

ACOUSTIC CUES FOR THE PERCEPTION OF TONES OF DISYLLABIC NOUNS IN EDO

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Most studies on speech perception, with particular reference to the perception of tones, explained this phenomenon mainly from the auditory point of view. Many questions were therefore left unanswered with regard to the mechanisms involved in the perception of tone. This paper attempts to explain this phenomenon from an acoustic standpoint using recorded disyllabic Edo nouns. It reveals in particular that certain acoustic cues are indispensable for an Edo speaker/hearer in the perception of tones of disyllabic nouns, the form and the direction of change of F_0 variation being the most important. F_0 is realized in different ways for a given speaker depending on the tone pattern as well as the frequency zone characteristic of each of the two basic tonemes, High and Low.

0. Introduction

In this paper the various acoustic cues used by Edo speakers/hearers in the perception of tones of disyllabic nouns are considered. Edo has two distinctive tones, High and Low, combined in the following manners in disyllabic nouns: $\acute{V}\acute{C}\acute{V}$, $\acute{V}\acute{C}\acute{V}$, $\acute{V}\acute{C}\acute{V}$ and $\acute{V}\acute{C}\acute{V}$.

Studies by Wescott [1962, 1965], Amayo [1976], Omozuwa [1987a, 1987b], Lhote et al. [1986], among others, show that

- (a) sequences of High tones on contiguous syllables are realized on the same pitch level;
- (b) sequences of Low tones on contiguous syllables are realized *not* on the same pitch level but as a short downglide (a case of successive lowering of like tones);

- (c) a Low tone immediately following a High tone is realized as a Falling tone since the Low tone assimilates to the level of the High tone preceding it before its characteristic downglide;
- (d) a Low tone preceding a High tone is realized as a low level tone (in physical terms).

The purpose of this paper is to determine the acoustic cue(s) used by Edo speakers/hearers in the perception of the basic tonemes, High and Low, in a given tone pattern.

1. Experimental Procedures

This investigation was carried out in three stages. In the first stage, a list consisting of the English translation of 28 Edo disyllabic nouns (7 different nouns for each of the four tone patterns—cf. list of test words in APPENDIX I) organized in random order was read by a female Edo speaker. The 28 test words were recorded by means of a magnetic tape recorder (a Revox B77 MK II high fidelity stereo tape recorder), a glottometer, and subsequently analysed logarithmically by a melody analyser and graphically by an oscillograph (a two-channel Oscillomink Recorder).

In the second stage, the recorded items were played back to a group of eight listeners from five different linguistic groups in a purely listening/repetition task. The purpose of making non-Edo speakers repeat Edo words was merely a means of simulating Edo tones in the absence of appropriate equipment for speech synthesis. Thus, the “mistakes” made in the production of Edo tones by the non-Edo speakers will serve as a basis for the interpretation of the perceptual cues for the perception of tones in such Edo nouns. The repetitions by each of the eight listeners were also recorded by means of a magnetic tape, a glottometer, and subsequently analysed by a melody analyser connected to an oscillograph which gives the graphical representation of the analysed signal. This exercise thus provided a second list of 224 (8 x 28) tokens for further analysis. Table 1 in APPENDIX II shows the fundamental frequency (F_0) values and duration of seven $\check{V}\check{V}$ words pronounced by a female Edo native speaker (ED) and eight non-Edo speakers from five different linguistic groups: 1 Yoruba native speaker (YB); 1 Ika native speaker (IK); 1 Hausa native speaker (HS); 3 French native speakers (two females: a phonetician and musicologist (FR₁), a speech therapist (FR₂); and a male speaker and non-linguist (FR₃); 2 native speakers of Cantonese Chinese (CH₁ and CH₂, both phoneticians).

In the third stage of the investigation, the list of 224 tokens was presented to ten Edo native speakers/hearers who were asked to write down in English the meaning of each test item presented to them. This is a purely linguistic perception exercise in which the listeners use their previous knowledge of their language in assessing

which of the productions/repetitions are acceptable or non-acceptable utterances in Edo.

1.1. Presentation of results, and discussion. The acoustic and perceptual results of each tone pattern considered in this investigation will be presented separately. For each tone pattern all the productions/repetitions by each of the eight listeners from five different linguistic groups accepted by the native speakers/hearers are classified separately from those productions/repetitions rejected with the goal of assessing, from the acoustic tracings, the acoustic cue(s) necessary for accepting or rejecting a given utterance in Edo. The acoustic properties of the accepted items for each tone pattern are compared with those of the rejected items.

The F_0 values for each syllable of each test word were taken at three points: at the beginning of the F_0 realization (F_{0i}), at a point two-thirds of the F_0 realization ($F_0 2/3$), and at the end of the F_0 realization, F_{0f} . F_0 values are expressed in Hertz (Hz) while duration is expressed in milliseconds (ms). F_{0m} represents the mean value of F_0 variation for each syllable. Two asterisks before the abbreviations for a given speaker shows that that word pronounced by that speaker was unanimously rejected by Edo speakers/hearers in the perception test.

1.2. Interpretation of acoustic results.

1.2.1. Perception of a sequence of high tones on disyllabic nouns of the $\acute{V}\acute{C}\acute{V}$ type. Fundamental frequency (F_0) values in Table 1 show that in sequences of High tones on disyllabic nouns (this is also true for polysyllabic nouns), a High tone is perceived only if the tone on the first syllabic peak, V_1 , is realized on the same pitch level, i.e. in the same frequency zone as the tone on the second syllabic peak, V_2 , independently of variations in the duration of the F_0 realization (there is usually no marked difference in the mean relative intensity for such contiguous High toned syllables). The physical realization of a High tone in Edo in terms of F_0 variation is

- (a) absence of F_0 variation from the beginning to the end of the F_0 realization for a given High toned syllable (cf. the word [úko] ‘gourd’ pronounced by ED and FR₁)
- or
- (b) a gradual rise from the beginning to the end of the F_0 realization, i.e. $F_{0f} \geq F_{0i}$ (cf. the word [úko] pronounced by YB, IK, CH₁, and CH₂).

Results of this experiment also show that a $\check{V}C\check{V}$ sequence is automatically perceived as a $\check{V}C\check{V}$ tone sequence if the direction of change of F_0 variation on the first syllabic peak is falling, i.e. F_{0f} is less than F_{0i} (cf. the word [úkó] pronounced by FR₂ and FR₃). In addition, the tone sequence is perceived as a Rising tone followed by a High tone if the value at a point 2/3 of the F_0 variation is more than the F_{0i} of the first syllabic peak but less than its F_{0f} and the F_{0i} of the second syllabic peak (cf. the words [áǵó] 'tin' and [áǵá] 'chair' pronounced by HS, or the word [úkuí] 'praise name for the king' pronounced by HS, FR₂, and FR₃).

Our investigation further revealed that a 1/4 tone difference between the end point of the F_0 variation on the first syllabic peak and the beginning of the F_0 variation on the second syllabic peak is not perceptually significant in the perception of High tones in a $\check{V}C\check{V}$ sequence. This is probably why the word [èkó] 'Lagos' pronounced by FR₁ was perceived as [ékó] (?) by Edo listeners. In the pronunciation of this word by FR₁, F_0 variation is nil on each of the two syllabic peaks but in absolute terms the difference between the F_{0f} of the first syllabic peak and the F_{0i} of the second syllabic peak is 1/4 of a musical tone.

1.2.2. Perception of tones of disyllabic nouns of the $\check{V}C\check{V}$ type. A low tone is perceived on the first syllabic peak if the difference between the F_{0f} value of V_1 and the F_{0i} value of V_2 is more than 1/4 of a musical tone. In other words a $\check{V}C\check{V}$ word is perceived in Edo only if the difference between F_{0f} of the first syllabic peak and the F_{0i} of the second syllabic peak is more than a 1/4 of a tone (cf. Table 3 in APPENDIX II for the F_0 realization of the $\check{V}C\check{V}$ word types in Edo).

1.2.3. Perception of a sequence of low tones on disyllabic nouns of the $\check{V}C\check{V}$ type. In a sequence of Low tones on disyllabic nouns, a Low tone is realised on the first syllabic peak either as a Low level tone (cf. the F_0 values for the word [úǵò] 'name of a village' pronounced by ED, YB, and FR₁ in Table 2), in which case the difference between the F_{0f} of the first syllabic peak and its F_{0i} is nil, or generally as a slightly falling tone (cf. the F_0 values for the same word pronounced by IK, HS, CH₁ and CH₂ in Table 2) in which case the F_{0f} of the first syllabic peak is more than the F_{0i} of the second syllabic peak. In both cases, the Low tone on the second syllabic peak *cannot* be realized physically as a low level tone in Edo but as a falling contour with a steeper gradient (cf. F_0 values for all speakers in Table 2). If the low tone on this syllabic peak, i.e. V_2 , is realized physically as a level tone a $\check{V}C\check{V}$ sequence is likely to be perceived if the F_{0f} of the Low tone on V_1 is less than its F_{0i} , while a $\check{V}C\check{V}$ sequence is likely to be perceived if the

difference between the F_{0f} and the F_{0i} of V_1 is nil. Further perceptual tests using synthesized materials are needed to support these claims.

It should be noted that for the same speaker, the F_0 values of the first syllable of the $\check{V}\check{C}\check{V}$ tone pattern is very close to the F_0 values of the first syllable of the $\acute{V}\acute{C}\acute{V}$ tone pattern. This has no effect on the perception of tones of these two word types since the direction of the F_0 realization of the two tone patterns is basically different (cf. §§1.2.1, 1.2.3).

It is also in this sequence of homotonous Low tones that F_0 variation is directly proportional to variation in intensity. In other words, intensity (I) varies with F_0 , the intensity at the end of a $\check{V}\check{C}\check{V}$ sequence being less than the intensity at the beginning of the sequence since the direction of change of F_0 on the first syllabic peak is the same (generally) as that of the second syllabic peak.

1.2.4. Perception of tones of disyllabic nouns of the $\acute{V}\acute{C}\acute{V}$ type. This study also reveals that the Low tone on the second syllabic peak of a $\acute{V}\acute{C}\acute{V}$ sequence is realized physically as a High-falling tone. In other words, F_0 variation on the second syllabic peak has its source in the frequency zone of the preceding High tone. Acoustic results presented in Table 4 in APPENDIX II clearly show that the onset of this tone is realized as a level tone (in the same frequency zone as the preceding High tone) for the first 20ms or more before the usual down glide (in the case of words with intervocalic voiced consonants). Where the intervocalic consonant is voiceless, the F_{0i} value of the second syllabic peak is usually higher than the F_{0f} of the first syllabic peak. In cases where the F_{0i} of the second syllabic peak is lower than the F_{0f} of the first syllabic peak by $3/4$ of a tone or more, i.e. where the F_{0i} of the second syllabic peak is *not* in the same frequency zone as the F_{0f} of the first syllabic peak, there is distortion of the usual Low tone perception in such $\acute{V}\acute{C}\acute{V}$ words, i.e. a High-falling tone (cf. the word [ázà] pronounced by FR₃ and [ibà] pronounced by CH₂). The Low tone in such cases is perceived more or less like the low tone of a $\check{V}\check{C}\check{V}$ word of the neighbouring and closely related Esan language, i.e. as a Low level tone. This study therefore corroborates earlier claims (based essentially on structural/auditory analyses) in respect of the realization of a Low tone after a High tone in Edo, viz. there is an assimilatory tonal process whereby a Low tone following a High tone is first assimilated to the level of the preceding High before its characteristic downglide (cf. Amayo [1976]; Omozuwa [1987a]). This phenomenon has been described by Hyman [1973, 1975] for other languages. Thus a H-L sequence is realized as a H-H \bar{L} .

2. Comments on Acceptability/Unacceptability of Pronunciation to the Native Speakers/Hearers

In this section we shall make some brief remarks on the acceptability/unacceptability judgements of the non-Edo speakers' repetitions of the test words by the ten Edo speakers/hearers. We will equally comment on the influence of the mother tongue (and some other factors) of the non-Edo speakers on the amount of "mistakes" made in producing Edo tones.

2.1. $\acute{V}C\acute{V}$ words. The repetitions of five out of the eight non-Edo speakers were accepted as being properly pronounced. The repetitions of the word [úkó] 'gourd' by FR₂ and FR₃ were rejected by all the "judges". It could be observed from the acoustic tracings that the direction of change of F₀ realization of the High tone on the first syllabic peak is completely different from that of the accepted tokens: F₀ of V₁ is less than its F_{0i} whereas F₀f of V₂ is more than its F_{0i} in the case of FR₂; F₀f of V₂ is equal to its F_{0i} in the case of FR₃. Consequently, the "word" [úkó] (which is meaningless in Edo) is perceived instead of the stimulus [úkó] presented. The same explanation holds for the repetition of the word [úkú] 'praise name for Edo king' by FR₃ and perceived by Edo listeners as [úkú] which is also meaningless. In this case, even though F₀f of V₁ is equal to its F_{0i}, its F₀2/3 is different from F_{0i} and F₀f by 3/4 of a musical tone, i.e. 12Hz (according to the conversion scale used in this work since F₀ values were taken in quarters of tone below a reference frequency of 600Hz). On the other hand, F_{0i} of V₂ is more than F₀f of V₁ by one musical tone. This was what probably gave the perceptual impression of a Low tone on the first syllabic peak contrasting with a High tone on the second syllabic peak (cf. §1.2.2 above).

The repetitions of the seven $\acute{V}C\acute{V}$ words by the HS speaker were judged to be "partially accepted", "accepted from a non-native speaker", etc., by the ten Edo listeners. A close observation of the F₀ contour of these test words as realized by the HS speaker reveals that the duration of the first syllabic peak is highly exaggerated. Moreover, F_{0i} to F₀2/3 is considerably lower in pitch than F₀f. Thus a "Rising tone" is perceived (cf. Omozuwa [1987a:307]) on V₁ rendering the pronunciation an "unnatural" realization of the $\acute{V}C\acute{V}$ stimulus. However, a difference in meaning was not signalled by the Edo native speaker/hearers since there is no distinctive R - H tonal melody on VCV words.

2.2. $\grave{V}C\grave{V}$ words. Some of the repetitions of four out of the eight non-Edo speakers were judged "unnatural" or "partially accepted" or "accepted from a non-native" by the ten Edo listeners. The repetition of the word [idí] by CH₂ was considered "partially accepted" even though the Low-Low tone melody on the $\grave{V}C\grave{V}$ word

was “properly” realized. This partial acceptability arises from the fact that the CH₂ speaker used the voiced alveolar fricative [z] instead of the voiced alveolar stop [d] in intervocalic position of the word, i.e. [iãĩ] was realized as [izĩ]. The words [ũdè] and [òkò] pronounced by FR₂ and FR₃ were considered “partially accepted by Edo native speakers” in view of the fact that the direction of change of the F₀ realization on V₁ is different from that of V₂: F₀f of V₁ is more than its F₀i whereas F₀f of V₂ is less than its F₀i. Consequently, a High tone is perceived on V₁ whereas a Low “level” tone is perceived on V₂ (cf. also the realization of [òdò] as [ó’dò] by FR₃). If the low tone on V₂ were realized by this speaker as a Falling tone, i.e. the usual realization of a Low tone after a High tone in Edo (cf. §2.4), the way [òdò] was realized by FR₃ would have led to a difference in meaning since the Edo language contrasts /òdò/ ‘yellow fever’ with /ódò/ [ódò] ‘potash’. However, [ó’dò] as realized by FR₃ was considered as a foreigner’s pronunciation of /ódò/ ‘potash’, i.e. a tonetic “level” Low tone after a High as in the neighbouring and closely related Esan language instead of a tonetic Falling tone after a High in Edo. As characteristic of HS’s repetition, the words /ũdè/, /ũdũ/, /òdò/, and /àdà/ were realized as [ũdè], [ũdũ], [òdò], and [ãdã] respectively, and thus judged “partially accepted” by the Edo listeners. This is remarkably different from the way the same HS speaker realized the words [ũgò] ‘name of a village’ and [òkò] ‘parcel’. The pronunciation of these words by HS was unanimously accepted by the Edo listeners.

2.3. $\check{V}C\check{V}$ words. Some of the repetitions of six out of the eight non-Edo speakers were either “rejected” or considered “partially accepted” by the ten Edo listeners. The words [èdò], [èbò], and [èkò] realized by FR₁ were perceived as [édò], [ébò], and [ékò] respectively. They were thus rejected by the Edo listeners since they have no meaning. The F₀ realization of the first two words by FR₁ reveals that F₀f of the first syllabic peak is more than its F₀i (F₀i to F₀2/3 of the second syllabic peak being the same as the F₀f of the first syllabic peak). In the case of the word [èkò] realized by FR₁ and perceived by the Edo listeners as [ékò], it would be observed that the F₀ variation is nil on both the first and second syllables: 252Hz (corresponding to 30 quarters of a musical tone on our conversion scale) from the beginning to the end of the F₀ realization on the first syllabic peak, 260Hz (corresponding to 29 quarters of a musical tone) from the beginning to the end of the F₀ realization on the second syllabic peak. Thus the difference between the pitch of the first syllabic peak and that of the second syllabic peak is 4Hz corresponding to 1/4 of a musical tone below 600Hz). This seems to suggest that a 1/4 of a musical tone is not sufficient to distinguish a Low tone from a High tone in Edo $\check{V}C\check{V}$ words. This corroborates our earlier claim that for a $\check{V}C\check{V}$ tone sequence to be perceived in Edo, the difference between the F₀f of V₁ and the F₀i of V₂ *must*

be more than 1/4 of a musical tone. A difference of 1/4 of a musical tone (or less) between the F_{0f} of V_1 and the F_{0i} of V_2 renders such a $\check{V}\check{C}\check{V}$ tone pattern to be perceived as a $\check{V}\check{C}\check{V}$ pattern as shown by the pronunciation of the word [èkò] by FR_1 (cf. also the F_0 contour of the same word realized by the HS speaker, rejected as the $\check{V}\check{C}\check{V}$ stimulus, and perceived as a $\check{V}\check{C}\check{V}$ “word” with no specific meaning in Edo). The pronunciation of the word [èdò] by FR_2 was considered partially accepted by the Edo native speakers/hearers in view of the fact that this speaker realized the $\check{V}\check{C}\check{V}$ pattern as a $\check{V}\check{C}\check{V}$ pattern, a tone pattern that does not exist in Edo. Similarly, the pronunciation of the words [èbò], [àkò], and [ùdò] by FR_2 was considered partially accepted because the direction of change of the F_0 realization on the first syllabic peak is the same as that of the second syllabic peak, i.e. F_{0f} is $>$ F_{0i} in each syllabic peak in most cases, and F_{0f} of V_1 is the same or very close to the F_{0i} of V_2 . This is probably what gave the perceptual impression of a $\check{V}\check{C}\check{V}$ tone sequence, thus rendering the words pronounced “unnatural” in the ears of the native listeners.

2.4. $\check{V}\check{C}\check{V}$ words. As noted earlier, for a pitch contour to be an acceptable realization of a $/\check{V}\check{C}\check{V}/$ word in Edo, i.e. tonetically [$\check{V}\check{C}\check{V}$], the F_{0i} of V_2 should, ideally, be equal to or more than the F_{0f} of V_1 but not less than it by more than 3/4 of a musical tone.

The non-Edo speakers' repetition of this tone pattern was generally better than that of the other tone patterns recorded since they made fewer “mistakes” in its production. All the repetitions of three out of the eight non-Edo speakers were considered acceptable pronunciations of the stimuli presented. The repetition of the word /ìbà/ by CH_2 , the word /ázà/ by HS and FR_3 , and the word /ákò/ by HS were considered “partially accepted” by the native speakers/hearers. A close observation of the F_0 realization of these tokens pronounced by the non-Edo speakers reveals that the F_0 contour of the Low tone on the second syllabic peak is “not properly realized” the way it should be in Edo, i.e. F_{0i} of V_2 should be in the same perceptual range as the F_{0f} of V_1 .

Let us consider the word /ìbà/ for instance. In the speech of the Edo native speaker recorded, F_{0i} of V_2 is less than F_{0f} of V_1 by 1/4 of a musical tone. This is also true of the repetitions of the same word by IK and FR_2 speakers. F_{0i} of V_2 is equal to F_{0f} of V_1 in the repetitions of YB, FR_1 , and CH_1 speakers for the same word. The difference between the F_{0i} of V_2 and the F_{0f} of V_1 is 1/2 of a musical tone in the repetition of the FR_3 speaker, and this was accepted by the native speakers/hearers. In the case of the repetition of the same word by the HS speaker, this value is *one* musical tone. Six out of the ten native listeners rejected this pronunciation whereas the remaining four responded that the pronunciation was par-

tially acceptable “at least from a non-native speaker”. Similarly the repetition of the word /ákkò/ by the HS speaker was partially accepted by the native listeners even though “the pronunciation sounds unnatural”. It could be noted from the F_0 realization of this word by HS that the tone on the first syllabic peak was realized as a Rising tone. The result is that /ákkò/ is perceived as [ákkò]. However, the difference between the F_0 f of V_1 and the F_0 i of V_2 for this word pronounced by this speaker (HS) is 1/4 of a musical tone, i.e. F_0 i of V_2 is more than the F_0 f of V_1 by a quarter of a musical tone. Thus, this may not have been responsible for its partial acceptability. Compare the F_0 realization of the word /ázà/ by this same speaker. This was also partially accepted by the native listeners. In this word, the High tone on the first syllabic peak was not only realized as a Rising tone but also the difference between the F_0 i of V_2 and the F_0 f of V_1 is five quarters of a tone.

Finally, five out of the ten native speakers/hearers were undecided on whether the pronunciation of the words /ákkò/ by FR₂ and /úddè/ by FR₂ and CH₂ were fully acceptable or partially acceptable whereas the remaining five listeners felt that the repetitions were partially acceptable. The difference between the F_0 i of V_2 and the F_0 f of V_1 is one musical tone (cf. the realization of /íbbà/ by the HS speaker as analysed above). It might be that *one* musical tone difference between the F_0 i of V_2 and the F_0 f of V_1 serves as the perceptual threshold for the perception of a / $\acute{V}C\acute{V}$ / tone pattern in Edo, i.e. if F_0 i of V_2 is less than F_0 f of V_1 . The perception of this tone pattern is distorted if this value is more than a musical tone. Words with such a / $\acute{V}C\acute{V}$ / tone pattern will therefore sound “unnatural” or like the pronunciation of similar words in the neighbouring Esan language. Synthesized materials would be required in order to be able to manipulate the various variables highlighted in this study with a view to determining the acoustic cue(s) and the perceptual threshold for the perception of the four tone patterns in Edo disyllabic nouns.

3. Conclusion

This study which is based on acoustic and perceptual analyses reveals that certain acoustic cues are indispensable for an Edo speaker/hearer in the perception of tones of disyllabic nouns:

- (a) The acoustic cue for the perception of a sequence of High tones on a $\acute{V}C\acute{V}$ word is the upward movement of F_0 in the same frequency zone intra syllabic or inter syllabic. These tones can also be realized as level tones in such words, i.e. F_0 variation from the beginning to the end of the F_0 realization is nil.

- (b) In a sequence of Low tones the acoustic cue is a decrease in F_0 values from the beginning to the end of the F_0 realization on each of the syllabic peaks even though in some cases the F_0 values are the same from the beginning to the end of the F_0 realization on the first syllabic peak. A Low tone is perceived globally from the beginning of the first syllabic peak to the end of the second syllabic peak in both cases.
- (c) The F_0 difference which must not be less than 1/4 of a musical tone between the end point of the F_0 realization of the Low tone on the first syllabic peak and the High tone on the second syllabic peak in a $\check{V}C\check{V}$ sequence is the major acoustic cue for the perception of these contrastive tones in such sequence.
- (d) In a $\check{V}C\check{V}$ sequence, the Low tone on the second syllabic peak is realized as a High-falling tone since it has its origin from the frequency zone of the preceding High tone, a case of tonal assimilation.

Results of this investigation show that the form and direction of change of F_0 variation are the most important acoustic cues for the perception of tones in Edo. This can be realized in different ways depending on the tone pattern as well as the frequency zone characteristic of each of the two tonemes (cf. similar perceptual studies in Yoruba by Hombert [1976], Dojio [1978]).

This investigation equally reveals that a phonologically Low tone is realized differently in physical terms depending on its position in a word, i.e. whether or not it is preceding or following a High tone and/or whether or not it is following another Low tone.

It can be inferred from results of this study that the mother tongue of a listener influences his/her perception/repetition of the tone melody of the words of a given tone language: the more closely related the languages are, the higher the performance of such non-native listeners. Moreover, a trained phonetician and/or musicologist (whose language is non-tonal) who is used to manipulating musical pitch differences is likely to have a greater ability in the perception/repetition of pitch variations in a tone language than his counterpart who has not received such training.

It would appear from results of this study that the ears of a native speaker accommodate a wide range of pitch variations in his acceptability/non-acceptability of a given tone melody produced by a non-native speaker, especially if the word bearing such a tone melody is not in minimal contrast with another word having a different tone melody.

More investigations need to be carried out to verify these claims, especially in the areas of speech synthesis and automatic recognition of speech.

APPENDIX I

EDO $\acute{V}C\acute{V}$ WORDS

Words	Phonetic Realization	Gloss
1. $\acute{u}k\acute{o}$	[$\acute{u}k\acute{o}$]	'gourd'
2. $\acute{a}g\acute{o}$	[$\acute{a}g\acute{o}$]	'can'
3. $\acute{u}k\acute{u}$	[$\acute{u}k\acute{u}$]	'praise name for Edo king'
4. $\acute{u}g\acute{u}$	[$\acute{u}g\acute{u}$]	'name of a clan'
5. $\acute{a}d\acute{a}$	[$\acute{a}d\acute{a}$]	'sceptre'
6. $\acute{i}b\acute{a}$	[$\acute{i}b\acute{a}$]	'mischief'
7. $\acute{a}g\acute{a}$	[$\acute{a}g\acute{a}$]	'chair'

EDO $\grave{V}C\grave{V}$ WORDS

Words	Phonetic Realization	Gloss
1. $\grave{u}g\grave{o}$	[$\grave{u}g\grave{o}$]	'name of a village'
2. $\grave{i}d\grave{i}n$	[$\grave{i}d\grave{i}$]	'grave'
3. $\grave{a}d\grave{a}$	[$\grave{a}d\grave{a}$]	'crossroad'
4. $\grave{o}k\grave{o}$	[$\grave{o}k\grave{o}$]	'parcel'
5. $\grave{u}d\grave{u}$	[$\grave{u}d\grave{u}$]	'heart'
6. $\grave{u}d\grave{e}$	[$\grave{u}d\grave{e}$]	'advice'
7. $\grave{o}d\grave{o}$	[$\grave{o}d\grave{o}$]	'yellow fever'

EDO $\grave{V}C\acute{V}$ WORDS

Words	Phonetic Realization	Gloss
1. $\grave{e}d\acute{o}$	[$\grave{e}d\acute{o}$]	'Edo (language)'
2. $\grave{e}b\acute{o}$	[$\grave{e}b\acute{o}$]	'charm'
3. $\grave{e}k\acute{o}$	[$\grave{e}k\acute{o}$]	'Lagos'
4. $\grave{a}k\acute{o}$	[$\grave{a}k\acute{o}$]	'portion'
5. $\grave{o}k\acute{o}$	[$\grave{o}k\acute{o}$]	'nest'
6. $\grave{u}g\acute{o}$	[$\grave{u}g\acute{o}$]	'a plant'
7. $\grave{u}d\acute{o}$	[$\grave{u}d\acute{o}$]	'name of a village'

EDO $\acute{V}C\acute{V}$ WORDS

Words	Phonetic Realization	Gloss
1. <i>ibà</i>	[<i>ibà</i>]	'mud bed'
2. <i>ókò</i>	[<i>ókò</i>]	'a flute'
3. <i>údè</i>	[<i>údè</i>]	'spleen ailment'
4. <i>ázà</i>	[<i>ázà</i>]	'treasury'
5. <i>ókà</i>	[<i>ókà</i>]	'maize'
6. <i>ákò</i>	[<i>ákò</i>]	'a fruit'
7. <i>ébò</i>	[<i>ébò</i>]	'white man'

APPENDIX II

Tables of Results

Table 1a: F_0 and duration values for seven Edo $\acute{V}C\acute{V}$ words pronounced by a female Edo speaker

SER. NO.	WORDS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION
		F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}	
1.	[<i>úko</i>] ¹	252	252	252	252	80	252	252	252	252	150
2.	[<i>ágo</i>]	260	260	260	260	120	260	260	260	260	210
3.	[<i>úku</i>]	275	275	275	275	120	275	275	275	275	160
4.	[<i>úgu</i>]	245	260	260	255	100	260	260	260	260	120
5.	[<i>áda</i>]	212	238	238	229	150	238	238	238	238	190
6.	[<i>ibá</i>]	245	252	252	250	120	245	245	245	245	220
7.	[<i>ága</i>]	252	260	260	257	130	260	275	275	270	170

¹ F_{0i} for the first syllabic peak for the words [*áda*] and [*ibá*] as realized by ED were 212Hz and 245Hz respectively for the first 40ms, after which it rose to 238Hz and 252Hz respectively for each of the two words. FR_1 also realized F_{0i} of the first syllabic peak of the word [*ibá*] as 225Hz for 40ms before it rose to 252Hz. For the same syllabic peak and for the same word, F_0 value for HS was 178Hz realized for 70ms before it rose to 200Hz. It is probably as a result of the nature of F_0 realization on this syllabic peak that the High tone was perceived as a Rising tone thereby resulting in its unacceptability by the Edo native speakers/hearers.

Table 1b: F_0 and duration values for seven Edo $\acute{V}\acute{C}\acute{V}$ words pronounced by eight non-Edo speakers in a listening task²

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		
1.	[úkó]	YB	130	126	123	126	120	130	130	130	130	140	
		IK	126	138	142	135	110	146	146	150	147	170	
		*	HS	178	200	200	193	80	200	200	200	200	200
		FR ₁	252	275	275	267	60	275	275	275	275	110	
		**	FR ₂	225	200	189	205	90	245	245	275	255	200
		**	FR ₃	146	146	126	139	80	159	159	159	159	80
		CH ₁	126	126	126	126	140	130	134	134	133	170	
		CH ₂	189	195	200	195	120	195	195	195	195	150	

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		
2.	[ágó]	YB	123	126	126	125	120	126	126	126	126	160	
		IK	112	126	130	123	110	123	138	142	134	150	
		*	HS	146	184	200	177	170	200	212	212	208	240
		FR ₁	252	252	252	252	160	252	252	245	250	150	
		FR ₂	206	225	231	221	70	252	252	252	252	220	
		FR ₃	142	146	150	146	60	146	154	159	153	130	
		CH ₁	134	134	134	134	130	138	138	138	138	160	
		CH ₂	164	168	168	167	180	164	168	184	172	200	

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		F_{0i}	$F_{02/3}$	F_{0f}	F_{0m}		
3.	[úkú]	YB	138	138	138	138	140	138	138	138	138	160	
		IK	134	146	146	142	130	138	142	150	143	160	
		*	HS	206	225	231	221	130	231	231	231	231	190
		FR ₁	252	260	267	260	140	275	275	275	275	150	
		*	FR ₂	231	275	300	269	100	300	300	300	300	150
		**	FR ₃	142	154	142	146	110	159	178	178	172	120
		CH ₁	146	146	146	146	100	146	146	146	146	160	
		CH ₂	189	195	200	195	160	195	195	195	195	220	

²The following symbols were used for the acceptability judgement:

- * (for partially accepted tokens)
- ** (for rejected tokens)
- ? (for borderline cases)

SER. No.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
4.	[úgú]	YB	130	130	130	130	140	126	126	126	126	120
		IK	134	142	142	139	80	138	146	150	145	130
	*	HS	173	206	212	197	180	212	212	212	212	180
		FR ₁	252	252	252	252	110	260	260	260	260	100
		FR ₂	212	231	252	232	100	275	275	283	278	90
	FR ₃	146	154	154	151	80	146	159	164	156	100	
	CH ₁	134	134	134	134	120	138	138	134	137	150	
CH ₂	189	195	200	195	150	195	195	195	195	160		

SER. No.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
5.	[áda]	YB	123	123	123	123	160	123	123	123	123	220
		IK	126	126	126	126	160	126	126	150	134	130
	*	HS	123	154	159	145	160	159	159	159	159	240
		FR ₁	245	245	245	245	150	245	245	245	245	150
		FR ₂	225	231	252	236	160	245	245	245	245	190
	FR ₃	142	142	142	142	110	142	142	146	143	100	
	?	CH ₁	130	123	123	125	120	123	123	126	124	170
CH ₂		164	173	173	170	180	173	178	178	176	180	

SER. No.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
6.	[íba]	YB	126	126	126	126	90	123	123	123	123	160
		IK	126	142	142	137	150	126	134	142	134	150
	*	HS	178	200	200	193	160	200	200	200	200	180
		FR ₁	225	252	252	243	180	252	252	252	252	170
		FR ₂	238	245	252	245	90	245	245	252	247	200
	FR ₃	134	138	142	138	80	142	146	150	146	110	
	CH ₁	134	134	134	134	80	134	134	134	134	160	
CH ₂	173	195	195	188	180	195	195	178	189	170		

SER. No.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
7.	[ága]	YB	126	126	126	126	160	126	126	126	126	190
		IK	123	126	138	129	140	126	126	142	131	190
	*	HS	159	184	195	179	160	195	195	195	195	210
		FR ₁	267	260	252	260	200	252	252	252	252	160
		FR ₂	206	225	260	230	160	275	245	252	257	190
	CH ₁	126	126	126	126	120	126	126	123	125	200	
	CH ₂	164	168	173	168	240	178	178	178	178	80	

Table 2a: F₀ and duration values for seven Edo $\check{V}C\check{V}$ words pronounced by a female Edo speaker

SER. NO.	WORDS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
1.	[<i>ùgò</i>]	231	238	231	233	80	231	189	146	189	170
2.	[<i>idi</i>]	252	245	238	245	170	231	189	150	190	200
3.	[<i>ìdù</i>]	252	252	245	250	130	231	189	173	198	180
4.	[<i>ìdè</i>]	245	252	245	247	80	238	200	173	204	170
5.	[<i>àdà</i>]	212	212	206	210	130	200	184	150	178	180
6.	[<i>òkò</i>]	245	238	231	238	140	245	184	173	201	180
7.	[<i>òdò</i>]	231	212	206	216	160	206	178	159	181	160

Table 2b: F₀ and duration values for seven Edo $\check{V}C\check{V}$ words pronounced by eight non-Edo speakers in a listening task

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
1.	[<i>ùgò</i>]	YB	119	119	119	119	90	112	103	89	101	130
		IK	134	134	119	129	120	116	103	94	104	120
		HS	189	189	195	191	140	173	138	103	138	270
		FR ₁	231	231	231	231	80	225	200	178	201	130
		* FR ₂	212	231	252	232	80	195	146	138	160	150
		* FR ₃	138	159	164	154	80	154	138	109	134	80
		CH ₁	138	134	134	135	120	130	103	97	110	110
		CH ₂	195	189	184	189	120	164	159	126	150	90
2.	[<i>idi</i>]	YB	126	126	116	123	90	116	103	100	106	180
		IK	138	138	134	137	130	126	106	103	112	120
		* HS	146	206	212	188	130	189	106	97	131	260
		FR ₁	267	260	260	262	120	212	184	159	185	160
		* FR ₂	206	225	212	228	80	173	146	134	151	120
		* FR ₃	134	154	154	147	60	150	154	130	145	90
		CH ₁	138	138	134	137	120	123	103	97	108	90
		* CH ₂	178	195	164	179	120	164	138	126	143	90

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
3.	[<i>üdü</i>]	YB	138	130	126	131	140	126	116	97	113	140
		IK	138	138	134	137	160	126	116	89	110	190
	*	HS	189	206	218	204	160	178	119	103	133	280
		FR ₁	245	245	238	243	120	231	200	173	201	180
	*	FR ₂	231	238	238	236	140	206	168	138	171	190
		FR ₃	138	150	164	151	100	159	159	154	157	90
	*	CH ₁	150	146	138	145	160	138	123	106	122	160
		CH ₂	178	195	195	189	200	195	150	126	157	180

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
4.	[<i>üdü</i>]	YB	126	123	119	123	90	116	109	97	107	150
		IK	126	126	126	126	80	123	116	94	111	170
	*	HS	173	206	212	197	150	189	126	94	136	270
		FR ₁	252	252	252	252	130	225	178	164	189	200
	FR ₂	225	231	231	229	80	195	159	134	163	140	
		FR ₃	150	150	150	150	80	146	126	97	123	170
	CH ₁	138	142	126	135	150	126	119	106	117	150	
		CH ₂	212	206	173	197	170	164	146	138	149	80

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
5.	[<i>ädä</i>]	YB	106	106	103	105	130	109	97	92	99	130
		IK	123	119	116	119	160	106	94	89	96	180
	*	HS	116	134	138	129	140	138	106	97	114	240
		FR ₁	212	212	212	212	120	195	184	150	176	160
	FR ₂	195	195	195	195	80	195	134	116	148	190	
		FR ₃	150	150	150	150	80	146	123	94	121	150
	CH ₁	126	130	126	127	110	126	106	97	110	150	
		CH ₂	164	164	164	164	200	159	134	116	136	160

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
6.	[<i>ökò</i>]	YB	116	116	109	114	110	116	112	100	109	90
		IK	126	123	116	122	140	126	103	89	106	150
	HS	178	178	178	178	160	178	138	106	141	290	
		FR ₁	231	231	231	231	120	231	189	159	193	200
	*	FR ₂	195	231	252	226	100	231	150	138	173	170
		FR ₃	150	159	164	158	80	138	123	97	119	160
	CH ₁	134	126	126	129	120	126	103	97	109	120	
		CH ₂	178	164	138	160	230	159	134	119	137	150

SER. NO.	WORDS	SPEAK- ERS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
7.	[òdò]	YB	116	112	106	111	160	109	103	94	102	120	
		IK	119	116	116	117	160	112	97	82	97	140	
		HS	138	142	142	141	120	138	119	97	118	280	
		FR ₁	218	212	212	214	160	212	178	159	183	220	
		FR ₂	212	212	212	212	140	189	134	112	145	160	
		*	FR ₃	142	150	154	149	100	138	119	97	118	120
			CH ₁	138	138	126	134	130	126	116	103	115	130
			CH ₂	164	168	164	165	170	159	134	123	139	100

Table 3a: F₀ and duration values for seven Edo $\check{V}C\check{V}$ words pronounced by a female Edo speaker

SER. NO.	WORDS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION
		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
1.	[èdò]	218	218	218	218	110	231	231	231	231	180
2.	[èbò]	212	212	212	212	100	231	231	231	231	190
3.	[èkò]	231	231	231	231	80	267	267	267	267	200
4.	[àkò]	218	218	218	218	80	245	245	245	245	120
5.	[òkò]	218	218	218	218	90	238	238	231	236	190
6.	[ùgò]	231	231	231	231	100	252	252	252	252	200
7.	[ùdò]	231	231	231	231	130	252	252	252	252	240

Table 3b: F₀ and duration values for seven Edo $\check{V}C\check{V}$ words pronounced by eight non-Edo speakers in a listening task

SER. NO.	WORDS	SPEAK- ERS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
1.	[èdò]	YB	109	109	109	109	140	126	126	126	126	160	
		IK	119	119	119	119	90	126	138	142	135	130	
		*	HS	138	150	150	146	140	164	164	164	164	240
		**	FR ₁	225	231	231	229	150	231	231	225	229	120
		*	FR ₂	206	206	206	206	120	218	245	275	246	210
		*	FR ₃	138	138	142	139	80	142	154	142	146	110
		*	CH ₁	134	138	138	137	120	138	138	138	138	120
		*	CH ₂	150	164	164	159	120	168	168	168	168	160

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
2.	[èbó]	YB	116	116	116	116	80	126	126	126	126	120	
		IK	116	116	116	116	130	123	138	150	137	140	
		*	HS	173	184	184	180	200	200	212	245	219	200
		**	FR ₁	231	231	231	231	160	231	231	231	231	200
		**	FR ₂	206	225	238	223	120	238	260	245	248	210
			FR ₃	138	138	134	137	60	134	150	150	145	100
			CH ₁	123	119	116	119	120	130	130	126	129	160
			CH ₂	159	164	164	162	220	178	195	195	189	180

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
3.	[àkó]	YB	126	126	126	126	110	138	138	138	138	160	
		IK	126	126	126	126	120	138	138	164	147	140	
		***	HS	173	173	173	173	160	178	178	178	178	220
		**	FR ₁	252	252	252	252	130	260	260	260	260	140
		**	FR ₂	206	225	238	223	100	238	275	252	255	170
			FR ₃	154	154	154	154	70	154	173	173	167	100
			CH ₁	112	112	112	112	80	134	134	134	134	160
			CH ₂	150	168	164	161	80	195	195	195	195	190

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
4.	[àkó]	YB	112	112	116	113	90	126	126	123	125	120	
		IK	106	106	119	110	150	126	130	126	127	170	
		**	HS	142	178	189	170	200	206	206	206	206	220
			FR ₁	225	225	218	223	140	275	252	245	257	190
		**	FR ₂	200	225	231	219	90	238	267	267	257	170
			FR ₃	138	138	138	138	50	138	154	159	150	120
			CH ₁	119	119	119	119	120	123	130	123	125	120
			CH ₂	154	154	154	154	130	173	178	184	178	170

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
5.	[òkó]	YB	116	116	116	116	100	126	126	126	126	160
		IK	119	119	119	119	140	138	142	142	141	140
		HS	164	195	200	186	190	225	231	225	227	240
		FR ₁	212	231	206	216	130	275	245	245	255	140
		FR ₂	173	206	212	197	90	245	252	245	247	200
		FR ₃	138	150	126	138	90	150	168	173	164	100
		CH ₁	126	119	112	119	110	134	134	134	134	120
		CH ₂	164	164	164	164	150	189	195	195	193	160

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
6.	[ùgò]	YB	116	116	116	116	100	138	138	138	138	140	
		IK	119	119	119	119	120	138	138	142	139	160	
		HS	173	178	178	176	130	206	206	206	206	240	
		FR ₁	231	231	231	231	110	252	252	245	250	200	
		FR ₂	206	231	231	223	90	252	252	252	252	280	
		**	FR ₃	138	142	138	139	100	142	150	150	147	120
			CH ₁	126	126	126	126	80	138	138	138	138	140
			CH ₂	164	164	164	164	160	189	189	189	189	240

SER. NO.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION	
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		
7.	[údò]	YB	119	119	119	119	140	134	134	134	134	200	
		IK	116	116	116	116	120	123	126	142	130	200	
		HS	173	178	178	176	160	189	206	206	200	250	
		FR ₁	231	231	231	231	140	245	245	245	245	200	
		**	FR ₂	195	225	231	217	90	231	267	275	258	200
		**	FR ₃	138	138	142	139	70	142	142	146	143	120
			CH ₁	116	116	116	116	100	134	134	134	134	160
			CH ₂	164	164	164	164	180	189	189	189	189	240

Table 4a: F₀ and duration values for seven Edo VC̣Ṿ words pronounced by a female Edo speaker

SER. NO.	WORDS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
		F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
1.	[ìbà]	267	275	275	272	120	267	195	164	209	160
2.	[ókò]	245	252	252	250	120	275	212	189	225	120
3.	[údè]	275	275	275	275	90	267	225	178	223	150
4.	[ázà]	252	252	252	252	110	252	206	173	210	150
5.	[škà]	245	275	275	265	120	275	245	206	242	120
6.	[àkò]	245	245	245	245	80	275	225	173	224	100
7.	[é'bo] ³	267	275	275	272	180	231	206	206	214	150

³The low tone on the second syllabic peak of this word is not realized as a Falling tone. It is realized more or less as a level Low tone after a High tone in the neighbouring Esan language; or as a downstepped Low tone. It might be necessary to find out the origin of this word, i.e. whether or not it is a borrowed word.

Table 4b: F₀ and duration values for seven Edo VC̣Ṿ words pronounced by eight non-Edo speakers in a listening task

SER. No.	WORDS	SPEAKERS	FIRST SYLLABLE				DURATION	SECOND SYLLABLE				DURATION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
1.	[ibà]	YB	134	134	134	134	120	134	116	103	118	130
		IK	138	142	142	141	140	138	112	97	116	150
	*	HS	164	200	200	188	120	178	138	106	141	140
		FR ₁	231	252	260	248	140	260	218	173	217	130
		FR ₂	206	245	252	234	120	245	206	173	208	150
	**	FR ₃	146	168	168	161	100	159	126	97	127	190
		CH ₁	146	146	146	146	110	146	123	112	127	140
		CH ₂	178	195	195	189	200	164	150	138	151	100
2.	[ókò]	YB	112	116	116	115	100	116	109	103	109	100
		IK	138	146	164	149	100	138	109	87	111	130
	*	HS	154	159	164	159	100	164	119	112	132	180
		FR ₁	231	252	231	238	110	252	195	138	195	180
		FR ₂	206	267	275	249	120	267	173	146	195	180
	?	FR ₃	159	159	164	161	80	159	134	106	133	160
		CH ₁	130	130	130	130	80	126	119	97	114	120
		CH ₂	189	195	189	191	120	195	164	126	162	130
	3.	[údè]	YB	138	142	142	141	80	142	123	103	123
IK			138	154	164	152	90	164	123	97	128	160
*		HS	178	231	238	216	130	206	146	112	155	220
		FR ₁	231	260	260	250	120	245	189	173	202	170
		FR ₂	252	267	283	267	110	245	173	134	184	200
?		FR ₃	150	154	154	153	80	150	112	94	119	180
		CH ₁	134	138	138	137	80	138	123	112	124	150
		CH ₂	195	195	195	195	160	173	159	138	157	110
4.		[ázà]	YB	126	134	138	133	150	126	116	103	115
	IK		123	130	138	130	120	126	112	87	108	130
	*	HS	134	189	189	171	210	164	116	103	128	200
		FR ₁	245	252	252	250	150	245	189	173	202	190
		FR ₂	189	225	231	215	140	238	146	123	169	130
	*	FR ₃	150	150	150	150	80	138	126	109	124	120
		CH ₁	126	138	138	134	100	126	109	97	111	160
		CH ₂	173	178	178	176	160	178	164	146	163	80

SER. NO.	WORDS	SPEAK- ERS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
5.	[ɔkà]	YB	123	123	126	124	120	126	112	103	114	110
		IK	103	130	130	121	120	130	116	89	112	80
	HS	150	189	195	178	130	200	142	123	155	200	
	FR ₁	245	267	275	262	110	275	206	189	223	80	
	*	FR ₂	206	245	260	237	110	225	138	134	166	150
	FR ₃	138	150	150	146	60	138	112	97	116	170	
	CH ₁	138	138	138	138	110	134	116	94	115	130	
	*	CH ₂	178	178	184	180	80	159	142	116	139	110

SER. NO.	WORDS	SPEAK- ERS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
6.	[ákò]	YB	116	126	116	119	140	126	116	103	115	110
		IK	123	130	130	128	100	126	97	87	103	120
	*	HS	142	184	195	174	160	200	159	126	162	170
	FR ₁	231	238	238	236	120	238	189	130	192	130	
	?	FR ₂	195	225	238	219	80	212	150	146	169	120
	FR ₃	126	138	134	133	80	134	126	116	125	100	
	CH ₁	126	126	130	127	80	138	116	97	117	140	
	CH ₂	164	168	168	167	110	200	150	123	158	140	

SER. NO.	WORDS	SPEAK- ERS	FIRST SYLLABLE				DURA -TION	SECOND SYLLABLE				DURA -TION
			F _{0i}	F _{02/3}	F _{0f}	F _{0m}		F _{0i}	F _{02/3}	F _{0f}	F _{0m}	
7.	[é'̀bò]	YB	126	130	130	129	120	116	103	97	105	160
		*	IK	146	154	154	151	190	119	119	123	120
	HS	146	178	178	167	120	150	119	103	124	180	
	*	FR ₁	245	252	267	255	160	212	212	206	210	190
	*	FR ₂	225	252	275	251	170	245	189	146	193	250
	FR ₃	173	195	195	188	110	189	154	112	152	120	
	CH ₁	123	126	123	124	130	138	123	116	126	210	
	CH ₂	195	195	195	195	200	146	138	138	141	120	

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