

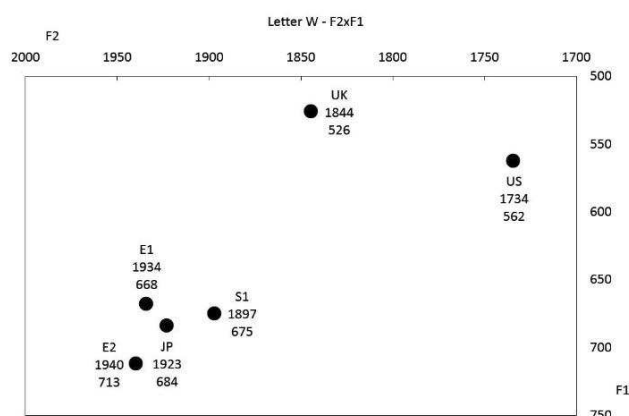


Fig. 67 F2 x F1 Graph. Letter W.

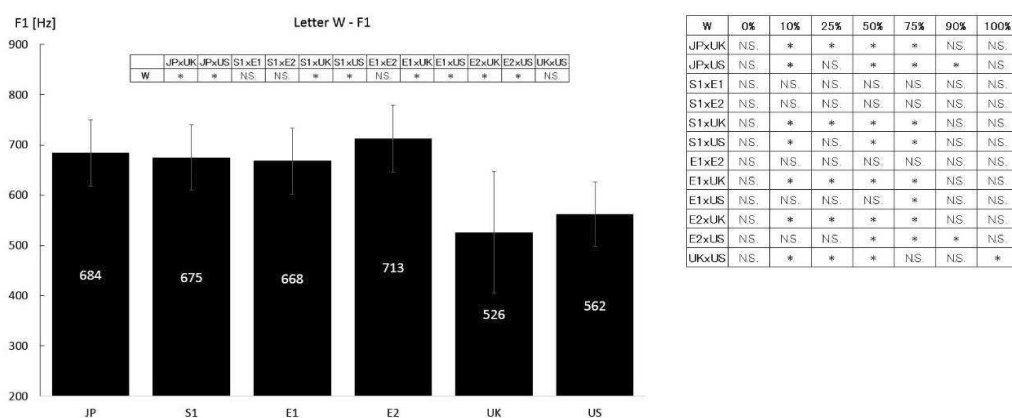


Fig. 68 Testing of F1. Left: whole utterance. Right: percentiles. Letter W.

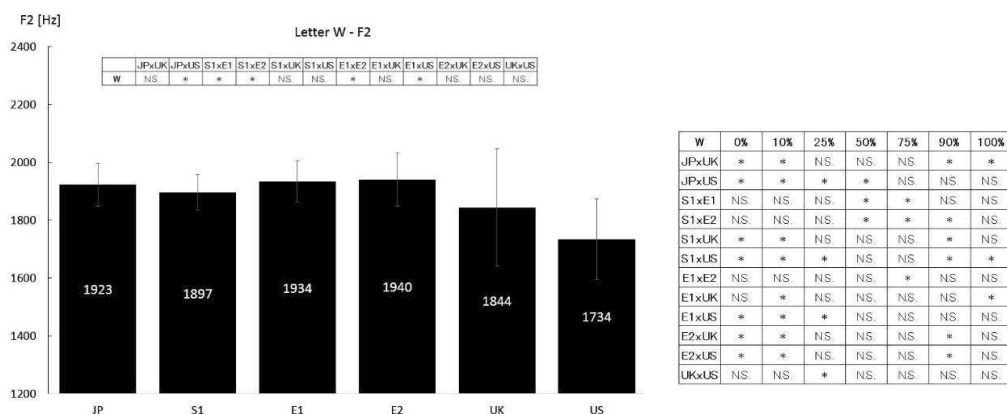


Fig. 69 Testing of F2. Left: whole utterance. Right: percentiles. Letter W.

Now, comparison result of F2s are as in Fig. 60 (left). Indeed, the values considered were JP(1923, 74), S1(1897, 60), E1(1934, 70), E2 (1940, 92), UK(1844, 203), and US(1734, 139); and we have that the groups of students were all not statistically different from the group UK. Yet, the pairs S1 and US, and E2 and US were ‘NS’ when compared with the group US. As for the results of the percentile comparisons depicted in Fig. 60 (right), JP and UK were not statistically different at 25% to 75%; JP and UK, at 75% to 100%; S1 and UK, at 25% to 75%, and 100%; S1 and US, at 50%, and 75%; E1 and UK, at 0%, 25% to 90%; E1 and US, at 50% to 100%; E2 and UK, at 25% to 75%, and 100%; E2 and US, at 25% to 75%, and 100%.

## Letter X

The points JP(2032, 981), S1(2038, 966), E1(2019, 990), E2 (2038, 987), UK(2208, 1206), and US(2054, 955) consisting of F2 and F1 formants are placed on the graph F2 x F1 in Fig. 70. Making the sequences (US, S1, JP, E2, E1, UK) and (E1, JP, S1, E2, US, UK) by taking the F1s and F2s from the smallest to greatest values, respectively, we see that the group UK located in the lower left region of the graph and the groups of students concentrated mainly in the upper right part of the graph.

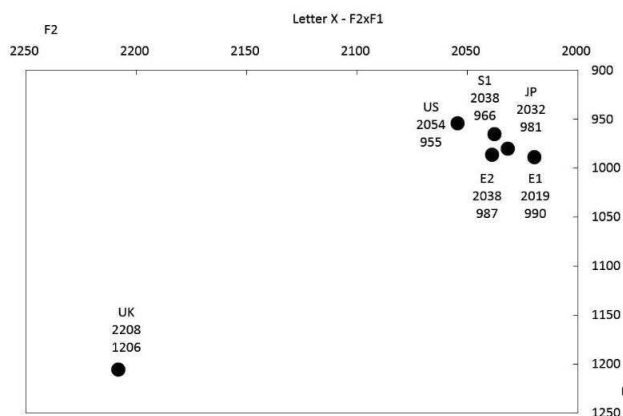


Fig.70 F2 x F1 Graph. Letter X.

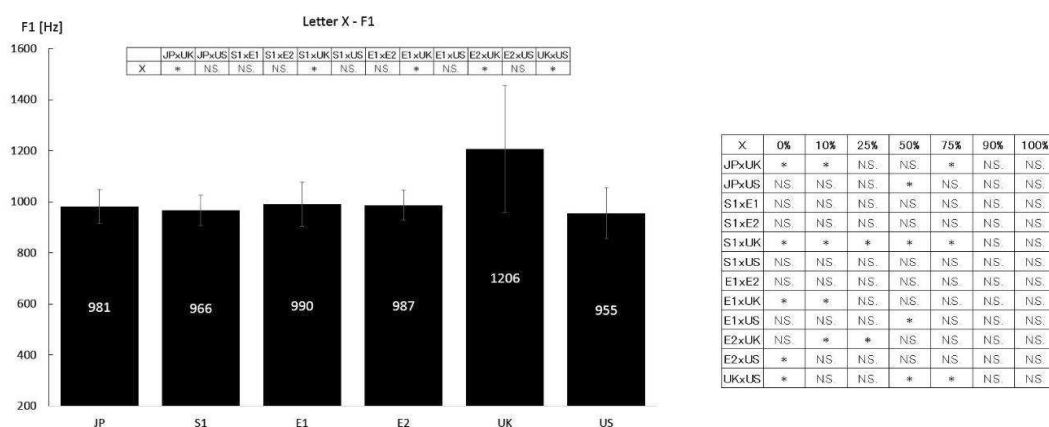


Fig. 71 Testing of F1. Left: whole utterance. Right: percentiles. Letter X.

Fig. 71 (left) presents the results of the F1 comparisons. The mean and standard deviation values of the groups were JP(981, 68), S1(966, 59), E1(990, 87), E2 (987, 58), UK(1206, 249), and US(955, 99). Here the groups of students were all not different from the groups of natives when paired and compared. As for the percentile comparisons, Fig. 71 (right) tells us that JP and UK were not statistically different at 25%, 50%, 90%, and 100%; JP and US, at all percentage points but 50%, S1 and UK, at 90%, and 100%; S1 and US, at all points; E1 and UK, at 25% to 100%; E1 and US, at all the percentage points but 50%; E2 and UK, at 0%, 50% to 100%; E2 and US, at

10% to 100%.

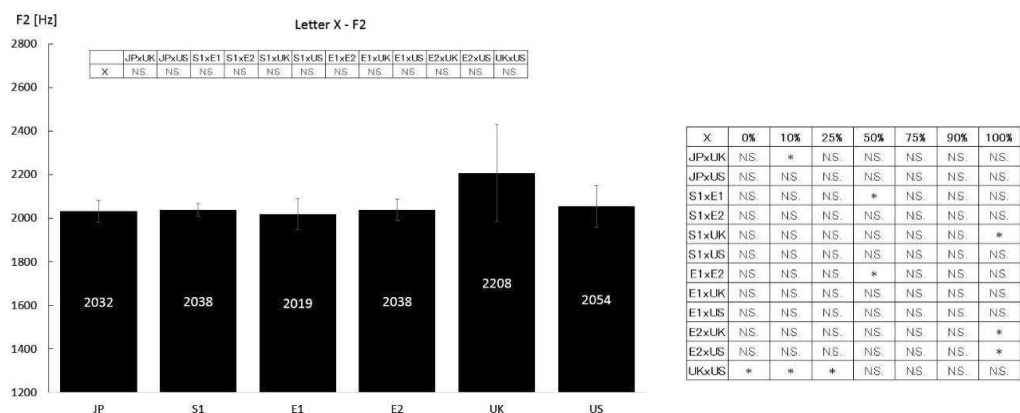


Fig. 72 Testing of F2. Left: whole utterance. Right: percentiles. Letter X.

The results of the F1 comparisons are shown in Fig. 72 (left). The groups were characterized by JP(2032, 51), S1(2038, 29), E1(2019, 70), E2 (2038, 50), UK(2208, 222), and US(2054, 96); and the comparisons turned out to be ‘NS’ for all the pairings of the groups of students and natives. For the percentile comparisons, Fig. 72 (right) shows that JP and UK were not statistically different at all the points but 10%; JP and US as well as S1 and US, E1 and UK, E1 and US, at all the percentage points; S1 and UK as well as E2 and UK, and E2 and US, at all points but 100%;.

## Letter Y

The points of the groups were JP (1826, 838), S1(1859, 838), E1(1793, 799), E2 (1825, 882), UK(1621, 715), and US(1697, 730) with the first component of the duo being the F2 formant and the second one F1. Ordering the formants in increasing order leads to the sequences (UK, US, E1, S1, JP, E2) and (UK, US, E1, E2, JP, S1) for the formants F1 and F2, respectively. These mean that the points of the groups lay on a diagonal-like line on the graph and the groups of the students are far from the crossing point of the graph axes whereas the groups of native speakers are near it.



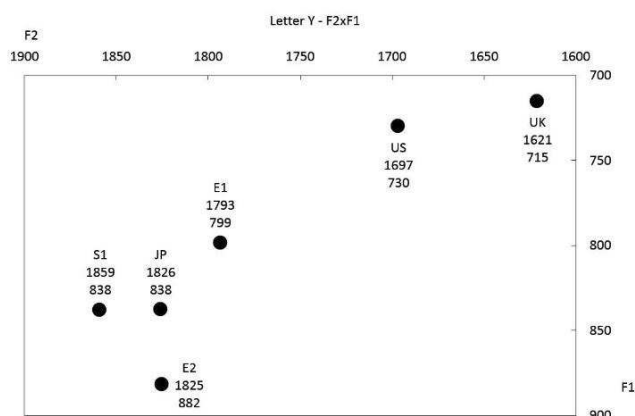


Fig. 73 F2 x F1 Graph. Letter Y.

Fig 74 (left) gives the results of the F1 comparisons for means and deviations characterizing the groups as JP (838, 60), S1(838, 37), E1(799, 72), E2 (882, 36), UK(715, 94), and US(730, 92). Amongst the groups of students, only E1 stood out, in the sense that it was not different to the groups UK as well as US. Fig 74 (right) describes the results of the percentile comparisons. JP and UK were not different at 90%; JP and US at 75% to 100%; S1 and UK, at 0%, 90%; S1 and US, at 0%, 75% to 100%; E1 and UK, at 75% and 90%; E1 and US, at 75% to 100%; E2 and UK as well as E2 and US, at 90%.

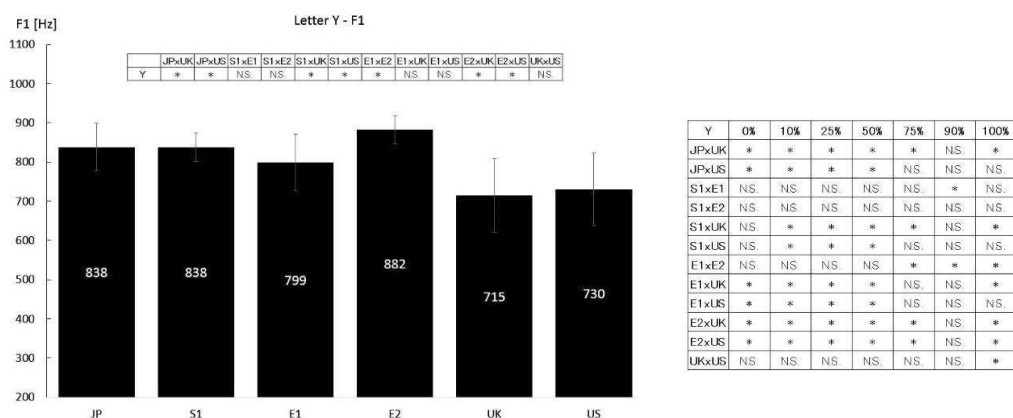


Fig. 74 Testing of F1. Left: whole utterance. Right: percentiles. Letter Y.

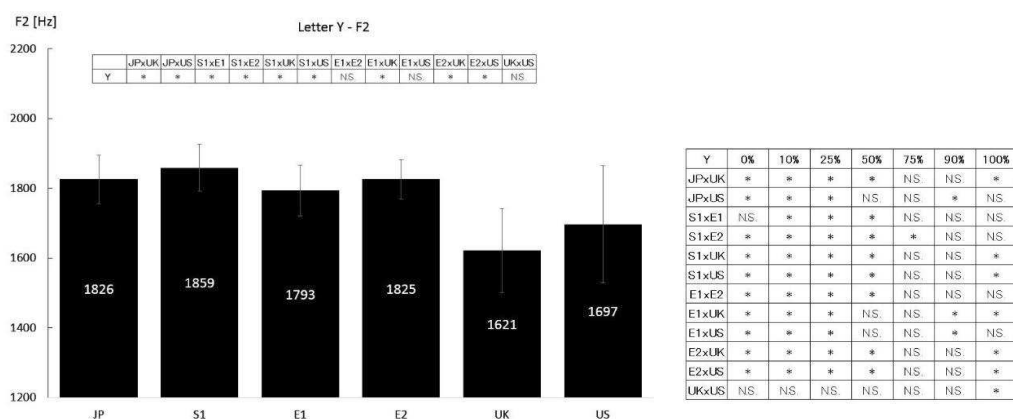


Fig. 75 Testing of F2. Left: whole utterance. Right: percentiles. Letter Y.

As far as the statistical comparisons of F2 are concerned, Fig. 75 (left) provides the result for the group typified by JP (1826, 69), S1(1859, 67), E1(1793, 73), E2 (1825, 56), UK(1621, 120), and US(1697, 167). Here, ‘NS’ was obtained for the pair of E1 and US only. Moreover, Fig. 75 (right) suggests that JP and UK were not statistically different at 75% and 90%; JP and US, at 50%, 75%, and 100%; S1 and UK as well as S1 and US, at 75% and 90%; E1 and UK, at 50% and 75%; E1 and US, at 50%, 75%, and 100%; E2 and UK as well as E2 and US, at 75% and 90%.

#### 4 DISCUSSION AND FINAL COMMENTS

Table I, which was shown in Izuta [9] and reproduced here for the sake of completeness, expresses the relationships of the group JP with UK as well as US. There, “f”, “n”, “s”, “q” and “i” correlated to UK for both F2 and F1 whereas “s”, “x”, “q” and “i” to US, in which “s”, “q” and “i” were closely related to both UK and US. Considering the categories used to classify the sounds of the English alphabet, category [i:/i] had the letters “b”, “c”, and “d”, fitted in US-<Only F2> and UK-<Only F1>; and considering that F2 is interpreted as the <forward/backward> positioning of the tongue whereas F1 to the rounding of the lips, these results suggest that the utterances were made with US-like tongue positioning while the openness tended to be UK-like. In

addition, “b”, “t”, “l”, “m” and “y” were in the group <neither F2 nor F1> .

TABLE I  
AFFINITY OF THE SOUNDS MADE BY THE GROUP JP

	Both F2 and F1	Only F2	Only F1	neither F2 nor F1
UK-like	f, n, s, q, i	x, u, w, o	c, d, e, g, p, t, v, j, k, r	b, t, l, m, y
US-like	s, x, q, i	c, d, e, g, p, v, a, u	f, h, j	

TABLE II  
AFFINITY OF THE SOUNDS MADE BY THE GROUP S1

	Both F2 and F1	Only F2	Only F1	neither F2 nor F1
UK-like	i, n, q	f, m, o, u, w, x	c, e, g, j, k, l, p, r, t, v	a, b, d, y
US-like	f, i, s, x	m, n, q, u, w,	g, h, j, l, r,	

TABLE III  
AFFINITY OF THE SOUNDS MADE BY THE GROUP E1

	Both F2 and F1	Only F2	Only F1	neither F2 nor F1
UK-like	f, i, n, q, s	m, o, u, w, x	c, d, e, g, j, k, l, p, r, t, v, y	
US-like	i, q, s, t, x, y	a, b, d, e, n, r, u, v	f, g, h, j, l, p	

TABLE IV  
AFFINITY OF THE SOUNDS MADE BY THE GROUP E2

	Both F2 and F1	Only F2	Only F1	neither F2 nor F1
UK-like	f, i, n, q	m, o, u, w, x	c, e, g, j, k, l, p, r, t, v	a, b, d, y
US-like	f, i, q, x	m, n, o, u, w,	g, h, j, l, s,	

The results of similar analyses for groups S1, E1 and E2 are gathered in Tables II – IV. The groups S1 and E2 had the same letters in the class <neither F2 nor F1> whereas E1 had no elements in it. Focusing on the class <Both F2 and F1>, the top runner group was E1 with 5 letters followed by E2 with 4, and S1 with 3.

Table V summarizes the statistical comparison results for the percentiles. Many of the letters that were not in <both F2 and F1> had some percentiles in this group. Still, these percentiles were mainly at the beginning and end of the utterances. These results suggest that the students tried to modulate the frequencies as the utterances were being produced.

TABLE V - Affinity of the sounds made by the groups for the percentiles

percentiles		0%		10%		25%		50%		75%		90%		100%	
affinity		UK	US	UK	US	UK	US	UK	US	UK	US	UK	US	UK	US
A	JP	, F2			, F2		, F2	,F2	,F2			F1		F1	F1
	S1	,F2	,F2	,F2	,F2			,F2	,F2			F1		F1,	F1
	E1	F1, F2	F1, F2		F1, F2		,F2	,F2	,F2		F1	F1		F1,	F1, F2
	E2	F1, F2	F1, F2	,F2	F1, F2			,F2	,F2		,F2	F1	,F2	F1,	F1, F2
B	JP	F1, F2		,F2	,F2	,F2	,F2	,F2	,F2	F1		F1		,F2	F1, F2
	S1	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2	,F2	F1		F1		F1,	F1, F2
	E1	F1, F2	F1	,F2	,F2		,F2	,F2	,F2	F1		F1	F1	F1,	F1, F2
	E2	F1, F2	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2			F1		F1,	F1, F2
C	JP	F1, F2			,F2		,F2	F1,	,F2	F1	F1	F1	F1	F1	F1
	S1	F1, F2	,F2					F1,	,F2	F1		F1	F1	F1,	F1
	E1	F1, F2	,F2		,F2		,F2	F1,	F1, F2	F1	F1	F1	F1	F1,	F1
	E2	F1, F2	,F2					F1,	,F2	F1	F1	F1	F1, F2	F1,	F1, F2
D	JP	,F2	,F2	,F2	,F2		,F2	,F2	,F2	F1		F1		F1	F1, F2
	S1	,F2	F1, F2	,F2	,F2			,F2	,F2	F1		F1		F1,	F1
	E1	,F2	F1, F2	,F2	,F2		,F2	,F2	,F2	F1		F1		F1,	F1, F2
	E2	,F2	F1, F2	,F2	,F2			,F2	,F2	F1		F1		F1,	F1, F2

E	JP	,F2		,F2	,F2		,F2	,F2	,F2	F1		F1		F1	F1
	S1	,F2	,F2	,F2	,F2			,F2	F1, F2	F1		F1			F1
	E1	F1, F2	F1	,F2	,F2		,F2	,F2	,F2	F1		F1		F1	F1, F2
	E2	,F2	,F2	,F2	,F2			,F2	F1, F2	F1		F1			F1
F	JP	F1	F1, F2		F1			,F2	F1, F2	,F2	F1, F2	F1,	,F2	F1,	F1, F2
	S1	F1, F2	F1, F2		F1		,F2	,F2	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	,F2
	E1	F1, F2	F1, F2	F1	F1, F2		F1	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2
	E2	F1, F2	F1, F2		F1		F1	F1,	,F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2
G	JP	,F2		,F2	,F2		,F2	,F2		F1		F1	F1		
	S1	,F2	F1, F2	,F2	,F2		,F2	F1,	,F2	F1		F1	F1		F1
	E1	,F2	F1	,F2	,F2		,F2	F1,	F1	F1	F1	F1	F1		
	E2	F1, F2	,F2	,F2	,F2			,F2	F1, F2		F1	F1	F1	F1	F1
H	JP	F1, F2	F1, F2	,F2	,F2	F1	,F2	F1	,F2		F1				
	S1	F1, F2	F1, F2	F1,	,F2	F1		F1,	,F2		F1				
	E1	F1, F2	F1, F2	F1	,F2	F1		F1	,F2		F1				
	E2	F, F2	F1, F2	F1,	,F2	F1		F1,	,F2		F1				
I	JP	F1				F1		F1	F1, F2	F1	F1, F2	F1	F1	F1,	F1, F2
	S1	,F2	,F2	F1	F1	F1	F1	F1	F1	F1	F1, F2	F1	F1	F1,	F1
	E1	F1, F2	F1	F1	F1	F1	,F2	F1,	F1, F2	F1	F1, F2	F1	F1, F2	F1,	F1, F2
	E2	F1, F2	F1, F2					F1	F1	F1	F1	F1	F1	F1,	F1, F2
J	JP	,F2		,F2	,F2		,F2	F1	F1, F2	F1,		F1	F1		
	S1	,F2	,F2	,F2	,F2	,F2	,F2	F1,	F1, F2	F1		F1	F1		F1
	E1	,F2	F1, F2	,F2	,F2		,F2	F1,	F1, F2	F1	F1	F1	F1		
	E2	,F2	,F2	,F2	,F2	,F2	,F2	F1,	F1, F2	F1		F1	F1		
K	JP	F1, F2			,F2		,F2	F1,	,F2	F1		F1	F1	F1	F1
	S1	F1, F2	,F2					F1,	F1, F2	F1		F1	F1	F1,	F1, F2
	E1	F1, F2	,F2		,F2		,F2	F1,	F1	F1	F1	F1	F1	F1	F1
	E2	F1, F2	,F2					F1,	,F2	F1		F1		F1,	F1, F2
L	JP			F1		F1	F1		F1	F1		F1,		F1,	F1, F2
	S1			F1	F1	F1	F1	F1	F1	F1,		F1,	,F2	F1,	F1, F2
	E1	F1, F2	F1		F1	F1	F1	F1,	F1, F2	F1,	F1	F1,	F1	F1,	F1, F2
	E2	F1	F1		F1	F1	F1	F1	F1	F1,	,F2	F1,	,F2	F1,	F1, F2
M	JP	F1, F2	F1	,F2		,F2		F1,		F1,		F1,		F1,	,F2
	S1	F1, F2	F1, F2	,F2	,F2	,F2	,F2	F1,	F1, F2	F1,	,F2	F1,	F1, F2	F1,	F1, F2
	E1	F1, F2	F1, F2	,F2	F1	,F2		F1,	F1, F2	F1,	F1	F1,		F1,	F1, F2
	E2	F1, F2	F1, F2	,F2	,F2	,F2	,F2	F1,	,F2	F1,	,F2	F1,	,F2	F1,	,F2
N	JP	F1, F2		,F2		,F2		F1,	,F2	F1,	,F2	F1,	,F2	F1,	F1, F2
	S1	F1, F2	F1, F2	,F2	,F2	,F2	,F2	F1,	F1, F2	F1,	,F2	F1,	F1, F2	F1,	F1, F2
	E1	F1, F2		,F2		,F2	,F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2
	E2	F1, F2	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2	F1,	,F2	F1,	,F2	F1,	F1, F2
O	JP	,F2		,F2				,F2		F1,		F1,	F1, F2	F1,	F1, F2
	S1									F1		F1	F1	F1	F1
	E1	F1, F2	F1	,F2			,F2	,F2	,F2	F1,	F1	F, F21	F1	F1,	F1, F2
	E2	F1	F1	,F2	,F2			,F2	,F2	,F2	,F2	F1,	,F2	F1,	F1, F2
P	JP	F1, F2	F1, F2	,F2	,F2		,F2	,F2	F1, F2	F1		F1		F1,	F1
	S1	F1, F2	F1, F2	,F2	F1, F2		F1	,F2	F1, F2	F1		F1	F1	F1,	F1, F2
	E1	F1, F2	F1, F2	,F2	,F2			,F2	,F2	F1, F2	F1	F1	F1	F1,	F1, F2
	E2	F1, F2	F1, F2	,F2	,F2		F1	,F2	F1, F2	F1		F1		F1,	F1, F2
Q	JP	F1				,F2		,F2	F1, F2	F1	F1		F1		F1
	S1	F1, F2	F1, F2			,F2	F1, F2	,F2	F1, F2	F1	F1		F1		F1
	E1	F1				,F2	F1	,F2	F1, F2	F1,	F1		F1		F1, F2
	E2	F1, F2	F1, F2			,F2	F1, F2	,F2	,F2	F1			F1		F1

R	JP	F1	F1	F1	F1	F1		F1	,F2	F1		F1,	,F2	F1,	F1, F2
	S1	F1	F1	F1	F1	F1	F1	F1,	F1	F1		F1,	F1, F2	F1,	F1, F2
	E1	F1	F1	F1	F1	F1		F1,	,F2	F1	,F2	F1,	F1, F2	F1,	F1, F2
	E2	F1	F1	F1		F1		F1,	F1, F2	F1		F1,	F1, F2	F1,	F1, F2
S	JP	F1	F1, F2	,F2	F1, F2		F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1	F1, F2
	S1	F1, F2	F1, F2	,F2	F1, F2		F1, F2	,F2	F1, F2	F1,	F1, F2	F1	F1, F2	F1,	F1
	E1	F1	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2
	E2	F1, F2	F1, F2	,F2	F1, F2		F1	F1,	F1, F2	F1,	F1, F2	F1	F1	F1,	F1, F2
T	JP	F1, F2	F1, F2		,F2		,F2	,F2	,F2	F1		F1	F1	F1,	F1, F2
	S1	F1, F2	F1, F2					,F2	,F2	F1	F1	F1	F1	F1,	F1
	E1	F1, F2	F1, F2		,F2		,F2	,F2	F1, F2	F1	F1	F1	F1	F1,	F1, F2
	E2	F1, F2	F1, F2					,F2	,F2	F1		F1		F1,	F1, F2
U	JP	F1, F2	F1					,F2	,F2	,F2		F1		F1,	F1, F2
	S1	F1, F2	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2	,F2		F1,	,F2	F1,	F1, F2
	E1	F1, F2	F1	,F2		,F2		,F2	,F2	,F2	F1	F1,		,F2	F1, F2
	E2	F1, F2	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2	,F2	,F2	F1,	,F2	F1,	F1, F2
V	JP	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2	,F2	F1		F1	F1	F1	F1, F2
	S1	F1, F2	,F2	,F2	,F2	,F2		,F2	,F2	F1		F1	F1	,F2	F1
	E1	F1, F2	,F2	,F2	,F2		,F2	,F2	,F2	F1	F1	F1	F1	F1	F1, F2
	E2	F1, F2	F1, F2	,F2	,F2	,F2	,F2	,F2	,F2	F1		F1		F1,	F1, F2
W	JP	F1	F1			,F2	F1	,F2		,F2	,F2	F1	,F2	F1	F1, F2
	S1	F1	F1			,F2	F1	,F2	,F2	,F2	,F2	F1	F1	F1,	F1
	E1	F1	F1		F1	,F2	F1	,F2	F1, F2	,F2	,F2	F1,	,F2	F1	F1, F2
	E2	F1	F1		F1	,F2	F1, F2	,F2	,F2	,F2	,F2	F1		F1,	F1, F2
X	JP	,F2	F1, F2		F1, F2	F1,	F1, F2	F1,	,F2	,F2	F1, F2	F1,	F1, F2	F1,	F1, F2
	S1	,F2	F1, F2	,F2	F1, F2	,F2	F1, F2	,F2	F1, F2	,F2	F1, F2	F1,	F1, F2	F1	F1, F2
	E1,	,F2	F1, F2	,F2	F1, F2	F1,	F1, F2	F1,	,F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2
	E2,	F1, F2	,F2	,F2	F1, F2	,F2	F1, F2	F1,	F1, F2	F1,	F1, F2	F1,	F1, F2	F1	F1
Y	JP								,F2	,F2	F1, F2	F1,	F1		F1, F2
	S1	F1	F1							,F2	F1, F2	F1,	F1, F2		F1
	E1							,F2	,F2	F1,	F1, F2	F1	F1		F1, F2
	E2								,F2	,F2	F1,	F1, F2			

Thus, recalling the “assistant language teachers (ALTs)” appointed to junior and high schools throughout the country are mostly from the USA, these results call on further investigations to understand the absence of a dominant variety of English in the speaking of Japanese female students.

### Acknowledgement

The authors would like to thank the students of Yonezawa Women’s College who provided us with their voice signals and helped us with the experiments. We are also thankful to our colleagues and friends for the support and cooperation.

### REFERENCES

- [1] J. Morley, "The pronunciation component in teaching English to speakers of other languages," *TESOL quarterly*, XXV (3), pp.481-520, 1991.
- [2] 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.
- [3] B. Smith, "Pronunciation Patterns of Japanese Learners and their Implications or Teaching", *Polyglossia*, Vol. 23, pp. 199-206, October 2012.
- [4] T. Riney and J. Anderson-Hsieh, "Japanese pronunciation of English," Vol. 15, No.1, pp. 21-36, 1993.
- [5] T. Derwing and M. J. Munro, "Second language accent and pronunciation teaching: A research-based approach," *TESOL Quarterly*, 39(3): 379-397, 2005.
- [6] R. Titze, "*I. Principles of Voice Production*," Prentice-Hall, 1994, Englewood Cliffs, NJ.
- [7] P. Ladefoged, "*A Course in Phonetics*," Harcourt Brace Jonanovich, 1993, Orlando.
- [8] P. Ladefoged, "*Phonetic Data Analysis*," Blakcwell Publishing, 2007, Carlton.
- [9] G. Izuta, "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, 2015.
- [10] G. Izuta, "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, 2015.

- [11] G. Izuta, “Formant Analysis of the English Alphabet Read by Japanese Female Students and Native Speakers,” *Proc. 1st Int. Conf. on Teaching & Learning (ICTL 2015)*, Langkawi, Malaysia 14-15, ISBN 978-967-13637-1-3, pp.18-22, September 2015.
- [12] G. Izuta, “A Study of the English Sounds Made by Japanese Female Students Based on the Percentile Analysis,” *Proc. 1st Int. Conf. on Teaching & Learning (ICTL 2015)*, Langkawi, Malaysia 14-15, ISBN 978-967-13637-1-3, pp.23-27, September 2015. 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).