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

Victor E. Omozuwa University of Benin, Nigeria

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 acoutic 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 disylabic 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 depeinding 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 disylabic nouns are considered. Edo has two distinctive tones, High and Low, combined in the following manners in disyllabic nouns: $\acute{V}C\acute{V}$, $\grave{V}C\acute{V}$, $\grave{V}C\acute{V}$ and $\acute{V}C\acute{V}$.

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 disylabic 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 (F₀) values and duration of seven VCV 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 lsit 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_0 i), at a point two-thirds of the F_0 realization (F_0 2/3), and at the end of the F_0 realization, F_0 f. F_0 values are expressed in Hertz (Hz) while duration is expressed in milliseconds (ms). F_0 m 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 $\acute{V}C\acute{V}$ 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 $[\acute{u}k\acute{o}]$ 'gourd' pronounced by ED and FR_1)

or

(b) a gradual rise from the beginning to the end of the F_0 realization, i.e. $F_0 f \ge F_0 i$ (cf. the word [$ik\delta$] pronounced by YB, IK, CH₁, and CH₂).

Results of this experiment also show that a \acute{V} C \acute{V} sequence is automatically perceived as a \r{V} C \acute{V} tone sequence if the direction of change of F_0 variation on the first syllabic peak is falling, i.e. F_0 f is less than F_0 i (cf. the word $[\acute{u}k\acute{o}]$ pronounced by FR_2 and FR_3). 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_0 i of the first syllabic peak but less than its F_0 f and the F_0 i of the second syllabic peak (cf. the words $[\acute{a}g\acute{o}]$ 'tin' and $[\acute{a}g\acute{a}]$ 'chair' pronounced by HS, or the word $[\acute{u}k\acute{u}]$ 'praise name for the king' pronounced by HS, FR_2 , and FR_3).

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 $\acute{V}C\acute{V}$ sequence. This is probably why the word $[\grave{e}k\acute{o}]$ 'Lagos' pronounced by FR_1 was perceived as $[\acute{e}k\acute{o}]$ (?) by Edo listeners. In the pronunciation of this word by FR_1 , F_0 variation is nil on each of the two syllabic peaks but in absolute terms the difference between the F_0 f of the first syllabic peak and the F_0 i of the second syllabic peak is 1/4 of a musical tone.

- **1.2.2. Perception of tones of disyllabic nouns of the \hat{\mathbf{V}}\mathbf{C}\hat{\mathbf{V}} type.** A low tone is perceived on the first syllabic peak if the difference between the F_0 f value of V_i and the F_0 i value of V_2 is more than 1/4 of a musical tone. In other words a $\hat{\mathbf{V}}\mathbf{C}\hat{\mathbf{V}}$ word is perceived in Edo only if the difference between F_0 f of the first syllabic peak and the F_0 i 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 $\hat{\mathbf{V}}\mathbf{C}\hat{\mathbf{V}}$ word types in Edo).
- 1.2.3. Perception of a sequence of low tones on disyllabic nouns of the $\hat{\mathbf{V}}\hat{\mathbf{C}}\hat{\mathbf{V}}$ 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 $[\hat{u}g\hat{\sigma}]$ 'name of a village' pronounced by ED, YB, and FR₁ in Table 2), in which case the difference between the F_0 f of the first syllabic peak and its F_0 i 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_0 f of the first syllabic peak is more than the F_0 i 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 $\hat{\mathbf{V}}\hat{\mathbf{C}}\hat{\mathbf{V}}$ sequence is likely to be perceived if the F_0 f of the Low tone on V_1 is less than its F_0 i, while a $\hat{\mathbf{V}}\hat{\mathbf{C}}\hat{\mathbf{V}}$ sequence is likely to be perceived if the

difference between the F_0 f and the F_0 i of V_i 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 $\mathring{V}C\mathring{V}$ tone pattern is very close to the F_0 values of the first syllable of the $\mathring{V}C\mathring{V}$ 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 $\dot{V}C\dot{V}$ 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 VCV type. This study also reveals that the Low tone on the second syllabic peak of a VCV sequence is realized physically as a High-falling tone. In other words, F₀ 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 F₀i value of the second syllabic peak is usually higher than the F₀f of the first syllabic peak. In cases where the F₀i 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_0 f of the first syllabic peak, there is distortion of the usual Low tone perception in such ÝCV words, i.e. a High-falling tone (cf. the word [ázà] pronounced by FR₃ and [íbà] pronounced by CH₂). The Low tone in such cases is perceived more or less like the low tone of a VCV 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-HL.

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. ÝCÝ words. The repetitions of five out of the eight non-Edo speakers were accepted as being properly pronounced. The repetitions of the word [uko] '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: F₀f of V_1 is less than its F_0 i whereas F_0 f of V_2 is more than its F_0 i in the case of FR_2 ; F_0f of V_2 is equal to its F_0i in the case of FR_3 . Consequently, the "word" [uko] (which is meaningless in Edo) is perceived instead of the stimulus $[\hat{u}k\hat{o}]$ presented. The same explanation holds for the repetition of the word [uku] 'praise name for Edo king' by FR₃ and perceived by Edo listeners as [ùku] which is also meaningless. In this case, even though F_0f of V_1 is equal to its F_0i , its $F_02/3$ is different from F₀i 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, F₀i 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 F_0 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_0 i to $F_02/3$ is considerably lower in pitch than F_0 f. Thus a "Rising tone" is perceived (cf. Omozuwa [1987a:307]) on V_1 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. $\hat{\mathbf{V}}\hat{\mathbf{C}}\hat{\mathbf{V}}$ 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 $[\hat{\imath}\hat{d}\hat{\imath}]$ by CH₂ was considered "partially accepted" even though the Low-Low tone melody on the $\hat{\mathbf{V}}\hat{\mathbf{C}}\hat{\mathbf{V}}$ 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. $[id\tilde{i}]$ was realized as $[iz\tilde{i}]$. The words $[id\tilde{e}]$ and [\displaystartage kappa] 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 V_1 is different from that of V_2 : $F_0 f$ of V_1 is more than its $F_0 i$ whereas $F_0 f$ of V₂ is less than its F₀i. Consequently, a High tone is perceived on V₁ whereas a Low "level" tone is perceived on V_2 (cf. also the realization of $[\partial d\hat{\partial}]$ as $[\partial' d\hat{\partial}]$ 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 $[\partial d\hat{o}]$ was realized by FR₃ would have led to a difference in meaning since the Edo language contrasts $|\partial d\partial|$ 'yellow fever' with $|\partial d\partial|$ [$\partial d\partial$] 'potash'. However, [$\partial' d\partial$] as realized by FR₃ was considered as a foreigner's pronunciation of $|\delta d\delta|$ '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 /\u00fcde/, /\u00fcd\u00fd, /\u00fcd\u00f6/, and /\u00e4d\u00e4/ were realized as $[\check{u}d\grave{e}]$, $[\check{u}d\grave{u}]$, $[\check{o}d\grave{o}]$, and $[\check{a}d\grave{a}]$ respectively, and thus judged "partially accepted" by the Edo listeners. This is remarkably different from the way the same HS speaker realized the words $[\dot{u}g\dot{\partial}]$ 'name of a village' and $[\dot{\partial}k\dot{\partial}]$ 'parcel'. The pronunciation of these words by HS was unanimously accepted by the Edo listeners.

2.3. VCV 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 $[\grave{\epsilon}d\acute{o}]$, $[\grave{\epsilon}b\acute{o}]$, and $[\grave{\epsilon}k\acute{o}]$ realized by FR₁were perceived as $[\acute{\epsilon}d\acute{o}]$, $[\acute{\epsilon}b\acute{o}]$, and $[\acute{e}k\acute{o}]$ 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 F_0i (F_0i to $F_02/3$ of the second syllabic peak being the same as the F₀f of the first syllabic peak). In the case of the word $[\grave{e}k\acute{o}]$ realized by FR₁ and perceived by the Edo listeners as $[\acute{e}k\acute{o}]$, it would be observed that he 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 VCV words. This corroborates our earlier claim that for a VCV tone sequence to be perceived in Edo, the difference between the F_0 f of V_1 and the F_0 i of V_2 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 VCV tone pattern to be perceived as a VCV pattern as shown by the pronunciation of the word $[\grave{e}ko]$ by FR_1 (cf. also the F_0 contour of the same word realized by the HS speaker, rejected as the VCV stimulus, and perceived as a VCV "word" with no specific meaning in Edo). The pronunciatoin of the word $[\grave{e}do]$ by FR_2 was considered partially accepted by the Edo native speakers/hearers in view of the fact that this speaker realized the VCV pattern as a VCV pattern, a tone pattern that does not exist in Edo. Similarly, the pronunciation of the words $[\grave{e}bo]$, $[\grave{a}ko]$, and $[\grave{u}do]$ 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 VCV tone sequence, thus rendering the words pronounced "unnatural" in the ears of the native listeners.

2.4. $\mathring{\mathbf{V}}\mathbf{C}\mathring{\mathbf{V}}$ words. As noted earlier, for a pitch contour to be an acceptable realization of a $/\mathring{\mathbf{V}}\mathbf{C}\mathring{\mathbf{V}}/$ word in Edo, i.e. tonetically $[\mathring{\mathbf{V}}\mathbf{C}\mathring{\mathbf{V}}]$, the F_0 i of V_2 should, ideally, be equal to or more than the F_0 f 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 $/ib\grave{a}/$ by CH₂, the word $/az\grave{a}/$ by HS and FR₃, and the word $/ak\grave{o}/$ by HS were considered "partially accepted" by the native speakers/hearers. A close observation of the F₀ realization of these tokens pronounced by the non-Edo speakers reveals that the F₀ contour of the Low tone on the second syllabic peak is "not properly realized" the way it should be in Edo, i.e. F₀i of V₂ should be in the same perceptual range as the F₀f of V₁.

Let us consider the word /ibà/ for instance. In the speech of the Edo native speaker recorded, F_0 i of V_2 is less than F_0 f 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_0 i of V_2 is equal to F_0 f of V_1 in the repetitions of YB, FR_1 , and CH_1 speakers for the same word. The difference between the F_0 i of V_2 and the F_0 f 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 $/\acute{a}k\grave{o}/$ 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 $/\acute{a}k\grave{o}/$ is perceived as $[\check{a}k\grave{o}]$. 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 $/\acute{a}z\grave{a}/$ 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 $/ak\dot{o}/$ by FR₂ and $/ud\dot{e}/$ 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 F₀i of V₂ and the F₀f of V₁ is one musical tone (cf. the realization of $/ib\dot{a}/$ by the HS speaker as analysed above). It might be that *one* musical tone difference between the F₀i of V₂ and the F₀f of V₁ serves as the perceptual threshold for the perception of a $/\dot{V}$ C $\dot{V}/$ tone pattern in Edo, i.e. if F₀i of V₂ is less than F₀f of V₁. The perception of this tone pattern is distorted if this value is more than a musical tone. Words with such a $/\dot{V}$ C $\dot{V}/$ 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 threshhold 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 disylabic 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 F₀ values from the beginning to the end of the F₀ realization on each of the syllabic peaks even though in some cases the F₀ values are the same from the beginning to the end of the F₀ 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 $\hat{V}C\hat{V}$ sequence is the major acoustic cue for the perception of these contrastive tones in such sequence.
- (d) In a VCV 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 ÝCÝ WORDS

| | Words | Phonetic Realization | Gloss |
|----|-------|-------------------------|----------------------------|
| 1. | úkó | [úkó] | 'gourd' |
| 2. | ágó | $[\acute{a}g\acute{o}]$ | 'can' |
| 3. | úkú | [úkú] | 'praise name for Edo king' |
| | úgú | [úgú] | 'name of a clan' |
| 5. | ádá | [ádá] | 'sceptre' |
| 6. | íbá | [<i>íbá</i>] | 'mischief' |
| 7. | ágá | [ágá] | 'chair' |

EDO VCV WORDS

| | Words | Phonetic Realization | Gloss |
|----|-------|-------------------------------|---------------------|
| 1. | ùgò | $[\grave{u}g\grave{o}]$ | 'name of a village' |
| 2. | ìdìn | [idi] | 'grave' |
| 3. | àdà | [<i>àdà</i>] | 'crossroad' |
| 4. | òkò | $[\partial k \dot{\partial}]$ | 'parcel' |
| 5. | ùdù | [ùdù] | 'heart' |
| 6. | ùdè | [ùdè] | 'advice' |
| 7. | òdò | [<i>òdò</i>] | 'yellow fever' |

EDO VCV WORDS

| | Words | Phonetic Realization | Gloss |
|----|-------|---------------------------------|---------------------|
| 1. | èdó | $[\grave{\epsilon}d\acute{o}]$ | 'Edo (language)' |
| 2. | èbó | $[\grave{arepsilon}b\acute{o}]$ | 'charm' |
| 3. | èkó | [<i>èkó</i>] | 'Lagos' |
| 4. | àkó | [<i>àkó</i>] | 'portion' |
| 5. | òkó | [<i>òkó</i>] | 'nest' |
| 6. | ùgó | [ùgó] | 'a plant' |
| 7. | ùdó | [<i>ùdó</i>] | 'name of a village' |

EDO ÝCÝ WORDS

| | Words | Phonetic Realization | Gloss |
|----|-------|-------------------------|------------------|
| 1. | íbà | [íbà] | 'mud bed' |
| 2. | ókò | [<i>ók</i> ò] | 'a flute' |
| 3. | údè | [údè] | 'spleen ailment' |
| 4. | ázà | [ázà] | 'treasury' |
| 5. | ókà | [<i>5kà</i>] | 'maize' |
| 6. | ákò | [ákò] | 'a fruit' |
| 7. | ébò | $[\acute{e}b\grave{o}]$ | '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 | SYLLABI | Æ | | DURA -TION | SECON | D SYLAB | | DURA -TION | |
|-------------|--------------------|------------------|-----------|------------------|------------------|---------------|------------------|--------------------|------------------|------------------|-----|
| | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | |
| 1. | [úkó] ¹ | 252 | 252 | 252 | 252 | 80 | 252 | 252 | 252 | 252 | 150 |
| 2. | [ágó] | 260 | 260 | 260 | 260 | 120 | 260 | 260 | 260 | 260 | 210 |
| 3. | [úkú] | 275 | 275 | 275 | 275 | 120 | 275 | 275 | 275 | 275 | 160 |
| 4. | [úgú] | 245 | 260 | 260 | 255 | 100 | 260 | 260 | 260 | 260 | 120 |
| 5. | [ádá] | 212 | 238 | 238 | 229 | 150 | 238 | 238 | 238 | 238 | 190 |
| 6. | [íbá] | 245 | 252 | 252 | 250 | 120 | 245 | 245 | 245 | 245 | 220 |
| 7. | [ágá] | 252 | 260 | 260 | 257 | 130 | 260 | 275 | 275 | 270 | 170 |

 $^{^{1}}F_{0}$ i for the first syllabic peak for the words [ádá] and [íbá] 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. FR₁ also realized F₀i 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, F₀ value for HS was 178Hz realized for 70ms before it rose to 200Hz. It is probably as a result of the nature of F₀ realization on this syllabic peak that the High tone was perceived as a Rising tone thereby resulting in its unacceptabilty by the Edo native speakers/hearers.

Table 1b: F₀ and duration values for seven Edo ÝCÝ words pronounced by eight non-Edo speakers in a listening task²

| SER. No. | WORDS | SPEAK- ERS | FIRST SYLLABLE | | | | DURA -TION | SECON | D SYLAB | LE | | DURA -TION |
|-------------|-------|------------------------------------|------------------|------------|------------------|------------------|----------------------|------------------|--------------------|------------------|------------------|---------------|
| | | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | |
| 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 | 252 225 | 275 200 | 275 189 | 267 205 | 60 90 | 275 245 | 275 245 | 275 | 275 255 | 110 |
| | ** | FR ₂ FR ₃ | 146 | 200 146 | 126 | 139 | 9 0 80 | 159 | 243 159 | 275 159 | 255 159 | 200 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 |
| | | CH2 | 10) | 173 | 200 | 173 | 120 | 193 | 193 | 193 | 193 | 150 |
| SER. | WORDS | SPEAK- | FIRST : | SYLLABL | Æ | 1 | DURA | SECON | D SYLAB | LE | 1 | DURA |
| No. | | ERS | | | | | -TION | | V | | | -TION |
| | | | F ₀ i | $F_0 2/3$ | F_0f | F ₀ m | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | |
| 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 FR ₁ | 146 252 | 184 252 | 200 252 | 177 252 | 170 160 | 200 252 | 212 252 | 212 245 | 208 250 | 240 150 |
| | | FR ₂ | 206 | 225 | 232 | 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 |
| | | CIIZ | 10. | 100 | 100 | 10. | 100 | 10. | 100 | 10. | | 200 |
| SER. | WORDS | SPEAK- | FIRST : | SYLLABL | Æ | I | DURA | SECON | D SYLAB | LE | ı | DURA |
| No. | | ERS | | | | | -TION | | | | | -TION |
| | | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | |
| 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 | 260 275 | 267 300 | 260 269 | 140 100 | 275 300 | 275 300 | 275 300 | 275 300 | 150 150 |
| | ** | FR ₂ FR ₃ | 231 142 | 275 154 | 300 142 | 209 146 | 110 | 300 159 | 300 178 | 300 178 | 300 172 | 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 |
| | | C112 | 107 | 173 | 200 | 1/3 | 100 | 1/3 | 175 | 175 | 175 | 220 |

²The following symbols were used for the acceptability judgement:

⁽for partially accepted tokens) (for rejected tokens) (for borderline cases)

[?]

| SER. No. | WORDS | SPEAK- ERS | | | | | DURA -TION | SECON | D SYLAB | LE | | DURA -TION |
|-------------|------------------------|---|--|--|---|---|--|---|---|---|--|--|
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0^{2/3}$ | F ₀ f | F ₀ m | |
| 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 |
| crn | WORDS | LCDEAN | прет | SYLLABI | Б | | l dura | LSECON | ID SYLAB | 1 E | | DURA |
| SER. No. | WORDS | SPEAK- ERS | riksi . | 3 I LLADI | JE: | | -TION | SECON | DSILAL | LL | | -TION |
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | |
| 5. | [ádá] | 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 |
| | | 2 | | | | | | | | | | |
| cen | l worns | | l ETPST | CVI I ADI | Е | | | l secon | ID GAI VE | n E | | |
| SER. No. | WORDS | SPEAK- ERS | FIRST | SYLLABI | Æ | | DURA -TION | SECON | ID SYLAE | BLE | | DURA -TION |
| | WORDS | SPEAK- | FIRST : | SYLLABI | E F ₀ f | F ₀ m | DURA | secon F ₀ i | ID SYLAE | F ₀ f | F ₀ m | DURA |
| | | SPEAK- | | | | 126 | DURA -TION | F ₀ i 123 | | | | DURA -TION |
| No. | [íbá] | SPEAK- ERS YB IK | F ₀ i 126 126 | F ₀ 2/3 126 142 | F ₀ f 126 142 | 126 137 | DURA -TION 90 150 | F ₀ i 123 126 | F ₀ 2/3 123 134 | F ₀ f 123 142 | F ₀ m 123 134 | DURA -TION 160 150 |
| No. | | SPEAK- ERS YB IK HS | F ₀ i 126 126 178 | 126 142 200 | F ₀ f 126 142 200 | 126 137 193 | DURA -TION 90 150 160 | F ₀ i 123 126 200 | F ₀ 2/3 123 134 200 | F ₀ f 123 142 200 | F ₀ m 123 134 200 | DURA -TION 160 150 180 |
| No. | [íbá] | SPEAK- ERS YB IK HS FR ₁ | F ₀ i 126 126 178 225 | 126 142 200 252 | F ₀ f 126 142 200 252 | 126 137 193 243 | 90 150 160 180 | F ₀ i 123 126 200 252 | 123 134 200 252 | F ₀ f 123 142 200 252 | F ₀ m 123 134 200 252 | DURA -TION 160 150 180 170 |
| No. | [íbá] | SPEAK- ERS YB IK HS FR ₁ FR ₂ | F ₀ i 126 126 178 225 238 | 126 142 200 252 245 | F ₀ f 126 142 200 252 252 | 126 137 193 243 245 | 90 150 160 180 90 | F ₀ i 123 126 200 252 245 | 123 134 200 252 245 | F ₀ f 123 142 200 252 252 | F ₀ m 123 134 200 252 247 | DURA -TION 160 150 180 170 200 |
| No. | [íbá] | YB IK HS FR ₁ FR ₂ FR ₃ | F ₀ i 126 126 178 225 238 134 | 126 142 200 252 245 138 | F ₀ f 126 142 200 252 252 142 | 126 137 193 243 245 138 | 90 150 160 180 90 80 | F ₀ i 123 126 200 252 245 142 | F ₀ 2/3 123 134 200 252 245 146 | 123 142 200 252 252 150 | F ₀ m 123 134 200 252 247 146 | DURA -TION 160 150 180 170 200 110 |
| No. | [íbá] | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ | F ₀ i 126 126 178 225 238 134 134 | 126 142 200 252 245 138 134 | F ₀ f 126 142 200 252 252 142 134 | 126 137 193 243 245 138 134 | 90 150 160 180 90 80 80 | F ₀ i 123 126 200 252 245 142 134 | F ₀ 2/3 123 134 200 252 245 146 134 | F ₀ f 123 142 200 252 252 150 134 | F ₀ m 123 134 200 252 247 146 134 | DURA -TION 160 150 180 170 200 110 160 |
| No. | [íbá] | YB IK HS FR ₁ FR ₂ FR ₃ | F ₀ i 126 126 178 225 238 134 | 126 142 200 252 245 138 | F ₀ f 126 142 200 252 252 142 | 126 137 193 243 245 138 | 90 150 160 180 90 80 | F ₀ i 123 126 200 252 245 142 | F ₀ 2/3 123 134 200 252 245 146 | 123 142 200 252 252 150 | F ₀ m 123 134 200 252 247 146 | DURA -TION 160 150 180 170 200 110 |
| 6. | [íbá] * | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 | F ₀ i 126 126 178 225 238 134 134 173 | F ₀ 2/3 126 142 200 252 245 138 134 195 | F ₀ f 126 142 200 252 252 142 134 195 | 126 137 193 243 245 138 134 | 90 150 160 180 90 80 80 | F ₀ i 123 126 200 252 245 142 134 195 | F ₀ 2/3 123 134 200 252 245 146 134 195 | F ₀ f 123 142 200 252 252 150 134 178 | F ₀ m 123 134 200 252 247 146 134 | DURA -TION 150 180 170 200 110 160 170 |
| No. 6. | [íbá] | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 | F ₀ i 126 126 178 225 238 134 134 173 | 126 142 200 252 245 138 134 | F ₀ f 126 142 200 252 252 142 134 195 | 126 137 193 243 245 138 134 | DURA -TION 90 150 160 180 90 80 80 180 | F ₀ i 123 126 200 252 245 142 134 195 | F ₀ 2/3 123 134 200 252 245 146 134 | F ₀ f 123 142 200 252 252 150 134 178 | F ₀ m 123 134 200 252 247 146 134 | DURA -TION 160 150 180 170 200 110 160 170 |
| 6. | [íbá] * | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 | F ₀ i 126 126 178 225 238 134 134 173 | F ₀ 2/3 126 142 200 252 245 138 134 195 SYLLABI | F ₀ f 126 142 200 252 252 142 134 195 | 126 137 193 243 245 138 134 188 | 90 150 160 180 90 80 80 | F ₀ i 123 126 200 252 245 142 134 195 SECON | F ₀ 2/3 123 134 200 252 245 146 134 195 | F ₀ f 123 142 200 252 252 150 134 178 | F ₀ m 123 134 200 252 247 146 134 189 | DURA -TION 150 180 170 200 110 160 170 |
| SER. | [iba] * words | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- | F ₀ i 126 126 178 225 238 134 134 173 FIRST | 126 142 200 252 245 138 134 195 SYLLABI | F ₀ f 126 142 200 252 252 142 134 195 LE | 126 137 193 243 245 138 134 188 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION | F ₀ i 123 126 200 252 245 142 134 195 SECON | 123 134 200 252 245 146 134 195 | F ₀ f 123 142 200 252 252 150 134 178 BLE | F ₀ m 123 134 200 252 247 146 134 189 | DURA -TION 150 180 170 200 110 160 170 DURA -TION |
| No. 6. | [íbá] * | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS | F ₀ i 126 126 178 225 238 134 134 173 FIRST | 126 142 200 252 245 138 134 195 SYLLABI | F ₀ f 126 142 200 252 252 142 134 195 LE | 126 137 193 243 245 138 134 188 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION 160 | F ₀ i 123 126 200 252 245 142 134 195 SECON F ₀ i 126 | 123 134 200 252 245 146 134 195 ND SYLAR | F ₀ f 123 142 200 252 252 150 134 178 BLE F ₀ f | F ₀ m 123 134 200 252 247 146 134 189 | DURA -TION 160 150 180 170 200 110 160 170 DURA -TION 190 |
| SER. | [iba] * words | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS | F ₀ i 126 126 178 225 238 134 134 173 FIRST F ₀ i 126 123 | F ₀ 2/3 126 142 200 252 245 138 134 195 SYLLABI F ₀ 2/3 126 126 | F ₀ f 126 142 200 252 252 142 134 195 LE F ₀ f 126 138 | 126 137 193 243 245 138 134 188 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION 160 140 | F ₀ i 123 126 200 252 245 142 134 195 SECON F ₀ i 126 126 | $\begin{array}{c} F_{0}2/3 \\ \hline 123 \\ 134 \\ 200 \\ 252 \\ 245 \\ 146 \\ 134 \\ 195 \\ \hline 195 \\ \hline 195 \\ \hline F_{0}2/3 \\ \hline 126 \\ 126 \\ \hline \end{array}$ | F ₀ f 123 142 200 252 252 150 134 178 BLE F ₀ f 126 142 | F ₀ m 123 134 200 252 247 146 134 189 F ₀ m 126 131 | DURA -TION 160 150 180 170 200 110 160 170 DURA -TION 190 190 |
| SER. | [ibá] * WORDS [ágá] | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS | F ₀ i 126 126 178 225 238 134 134 173 FIRST | 126 142 200 252 245 138 134 195 SYLLABI | F ₀ f 126 142 200 252 252 142 134 195 LE | 126 137 193 243 245 138 134 188 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION 160 | F ₀ i 123 126 200 252 245 142 134 195 SECON F ₀ i 126 | 123 134 200 252 245 146 134 195 ND SYLAR | F ₀ f 123 142 200 252 252 150 134 178 BLE F ₀ f | F ₀ m 123 134 200 252 247 146 134 189 | DURA -TION 160 150 180 170 200 110 160 170 DURA -TION 190 |
| SER. | [ibá] * WORDS [ágá] | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS | F ₀ i 126 126 178 225 238 134 134 173 FIRST F ₀ i 126 123 159 | $\begin{array}{c} F_02/3 \\ \hline 126 \\ 142 \\ 200 \\ 252 \\ 245 \\ 138 \\ 134 \\ 195 \\ \hline \text{SYLLABI} \\ \hline F_02/3 \\ \hline 126 \\ 126 \\ 184 \\ 260 \\ 225 \\ \end{array}$ | F ₀ f 126 142 200 252 252 142 134 195 LE F ₀ f 126 138 195 | 126 137 193 243 245 138 134 188 Fom 126 129 179 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION 160 140 160 200 160 | F ₀ i 123 126 200 252 245 142 134 195 SECON F ₀ i 126 126 195 | $\begin{array}{c} F_{0}2/3 \\ \hline 123 \\ 134 \\ 200 \\ 252 \\ 245 \\ 146 \\ 134 \\ 195 \\ \hline \text{ND SYLAB} \\ \hline F_{0}2/3 \\ \hline 126 \\ 126 \\ 195 \\ \end{array}$ | F ₀ f 123 142 200 252 252 150 134 178 BLE F ₀ f 126 142 195 | F ₀ m 123 134 200 252 247 146 134 189 F ₀ m 126 131 195 252 257 | DURA -TION 160 150 180 170 200 110 160 170 DURA -TION 190 190 210 |
| SER. | [ibá] * WORDS [ágá] | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 CH1 | F ₀ i 126 178 225 238 134 134 173 FIRST F ₀ i 126 123 159 267 | $\begin{array}{c} F_02/3 \\ \hline 126 \\ 142 \\ 200 \\ 252 \\ 245 \\ 138 \\ 134 \\ 195 \\ \hline \text{SYLLABI} \\ \hline F_02/3 \\ \hline 126 \\ 126 \\ 184 \\ 260 \\ 225 \\ 126 \\ \end{array}$ | F ₀ f 126 142 200 252 252 142 134 195 LE F ₀ f 126 138 195 252 260 126 | 126 137 193 243 245 138 134 188 Fom 126 129 179 260 230 126 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION 160 140 160 200 | F ₀ i 123 126 200 252 245 142 134 195 SECON F ₀ i 126 126 195 252 275 126 | $\begin{array}{c} F_{0}2/3 \\ \hline 123 \\ 134 \\ 200 \\ 252 \\ 245 \\ 146 \\ 134 \\ 195 \\ \hline \text{ND SYLAB} \\ \hline F_{0}2/3 \\ \hline 126 \\ 195 \\ 252 \\ \end{array}$ | F ₀ f 123 142 200 252 252 150 134 178 BLE F ₀ f 126 142 195 252 252 123 | F ₀ m 123 134 200 252 247 146 134 189 F ₀ m 126 131 195 252 257 125 | DURA -TION 160 150 180 170 200 110 160 170 DURA -TION 190 190 210 160 190 200 |
| SER. | [ibá] * WORDS [ágá] | SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 | F ₀ i 126 126 178 225 238 134 134 173 FIRST F ₀ i 126 123 159 267 206 | $\begin{array}{c} F_02/3 \\ \hline 126 \\ 142 \\ 200 \\ 252 \\ 245 \\ 138 \\ 134 \\ 195 \\ \hline \text{SYLLABI} \\ \hline F_02/3 \\ \hline 126 \\ 126 \\ 184 \\ 260 \\ 225 \\ \end{array}$ | F ₀ f 126 142 200 252 252 142 134 195 LE F ₀ f 126 138 195 252 260 | 126 137 193 243 245 138 134 188 Fom 126 129 179 260 230 | DURA -TION 90 150 160 180 90 80 80 180 DURA -TION 160 140 160 200 160 | F ₀ i 123 126 200 252 245 142 134 195 SECON F ₀ i 126 126 195 252 275 | $\begin{array}{c} F_{0}2/3 \\ \hline 123 \\ 134 \\ 200 \\ 252 \\ 245 \\ 146 \\ 134 \\ 195 \\ \hline \text{ND SYLAB} \\ \hline F_{0}2/3 \\ \hline 126 \\ 195 \\ 252 \\ 245 \\ \end{array}$ | F ₀ f 123 142 200 252 252 150 134 178 BLE F ₀ f 126 142 195 252 252 | F ₀ m 123 134 200 252 247 146 134 189 F ₀ m 126 131 195 252 257 | DURA -TION 160 150 180 170 200 110 160 170 DURA -TION 190 190 210 160 190 |

Table 2a: F₀ and duration values for seven Edo VCV words pronounced by a female Edo speaker

| SER. No. | WORDS | FIRST S | SYLLABL | Æ | | DURA -TION | SECOND SYLABLE | | | | DURA -TION |
|-------------|-------|------------------|----------|------------------|------------------|---------------|------------------|----------|------------------|------------------|---------------|
| | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | |
| 1. | [ùgò] | 231 | 238 | 231 | 233 | 80 | 231 | 189 | 146 | 189 | 170 |
| 2. | [ìdì] | 252 | 245 | 238 | 245 | 170 | 231 | 189 | 150 | 190 | 200 |
| 3. | [ùdù] | 252 | 252 | 245 | 250 | 130 | 231 | 189 | 173 | 198 | 180 |
| 4. | [ùdè] | 245 | 252 | 245 | 247 | 80 | 238 | 200 | 173 | 204 | 170 |
| 5 | [àdà] | 212 | 212 | 206 | 210 | 130 | 200 | 184 | 150 | 178 | 180 |
| 6. | [òkò] | 245 | 238 | 231 | 238 | 140 | 245 | 184 | 173 | 201 | 180 |
| 7. | [òdò] | 231 | 212 | 206 | 216 | 160 | 206 | 178 | 159 | 181 | 160 |

Table 2b: F₀ and duration values for seven Edo VCV words pronounced by eight non-Edo speakers in a listening task

| SER. No. | WORDS | SPEAK- ERS | | SYLLABL | | | DURA -TION | | D SYLAB | | | DURA -TION |
|-------------|---------|---------------|------------------|--------------------|------------------|------------------|---------------|------------------|--------------------|------------------|------------------|---------------|
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 1. | [ùgò] | 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 |
| | | CHi | 138 | 134 | 134 | 135 | 120 | 130 | 103 | 97 | 110 | 110 |
| | | CH_2 | 195 | 189 | 184 | 189 | 120 | 164 | 159 | 126 | 150 | 90 |
| arn | l words | Langua | Impere | SYLLABL | г | | DURA | Lecon | D SYLAB | I E | | DURA |
| SER. No. | WOKDS | SPEAK- ERS | LIKST | LLADI | Æ | l | -TION | SECON | DSILAD | LE | | -TION |
| No. | | LIKS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -11011 | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -11011 |
| | | | | | | | L | | | | | <u> </u> |
| 2. | [ìdì] | 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 |

FR₃

 CH_1

 CH_2

| SER. No. | WORDS | SPEAK- ERS | FIRST SYLLABLE | | | 1 | DURA -TION | SECOND SYLABLE | | | | DURA -TION |
|-------------|------------------------|--|--|---|--|--|--|--|---|---|--|--|
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 3. | [ùdù] | 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 FR ₂ | 245 231 | 245 238 | 238 238 | 243 236 | 120 140 | 231 206 | 200 168 | 173 138 | 201 171 | 180 190 |
| | * | 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 |
| | | 0112 | 1.0 | | 270 | -07 | | | | | 10. | 100 |
| SER. | WORDS | SPEAK- | FIRST S | YLLABL | Æ | ı | DURA | SECON | D SYLAB | LE | I | DURA |
| No. | | ERS | | E 0/0 | T . | | -TION | <u> </u> | I = 0/01 | E 6 | | -TION |
| | | <u> </u> | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | <u> </u> | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | <u> </u> |
| 4. | [ùdè] | YB | 126 | 123 | 119 | 123 | 90 | 116 | 109 | 97 | 107 | 150 |
| | * | IK HS | 126 173 | 126 206 | 126 212 | 126 197 | 80 150 | 123 189 | 116 126 | 94 94 | 111 136 | 170 270 |
| | • | 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. | words | SPEAK- | FIRST S | YLLABI | Æ | İ | DURA | SECON | D SYLAB | LE | ı | DURA |
| SER. No. | WORDS | SPEAK- ERS | | | | Fom | DURA -TION | | | | Fom | DURA -TION |
| No. | | ERS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION |
| | words [àdà] | ERS YB | F ₀ i | F ₀ 2/3 | F ₀ f | 105 | -TION 130 | F ₀ i 109 | F ₀ 2/3 | F ₀ f | 99 | -TION 130 |
| No. | | YB IK | F ₀ i 106 123 | F ₀ 2/3 106 119 | F ₀ f 103 116 | 105 119 | 130 160 | F ₀ i 109 106 | 97 94 | F ₀ f 92 89 | 99 96 | 130 180 |
| No. | [àdà] | YB IK HS | F ₀ i 106 123 116 | F ₀ 2/3 106 119 134 | F ₀ f 103 116 138 | 105 119 129 | 130 160 140 | F ₀ i 109 106 138 | 97 94 106 | F ₀ f 92 89 97 | 99 | -TION 130 |
| No. | [àdà] | YB IK HS FR ₁ | F ₀ i 106 123 116 212 | F ₀ 2/3 106 119 134 212 | F ₀ f 103 116 138 212 | 105 119 129 212 | 130 160 | F ₀ i 109 106 138 195 | 97 94 | F ₀ f 92 89 97 150 | 99 96 114 176 | 130 180 240 |
| No. | [àdà] | YB IK HS | F ₀ i 106 123 116 | F ₀ 2/3 106 119 134 | F ₀ f 103 116 138 | 105 119 129 | 130 160 140 120 | F ₀ i 109 106 138 | 97 94 106 184 | F ₀ f 92 89 97 | 99 96 114 | 130 180 240 160 |
| No. | [àdà] | YB IK HS FR ₁ FR ₂ | F ₀ i 106 123 116 212 195 | F ₀ 2/3 106 119 134 212 195 | F ₀ f 103 116 138 212 195 | 105 119 129 212 195 | 130 160 140 120 80 | F ₀ i 109 106 138 195 195 | 97 94 106 184 134 | 92 89 97 150 116 | 99 96 114 176 148 | 130 180 240 160 190 |
| No. | [àdà] | YB IK HS FR ₁ FR ₂ FR ₃ | F ₀ i 106 123 116 212 195 150 | 106 119 134 212 195 150 | F ₀ f 103 116 138 212 195 150 | 105 119 129 212 195 150 | 130 160 140 120 80 80 | F ₀ i 109 106 138 195 195 146 | 97 94 106 184 134 123 | 92 89 97 150 116 94 | 99 96 114 176 148 121 | 130 180 240 160 190 150 |
| No. | [àdà] * | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ | F ₀ i 106 123 116 212 195 150 126 164 | F ₀ 2/3 106 119 134 212 195 150 130 164 | F ₀ f 103 116 138 212 195 150 126 164 | 105 119 129 212 195 150 127 | 130 160 140 120 80 80 110 200 | F ₀ i 109 106 138 195 195 146 126 159 | F ₀ 2/3 97 94 106 184 134 123 106 134 | 92 89 97 150 116 94 97 116 | 99 96 114 176 148 121 110 | 130 180 240 160 190 150 150 160 |
| No. 5. | [àdà] * | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 106 123 116 212 195 150 126 164 | F ₀ 2/3 106 119 134 212 195 150 130 | F ₀ f 103 116 138 212 195 150 126 164 | 105 119 129 212 195 150 127 | 130 160 140 120 80 80 110 200 | F ₀ i 109 106 138 195 195 146 126 159 | 97 94 106 184 134 123 106 | 92 89 97 150 116 94 97 116 | 99 96 114 176 148 121 110 | 130 180 240 160 190 150 150 160 |
| No. 5. | [àdà] * | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 106 123 116 212 195 150 126 164 | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABI | F ₀ f 103 116 138 212 195 150 126 164 | 105 119 129 212 195 150 127 164 | 130 160 140 120 80 80 110 200 | F ₀ i 109 106 138 195 195 146 126 159 | 97 94 106 184 134 123 106 134 D SYLAB | F ₀ f 92 89 97 150 116 94 97 116 | 99 96 114 176 148 121 110 136 | 130 180 240 160 190 150 150 160 |
| SER. | [àdà] * words | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 106 123 116 212 195 150 126 164 FIRST S | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABL | F ₀ f 103 116 138 212 195 150 126 164 E | 105 119 129 212 195 150 127 164 | 130 160 140 120 80 80 110 200 | F ₀ i 109 106 138 195 195 146 126 159 secon | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB | F ₀ f 92 89 97 150 116 94 97 116 LE | 99 96 114 176 148 121 110 136 | 130 180 240 160 190 150 150 160 DURA -TION |
| No. 5. | [àdà] * | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 106 123 116 212 195 150 126 164 FIRST S | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABLE F ₀ 2/3 116 | F ₀ f 103 116 138 212 195 150 126 164 E | 105 119 129 212 195 150 127 164 | 130 160 140 120 80 80 110 200 DURA -TION | F ₀ i 109 106 138 195 195 146 126 159 secon F ₀ i 116 | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB F ₀ 2/3 112 | F ₀ f 92 89 97 150 116 94 97 116 LE F ₀ f 100 | 99 96 114 176 148 121 110 136 | 130 180 240 160 190 150 150 160 DURA -TION |
| SER. | [àdà] * words | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS | F ₀ i 106 123 116 212 195 150 126 164 FIRST S | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABL | F ₀ f 103 116 138 212 195 150 126 164 E | 105 119 129 212 195 150 127 164 | 130 160 140 120 80 80 110 200 DURA -TION 110 140 160 | F ₀ i 109 106 138 195 195 146 126 159 secon | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB | F ₀ f 92 89 97 150 116 94 97 116 LE | 99 96 114 176 148 121 110 136 | 130 180 240 160 190 150 150 160 DURA -TION |
| SER. | [àdà] * words | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 | F ₀ i 106 123 116 212 195 150 126 164 FIRST S F ₀ i 116 126 178 231 | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABI F ₀ 2/3 116 123 178 231 | F ₀ f 103 116 138 212 195 150 126 164 E F ₀ f 109 116 178 231 | 105 119 129 212 195 150 127 164 F ₀ m 114 122 178 231 | 130 160 140 120 80 80 110 200 DURA -TION 140 160 120 | F ₀ i 109 106 138 195 195 146 126 159 SECON F ₀ i 116 126 178 231 | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB F ₀ 2/3 112 103 138 189 | F ₀ f 92 89 97 150 116 94 97 116 LE F ₀ f 100 89 106 159 | 99 96 114 176 148 121 110 136 F ₀ m 109 106 141 193 | 130 180 240 160 190 150 150 160 DURA -TION 90 150 290 200 |
| SER. | [àdà] * WORDS [òkò] | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 | F ₀ i 106 123 116 212 195 150 126 164 FIRST S F ₀ i 116 126 178 231 195 | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABI F ₀ 2/3 178 231 231 | F ₀ f 103 116 138 212 195 150 126 164 E F ₀ f 109 116 178 231 252 | 105 119 129 212 195 150 127 164 F ₀ m 114 122 178 231 226 | 130 160 140 120 80 80 110 200 DURA -TION 110 140 160 120 100 | F ₀ i 109 106 138 195 195 146 126 159 secon F ₀ i 116 126 178 231 231 | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB F ₀ 2/3 112 103 138 189 150 | F ₀ f 92 89 97 150 116 94 97 116 LE F ₀ f 100 89 106 159 138 | 99 96 114 176 148 121 110 136 F ₀ m 109 106 141 193 173 | 130 180 240 160 190 150 150 160 DURA -TION 90 150 290 200 170 |
| SER. | [àdà] * WORDS [òkò] | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 FR3 | F ₀ i 106 123 116 212 195 150 126 164 FIRST S F ₀ i 116 126 178 231 195 150 | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABI F ₀ 2/3 178 231 231 159 | F ₀ f 103 116 138 212 195 150 126 164 E F ₀ f 109 116 178 231 252 164 | 105 119 129 212 195 150 127 164 F ₀ m 114 122 178 231 226 158 | -TION | F ₀ i 109 106 138 195 195 146 126 159 SECON F ₀ i 116 126 178 231 231 138 | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB F ₀ 2/3 112 103 138 189 150 123 | F ₀ f 92 89 97 150 116 94 97 116 LE F ₀ f 100 89 106 159 138 97 | 99 96 114 176 148 121 110 136 F ₀ m 109 106 141 193 173 119 | 130 180 240 160 190 150 150 160 DURA -TION 90 150 290 200 170 160 |
| SER. | [àdà] * WORDS [òkò] | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 | F ₀ i 106 123 116 212 195 150 126 164 FIRST S F ₀ i 116 126 178 231 195 | F ₀ 2/3 106 119 134 212 195 150 130 164 SYLLABI F ₀ 2/3 178 231 231 | F ₀ f 103 116 138 212 195 150 126 164 E F ₀ f 109 116 178 231 252 | 105 119 129 212 195 150 127 164 F ₀ m 114 122 178 231 226 | 130 160 140 120 80 80 110 200 DURA -TION 110 140 160 120 100 | F ₀ i 109 106 138 195 195 146 126 159 secon F ₀ i 116 126 178 231 231 | F ₀ 2/3 97 94 106 184 134 123 106 134 D SYLAB F ₀ 2/3 112 103 138 189 150 | F ₀ f 92 89 97 150 116 94 97 116 LE F ₀ f 100 89 106 159 138 | 99 96 114 176 148 121 110 136 F ₀ m 109 106 141 193 173 | 130 180 240 160 190 150 150 160 DURA -TION 90 150 290 200 170 |

| SER. No. | WORDS | SPEAK- ERS | FIRST SYLLABLE | | | | DURA -TION | SECON | ID SYLAB | | DURA -TION | |
|-------------|-------|---------------|------------------|----------|------------------|------------------|---------------|------------------|-----------|------------------|------------------|-----|
| | | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 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_3^2 | 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 VCV words pronounced by a female Edo speaker

| SER. No. | WORDS | FIRST : | SYLLABI | Æ | | DURA -TION | SECON | D SYLAB | | DURA -TION | |
|-------------|-------|------------------|--------------------|------------------|------------------|---------------|------------------|--------------------|------------------|------------------|-----|
| 110. | | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | |
| 1. | [èdo] | 218 | 218 | 218 | 218 | 110 | 231 | 231 | 231 | 231 | 180 |
| 2. | [èbo] | 212 | 212 | 212 | 212 | 100 | 231 | 231 | 231 | 231 | 190 |
| 3. | [èkó] | 231 | 231 | 231 | 231 | 80 | 267 | 267 | 267 | 267 | 200 |
| 4. | [àko] | 218 | 218 | 218 | 218 | 80 | 245 | 245 | 245 | 245 | 120 |
| 5. | [òko] | 218 | 218 | 218 | 218 | 90 | 238 | 238 | 231 | 236 | 190 |
| 6. | [ùgo] | 231 | 231 | 231 | 231 | 100 | 252 | 252 | 252 | 252 | 200 |
| 7. | [ùdo] | 231 | 231 | 231 | 231 | 130 | 252 | 252 | 252 | 252 | 240 |

 $\textbf{Table 3b:} \ \ F_0 \ \ \text{and duration values for seven Edo \'VC\'V words pronounced by eight non-Edo speakers in a listening task } \\$

| SER. No. | WORDS | SPEAK- ERS | FIRST S | SYLLABL | | | DURA -TION | SECON | D SYLAB | | DURA -TION | |
|-------------|-------|-----------------|------------------|-----------|------------------|------------------|---------------|------------------|-----------|------------------|------------------|-----|
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 1. | [èdo] | 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 | SPEAK- ERS | FIRST SYLLABLE | | | | DURA -TION | SECON | D SYLAB | | DURA -TION | |
|-------------------|-------------------|---|---|---|--|--|--|---|---|--|--|---|
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 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 FR ₁ | 173 231 | 184 231 | 184 231 | 180 231 | 200 160 | 200 231 | 212 231 | 245 231 | 219 231 | 200 200 |
| | ** | 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 |
| | | 2 | | | | | | | | | | |
| SER. | WORDS | SPEAK- | FIRST S | YLLABL | E. | | DURA | SECON | D SYLAB | LE | | DURA |
| No. | | ERS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION |
| 3. | [èkó] | YB | 126 | 126 | 126 | 126 | 110 | 138 | 138 | 138 | 138 | 160 |
| 5. | [eko] | 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_3^2 | 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 |
| | | | | | | | | | | | | |
| SFR | WORDS | SPEAK- | FIRST S | YLLABI | .E | i | DURA | l secon | D SYLAB | LE | 1 | DURA |
| SER. | WORDS | SPEAK- ERS | | SYLLABL | | | DURA -TION | | D SYLAB | | | DURA -TION |
| | WORDS | ERS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION |
| | words [àko] | YB | F ₀ i 112 | F ₀ 2/3 | F ₀ f | 113 | -TION 90 | F ₀ i 126 | F ₀ 2/3 | F ₀ f | 125 | -TION 120 |
| No. | [àkớ] | YB IK | F ₀ i 112 106 | F ₀ 2/3 112 106 | F ₀ f 116 119 | 113 110 | 90 150 | F ₀ i 126 126 | F ₀ 2/3 126 130 | F ₀ f 123 126 | 125 127 | 120 170 |
| No. | | YB IK HS | F ₀ i 112 106 142 | F ₀ 2/3 112 106 178 | F ₀ f 116 119 189 | 113 110 170 | 90 150 200 | F ₀ i 126 126 206 | F ₀ 2/3 126 130 206 | F ₀ f 123 126 206 | 125 127 206 | 120 170 220 |
| No. | [àkớ] | YB IK HS FR ₁ | F ₀ i 112 106 142 225 | F ₀ 2/3 112 106 178 225 | F ₀ f 116 119 189 218 | 113 110 170 223 | 90 150 200 140 | F ₀ i 126 126 206 275 | F ₀ 2/3 126 130 206 252 | F ₀ f 123 126 206 245 | 125 127 206 257 | 120 170 220 190 |
| No. | [àkó] ** | YB IK HS FR ₁ FR ₂ | F ₀ i 112 106 142 225 200 | 112 106 178 225 225 | F ₀ f 116 119 189 218 231 | 113 110 170 223 219 | 90 150 200 140 90 | F ₀ i 126 126 206 275 238 | 126 130 206 252 267 | F ₀ f 123 126 206 245 267 | 125 127 206 257 257 | 120 170 220 190 170 |
| No. | [àkó] ** | YB IK HS FR ₁ FR ₂ FR ₃ | F ₀ i 112 106 142 225 200 138 | F ₀ 2/3 112 106 178 225 225 138 | F ₀ f 116 119 189 218 231 138 | 113 110 170 223 219 138 | 90 150 200 140 90 50 | F ₀ i 126 126 206 275 | F ₀ 2/3 126 130 206 252 267 154 | F ₀ f 123 126 206 245 | 125 127 206 257 257 150 | 120 170 220 190 170 120 |
| No. | [àkó] ** | YB IK HS FR ₁ FR ₂ | F ₀ i 112 106 142 225 200 | 112 106 178 225 225 | F ₀ f 116 119 189 218 231 | 113 110 170 223 219 | 90 150 200 140 90 | F ₀ i 126 126 206 275 238 138 | 126 130 206 252 267 | F ₀ f 123 126 206 245 267 159 | 125 127 206 257 257 | 120 170 220 190 170 |
| No. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ | F ₀ i 112 106 142 225 200 138 119 154 | F ₀ 2/3 112 106 178 225 225 138 119 154 | F ₀ f 116 119 189 218 231 138 119 154 | 113 110 170 223 219 138 119 | 90 150 200 140 90 50 120 130 | F ₀ i 126 126 206 275 238 138 123 173 | F ₀ 2/3 126 130 206 252 267 154 130 178 | F ₀ f 123 126 206 245 267 159 123 184 | 125 127 206 257 257 150 125 | 120 170 220 190 170 120 120 170 |
| No. 4. SER. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 112 106 142 225 200 138 119 154 | F ₀ 2/3 112 106 178 225 225 138 119 | F ₀ f 116 119 189 218 231 138 119 154 | 113 110 170 223 219 138 119 | 90 150 200 140 90 50 120 130 | F ₀ i 126 126 206 275 238 138 123 173 | F ₀ 2/3 126 130 206 252 267 154 130 | F ₀ f 123 126 206 245 267 159 123 184 | 125 127 206 257 257 150 125 | 120 170 220 190 170 120 120 170 |
| No. 4. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 112 106 142 225 200 138 119 154 | F ₀ 2/3 112 106 178 225 225 138 119 154 | F ₀ f 116 119 189 218 231 138 119 154 | 113 110 170 223 219 138 119 | 90 150 200 140 90 50 120 130 | F ₀ i 126 126 206 275 238 138 123 173 | F ₀ 2/3 126 130 206 252 267 154 130 178 | F ₀ f 123 126 206 245 267 159 123 184 | 125 127 206 257 257 150 125 178 | 120 170 220 190 170 120 120 170 |
| No. 4. SER. No. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 112 106 142 225 200 138 119 154 | 112 106 178 225 225 138 119 154 | F ₀ f 116 119 189 218 231 138 119 154 | 113 110 170 223 219 138 119 154 | 90 150 200 140 90 50 120 130 | F ₀ i 126 126 206 275 238 138 123 173 | 126 130 206 252 267 154 130 178 D SYLAB | F ₀ f 123 126 206 245 267 159 123 184 | 125 127 206 257 257 150 125 | 120 170 220 190 170 120 120 170 DURA -TION |
| No. 4. SER. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ SPEAK-ERS | F ₀ i 112 106 142 225 200 138 119 154 FIRST 5 F ₀ i 116 119 | F ₀ 2/3 112 106 178 225 225 138 119 154 SYLLABI F ₀ 2/3 116 119 | F ₀ f 116 119 189 218 231 138 119 154 E F ₀ f 116 119 | 113 110 170 223 219 138 119 154 F ₀ m 116 119 | 90 150 200 140 90 50 120 130 DURA -TION 100 140 | F ₀ i 126 126 206 275 238 138 123 173 SECON F ₀ i 126 138 | 126 130 206 252 267 154 130 178 D SYLAB 126 142 | F ₀ f 123 126 206 245 267 159 123 184 LE F ₀ f 126 142 | 125 127 206 257 257 150 125 178 F ₀ m 126 141 | 120 170 220 190 170 120 120 170 DURA -TION 160 140 |
| No. 4. SER. No. | [àkó] ** ** | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK-ERS YB IK HS | F ₀ i 112 106 142 225 200 138 119 154 FIRST 5 F ₀ i 116 119 164 | F ₀ 2/3 112 106 178 225 225 138 119 154 SYLLABI F ₀ 2/3 116 119 195 | F ₀ f 116 119 189 218 231 138 119 154 E F ₀ f 116 119 200 | 113 110 170 223 219 138 119 154 F ₀ m 116 119 186 | 90 150 200 140 90 50 120 130 DURA -TION 100 140 190 | F ₀ i 126 126 206 275 238 138 123 173 SECON F ₀ i 126 138 225 | 126 130 206 252 267 154 130 178 D SYLAB F ₀ 2/3 126 142 231 | F ₀ f 123 126 206 245 267 159 123 184 LE F ₀ f 126 142 225 | 125 127 206 257 257 150 125 178 F ₀ m 126 141 227 | -TION |
| No. 4. SER. No. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ SPEAKERS YB IK HS FR ₁ | F ₀ i 112 106 142 225 200 138 119 154 FIRST 5 F ₀ i 116 119 164 212 | F ₀ 2/3 112 106 178 225 225 138 119 154 SYLLABI F ₀ 2/3 116 119 195 231 | F ₀ f 116 119 189 218 231 138 119 154 E F ₀ f 116 119 200 206 | 113 110 170 223 219 138 119 154 F ₀ m 116 119 186 216 | -TION 90 150 200 140 90 50 120 130 DURA -TION 100 140 190 130 | F ₀ i 126 126 206 275 238 138 123 173 SECON F ₀ i 126 138 225 275 | F ₀ 2/3 126 130 206 252 267 154 130 178 D SYLAB F ₀ 2/3 126 142 231 245 | F ₀ f 123 126 206 245 267 159 123 184 LE F ₀ f 126 142 225 245 | 125 127 206 257 257 150 125 178 F ₀ m 126 141 227 255 | -TION |
| No. 4. SER. No. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ SPEAKERS YB IK HS FR ₁ FR ₂ | F ₀ i 112 106 142 225 200 138 119 154 FIRST 5 F ₀ i 116 119 164 212 173 | F ₀ 2/3 112 106 178 225 225 138 119 154 SYLLABI F ₀ 2/3 116 119 195 231 206 | F ₀ f 116 119 189 218 231 138 119 154 E F ₀ f 116 119 200 206 212 | 113 110 170 223 219 138 119 154 F ₀ m 116 119 186 216 197 | -TION 90 150 200 140 90 50 120 130 DURA -TION 140 190 130 90 | F ₀ i 126 126 206 275 238 138 123 173 SECON F ₀ i 126 138 225 275 245 | F ₀ 2/3 126 130 206 252 267 154 130 178 D SYLAB F ₀ 2/3 126 142 231 245 252 | F ₀ f 123 126 206 245 267 159 123 184 LE F ₀ f 126 142 225 245 245 | 125 127 206 257 257 150 125 178 F ₀ m 126 141 227 255 247 | -TION |
| No. 4. SER. No. | [àkó] ** ** | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 FR3 | F ₀ i 112 106 142 225 200 138 119 154 FIRST 5 F ₀ i 116 119 164 212 173 138 | F ₀ 2/3 112 106 178 225 225 138 119 154 SYLLABI F ₀ 2/3 116 119 195 231 206 150 | F ₀ f 116 119 189 218 231 138 119 154 E F ₀ f 116 119 200 206 212 126 | 113 110 170 223 219 138 119 154 F ₀ m 116 119 186 216 197 138 | 90 150 200 140 90 50 120 130 DURA -TION 100 140 190 130 90 | F ₀ i 126 126 206 275 238 138 123 173 SECON F ₀ i 126 138 225 275 245 150 | F ₀ 2/3 126 130 206 252 267 154 130 178 D SYLAB F ₀ 2/3 126 142 231 245 252 168 | F ₀ f 123 126 206 245 267 159 123 184 LE F ₀ f 126 142 225 245 245 173 | 125 127 206 257 257 150 125 178 F ₀ m 126 141 227 255 247 164 | -TION |
| No. 4. SER. No. | [àkó] ** ** | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ SPEAKERS YB IK HS FR ₁ FR ₂ | F ₀ i 112 106 142 225 200 138 119 154 FIRST 5 F ₀ i 116 119 164 212 173 | F ₀ 2/3 112 106 178 225 225 138 119 154 SYLLABI F ₀ 2/3 116 119 195 231 206 | F ₀ f 116 119 189 218 231 138 119 154 E F ₀ f 116 119 200 206 212 | 113 110 170 223 219 138 119 154 F ₀ m 116 119 186 216 197 | -TION 90 150 200 140 90 50 120 130 DURA -TION 140 190 130 90 | F ₀ i 126 126 206 275 238 138 123 173 SECON F ₀ i 126 138 225 275 245 | F ₀ 2/3 126 130 206 252 267 154 130 178 D SYLAB F ₀ 2/3 126 142 231 245 252 | F ₀ f 123 126 206 245 267 159 123 184 LE F ₀ f 126 142 225 245 245 | 125 127 206 257 257 150 125 178 F ₀ m 126 141 227 255 247 | -TION |

| SER. No. | WORDS | SPEAK- ERS | | | | | DURA -TION | | D SYLAB | | DURA -TION | |
|-------------|----------------|--|--|--|---|---------------------------------|--------------------------------|---------------------------------------|--|---|---------------------------------|--|
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 6. | [ùgó] | YB | 116 | 116 | 116 | 116 | 100 | 138 | 138 | 138 | 138 | 140 |
| | - 0 - | 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. | WORDS | SPEAK- | FIRST : | SYLLABL | Æ | l | DURA | SECON | D SYLAB | LE | 1 | DURA |
| SER. No. | WORDS | SPEAK- ERS | | | | | DURA -TION | | | | | DURA -TION |
| | WORDS | | FIRST : | F ₀ 2/3 | F ₀ f | F ₀ m | | secon F ₀ i | D SYLAB | LE F ₀ f | F ₀ m | |
| | words [ùdo] | | | F ₀ 2/3 | | F ₀ m | | | F ₀ 2/3 | F ₀ f 134 | 134 | |
| No. | | YB IK | F ₀ i 119 116 | 119 116 | F ₀ f 119 116 | 119 116 | -TION 140 120 | F ₀ i 134 123 | F ₀ 2/3 134 126 | F ₀ f 134 142 | 134 130 | 200 200 |
| No. | | YB IK HS | F ₀ i 119 116 173 | F ₀ 2/3 119 116 178 | F ₀ f 119 116 178 | 119 116 176 | 140 120 160 | F ₀ i 134 123 189 | F ₀ 2/3 134 126 206 | F ₀ f 134 142 206 | 134 130 200 | 200 200 250 |
| No. | [ùdo] | YB IK | F ₀ i 119 116 | 119 116 | F ₀ f 119 116 | 119 116 176 231 | -TION 140 120 | F ₀ i 134 123 189 245 | F ₀ 2/3 134 126 | F ₀ f 134 142 | 134 130 200 245 | 200 200 250 200 |
| No. | | YB IK HS | F ₀ i 119 116 173 | F ₀ 2/3 119 116 178 | F ₀ f 119 116 178 | 119 116 176 | 140 120 160 | F ₀ i 134 123 189 | F ₀ 2/3 134 126 206 | F ₀ f 134 142 206 | 134 130 200 | 200 200 250 |
| No. | [ùdo] | YB IK HS FR ₁ | F ₀ i 119 116 173 231 | F ₀ 2/3 119 116 178 231 | F ₀ f 119 116 178 231 | 119 116 176 231 | 140 120 160 140 | F ₀ i 134 123 189 245 | F ₀ 2/3 134 126 206 245 | F ₀ f 134 142 206 245 | 134 130 200 245 | 200 200 250 200 |
| No. | [ùdo] ** | YB IK HS FR ₁ FR ₂ | F ₀ i 119 116 173 231 195 | 119 116 178 231 225 | F ₀ f 119 116 178 231 231 | 119 116 176 231 217 | 140 120 160 140 90 | F ₀ i 134 123 189 245 231 | 134 126 206 245 267 | F ₀ f 134 142 206 245 275 | 134 130 200 245 258 | 200 200 250 200 200 200 |

Table 4a: F_0 and duration values for seven Edo $\acute{V}C\grave{V}$ words pronounced by a female Edo speaker

| SER. | WORDS | FIRST S | SYLLABL | Æ | | DURA | SECON | D SYLAB | LE | l | DURA |
|------|----------------------------|------------------|-----------|------------------|------------------|-------|------------------|-----------|------------------|------------------|-------|
| No. | | | | | | -TION | | | | | -TION |
| | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 1. | [íbà] | 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. | azal | 252 | 252 | 252 | 252 | 110 | 252 | 206 | 173 | 210 | 150 |
| 5 | ĺ śkà ĺ | 245 | 275 | 275 | 265 | 120 | 275 | 245 | 206 | 242 | 120 |
| 6. | [ákò] | 245 | 245 | 245 | 245 | 80 | 275 | 225 | 173 | 224 | 100 |
| 7. | $[\acute{e}'b\grave{o}]^3$ | 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: F_0 and duration values for seven Edo ÝCÝ words pronounced by eight non-Edo speakers in a listening task

| SER. | WORDS | SPEAK- | FIRST S | SYLLABL | Æ | l | DURA -TION | SECON | ID SYLAB | LE | ŀ | DURA |
|-------------|--------------------------------|--|--|--|---|---|---|--|--|--|---|--|
| No. | | ERS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -HON | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION |
| 1. | [íbà] | YB | 134 | 134 | 134 | 134 | 120 | 134 | 116 | 103 | 118 | 130 |
| 1. | [iva] | 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_1 | 178 | 195 | 195 | 189 | 200 | 164 | 150 | 138 | 151 | 100 |
| | | CH ₂ | 1/0 | 193 | 193 | 109 | 200 | 104 | 130 | 136 | 131 | 100 |
| SER. | WORDS | SPEAK- | I FIRST S | SYLLABL | Æ | ı | DURA | I SECON | ID SYLAB | LE | 1 | DURA |
| NO. | | ERS | | | _ | | -TION | | | | 1 | -TION |
| | | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | |
| 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 |
| | | | | | | | | | | | | |
| SER | WORDS | SPEAK- | FIRST | SYLLABL | Æ | ı | DURA | I SECON | ID SYLAB | LE | ı | DURA |
| SER. No. | WORDS | SPEAK- ERS | | SYLLABL | | | DURA -TION | | ID SYLAB | | | DURA -TION |
| No. | | ERS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION |
| | words [údè] | ERS YB | F ₀ i 138 | F ₀ 2/3 | F ₀ f | 141 | -TION 80 | F ₀ i 142 | F ₀ 2/3 | F ₀ f | 123 | -TION 120 |
| No. | [údè] | YB IK | F ₀ i 138 138 | F ₀ 2/3 142 154 | F ₀ f 142 164 | 141 152 | -TION 80 90 | F ₀ i 142 164 | F ₀ 2/3 123 123 | F ₀ f 103 97 | 123 128 | 120 160 |
| No. | | YB IK HS | F ₀ i 138 138 178 | F ₀ 2/3 142 154 231 | F ₀ f 142 164 238 | 141 152 216 | 80 90 130 | F ₀ i 142 164 206 | F ₀ 2/3 123 123 146 | F ₀ f 103 97 112 | 123 128 155 | 120 160 220 |
| No. | [údè] | YB IK HS FR ₁ | F ₀ i 138 138 178 231 | F ₀ 2/3 142 154 231 260 | F ₀ f 142 164 238 260 | 141 152 216 250 | 80 90 130 120 | F ₀ i 142 164 206 245 | F ₀ 2/3 123 123 146 189 | F ₀ f 103 97 112 173 | 123 128 155 202 | 120 160 220 170 |
| No. | [údè] | YB IK HS FR ₁ FR ₂ | F ₀ i 138 138 178 231 252 | 142 154 231 260 267 | F ₀ f 142 164 238 260 283 | 141 152 216 250 267 | 80 90 130 120 110 | F ₀ i 142 164 206 245 245 | F ₀ 2/3 123 123 146 189 173 | F ₀ f 103 97 112 173 134 | 123 128 155 202 184 | 120 160 220 170 200 |
| No. | [údè] | YB IK HS FR ₁ FR ₂ FR ₃ | F ₀ i 138 138 178 231 252 150 | F ₀ 2/3 142 154 231 260 267 154 | F ₀ f 142 164 238 260 283 154 | 141 152 216 250 267 153 | 80 90 130 120 110 80 | F ₀ i 142 164 206 245 245 150 | F ₀ 2/3 123 123 146 189 173 112 | F ₀ f 103 97 112 173 134 94 | 123 128 155 202 184 119 | 120 160 220 170 200 180 |
| No. | [údè] * ? | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ | F ₀ i 138 138 178 231 252 150 134 | F ₀ 2/3 142 154 231 260 267 154 138 | F ₀ f 142 164 238 260 283 154 138 | 141 152 216 250 267 153 137 | 80 90 130 120 110 80 80 | F ₀ i 142 164 206 245 245 150 138 | F ₀ 2/3 123 123 146 189 173 112 123 | F ₀ f 103 97 112 173 134 94 112 | 123 128 155 202 184 119 124 | 120 160 220 170 200 180 150 |
| No. | [údè] | YB IK HS FR ₁ FR ₂ FR ₃ | F ₀ i 138 138 178 231 252 150 | F ₀ 2/3 142 154 231 260 267 154 | F ₀ f 142 164 238 260 283 154 | 141 152 216 250 267 153 | 80 90 130 120 110 80 | F ₀ i 142 164 206 245 245 150 | F ₀ 2/3 123 123 146 189 173 112 | F ₀ f 103 97 112 173 134 94 | 123 128 155 202 184 119 | 120 160 220 170 200 180 |
| No. | [údè] * ? | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ | F ₀ i 138 138 178 231 252 150 134 195 | F ₀ 2/3 142 154 231 260 267 154 138 | F ₀ f 142 164 238 260 283 154 138 195 | 141 152 216 250 267 153 137 | 80 90 130 120 110 80 80 | F ₀ i 142 164 206 245 245 150 138 173 | F ₀ 2/3 123 123 146 189 173 112 123 | F ₀ f 103 97 112 173 134 94 112 138 | 123 128 155 202 184 119 124 | 120 160 220 170 200 180 150 |
| 3. | [údè] * ? | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ | F ₀ i 138 138 178 231 252 150 134 195 | 142 154 231 260 267 154 138 195 | F ₀ f 142 164 238 260 283 154 138 195 | 141 152 216 250 267 153 137 195 | 80 90 130 120 110 80 80 160 | F ₀ i 142 164 206 245 245 150 138 173 | F ₀ 2/3 123 123 146 189 173 112 123 159 | F ₀ f 103 97 112 173 134 94 112 138 | 123 128 155 202 184 119 124 157 | 120 160 220 170 200 180 150 110 |
| SER. | [údè] * ? ? words | YB IK HS FR1 FR2 FR3 CH1 CH2 | F ₀ i 138 138 178 231 252 150 134 195 FIRST 5 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL | F ₀ f 142 164 238 260 283 154 138 195 | 141 152 216 250 267 153 137 195 | 80 90 130 120 110 80 80 160 DURA -TION | F ₀ i 142 164 206 245 245 150 138 173 SECON | 123 123 146 189 173 112 123 159 F ₀ 2/3 | F ₀ f 103 97 112 173 134 94 112 138 SLE | 123 128 155 202 184 119 124 157 | 120 160 220 170 200 180 150 110 DURA -TION |
| 3. | [údè] * ? | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK-ERS | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 | F ₀ f 142 164 238 260 283 154 138 195 E | 141 152 216 250 267 153 137 195 | 80 90 130 120 110 80 80 160 DURA -TION | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 | 123 123 146 189 173 112 123 159 ND SYLAB | F ₀ f 103 97 112 173 134 94 112 138 SLE F ₀ f 103 | 123 128 155 202 184 119 124 157 | 120 160 220 170 200 180 150 110 DURA -TION |
| SER. | [údè] * ? ? WORDS | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK-ERS | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 | 141 152 216 250 267 153 137 195 F ₀ m | 80 90 130 120 110 80 80 160 DURA -TION 150 120 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 | 123 123 146 189 173 112 123 159 ND SYLAB F ₀ 2/3 116 112 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 | 123 128 155 202 184 119 124 157 F ₀ m | 120 160 220 170 200 180 150 110 DURA -TION |
| SER. | [údè] * ? ? words | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ SPEAK-ERS YB IK HS | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 134 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 189 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 138 | 141 152 216 250 267 153 137 195 F ₀ m 133 130 171 | 80 90 130 120 110 80 80 160 DURA -TION 150 120 210 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 164 | 123 123 146 189 173 112 123 159 ID SYLAB F ₀ 2/3 116 112 116 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 103 | 123 128 155 202 184 119 124 157 F ₀ m 115 108 128 | 120 160 220 170 200 180 150 110 DURA -TION |
| SER. | [údè] * ? ? WORDS | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 134 245 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 189 252 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 138 189 252 | 141 152 216 250 267 153 137 195 F ₀ m 133 130 171 250 | 80 90 130 120 110 80 80 160 DURA -TION 120 210 150 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 164 245 | F ₀ 2/3 123 1246 189 173 112 123 159 F ₀ 2/3 116 112 116 189 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 103 173 | 123 128 155 202 184 119 124 157 F ₀ m 115 108 128 202 | 120 160 220 170 200 180 150 110 DURA -TION 160 130 200 190 |
| SER. | [údè] * ? ? WORDS [ázà] * | YB IK HS FR ₁ FR ₂ FR ₃ CH ₁ CH ₂ SPEAK-ERS YB IK HS FR ₁ FR ₂ | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 134 245 189 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 189 252 225 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 189 252 231 | 141 152 216 250 267 153 137 195 F ₀ m 133 130 171 250 215 | 80 90 130 120 110 80 80 160 DURA -TION 150 120 210 150 140 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 164 245 238 | F ₀ 2/3 123 1246 189 173 112 123 159 ID SYLAB F ₀ 2/3 116 189 146 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 103 173 123 | 123 128 155 202 184 119 124 157 F ₀ m 115 108 128 202 169 | 120 160 220 170 200 180 150 110 DURA -TION 160 130 200 190 130 |
| SER. | [údè] * ? ? WORDS | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 FR3 | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 134 245 189 150 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 189 252 225 150 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 189 252 231 150 | 141 152 216 250 267 153 137 195 F ₀ m 133 130 171 250 215 150 | -TION 80 90 130 120 110 80 80 160 DURA -TION 150 120 210 150 140 80 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 164 245 238 138 | F ₀ 2/3 123 123 146 189 173 112 123 159 ID SYLAB F ₀ 2/3 116 189 146 126 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 103 173 123 109 | 123 128 155 202 184 119 124 157 F ₀ m 115 108 128 202 169 124 | 120 160 220 170 200 180 150 110 DURA -TION 160 130 200 190 130 120 |
| SER. | [údè] * ? ? WORDS [ázà] * | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 FR3 CH1 | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 134 245 189 150 126 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 189 252 225 150 138 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 189 252 231 150 138 | 141 152 216 250 267 153 137 195 F ₀ m 133 130 171 250 215 150 134 | -TION 80 90 130 120 110 80 80 160 DURA -TION 150 120 210 150 140 80 100 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 164 245 238 138 126 | F ₀ 2/3 123 1246 189 173 112 123 159 ID SYLAB F ₀ 2/3 116 112 116 189 146 126 109 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 103 173 123 109 97 | 123 128 155 202 184 119 124 157 F ₀ m 115 108 128 202 169 124 111 | 120 160 220 170 200 180 150 110 DURA -TION 160 130 200 190 130 120 160 |
| SER. | [údè] * ? ? WORDS [ázà] * | YB IK HS FR1 FR2 FR3 CH1 CH2 SPEAK- ERS YB IK HS FR1 FR2 FR3 | F ₀ i 138 138 178 231 252 150 134 195 FIRST: F ₀ i 126 123 134 245 189 150 | F ₀ 2/3 142 154 231 260 267 154 138 195 SYLLABL F ₀ 2/3 134 130 189 252 225 150 | F ₀ f 142 164 238 260 283 154 138 195 E F ₀ f 138 138 189 252 231 150 | 141 152 216 250 267 153 137 195 F ₀ m 133 130 171 250 215 150 | -TION 80 90 130 120 110 80 80 160 DURA -TION 150 120 210 150 140 80 | F ₀ i 142 164 206 245 245 150 138 173 SECON F ₀ i 126 126 164 245 238 138 | F ₀ 2/3 123 123 146 189 173 112 123 159 ID SYLAB F ₀ 2/3 116 189 146 126 | F ₀ f 103 97 112 173 134 94 112 138 BLE F ₀ f 103 87 103 173 123 109 | 123 128 155 202 184 119 124 157 F ₀ m 115 108 128 202 169 124 | 120 160 220 170 200 180 150 110 DURA -TION 160 130 200 190 130 120 |

| SER. No. | WORDS | SPEAK- ERS | | | | | DURA -TION | SECOND SYLABLE | | | | DURA -TION |
|-------------|---------|------------------------------------|------------------|--------------------|------------------|------------------|---------------------|------------------|--------------------|------------------|------------------|---------------|
| | | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_0 2/3$ | F ₀ f | F ₀ m | |
| 5. | [śkà] | 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 | 178 262 | 130 | 200 | 142 | 123 | 155 | 200 |
| | * | FR ₁ FR ₂ | 245 206 | 267 245 | 275 260 | 237 | 110 110 | 275 225 | 206 138 | 189 134 | 223 166 | 80 150 |
| | * | 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 |
| | | CII | 170 | 170 | 104 | 100 | 00 | 137 | 172 | 110 | 137 | 110 |
| SER. | WORDS | SPEAK- | FIRST | SYLLABL | Æ | 1 | DURA -TION | SECON | D SYLAB | LE | l | DURA |
| No. | | ERS | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -HON | F ₀ i | F ₀ 2/3 | F ₀ f | F ₀ m | -TION |
| | 5 (1) 1 | L VD | | | | | 140 | | | | | L |
| 6. | [ákò] | YB IK | 116 123 | 126 130 | 116 130 | 119 128 | 140 100 | 126 126 | 116 97 | 103 87 | 115 103 | 110 120 |
| | * | 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_3^2 | 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 |
| a=n | l words | Lannir | Lemen | SYLLABL | Б | | DURA SECOND SYLABLE | | | | DURA | |
| SER. No. | WORDS | SPEAK- ERS | LIKSI | SILLADI | Æ | | -TION | SECON | DSILAB | LE | | -TION |
| | | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | | F ₀ i | $F_02/3$ | F ₀ f | F ₀ m | |
| 7. | [é'bò] | YB | 126 | 130 | 130 | 129 | 120 | 116 | 103 | 97 | 105 | 160 |
| | * | IK | 146 | 154 | 154 | 151 | 190 | 119 | 119 | 123 | 120 | 160 |
| | | 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 |

REFERENCES

- Amayo, A.M. 1976. "A generative Edo phonology." Unpublished Doctoral Thesis, University of Ibadan, Ibadan, Nigeria.
- Dojio, L.A. 1978. "Analysis instrumentales et perceptives des réalisations tonales du yoruba." Thèse de 3e Cycle, Université des Sciences Humaines, Strasbourg, France.
- Hombert, J-M. 1976. "Perception of tones on bisyllabic nouns in Yoruba." In Larry M. Hyman, Russell G. Schuh, and Leon C. Jacobson (eds.), Papers in African Linguistics in Honor of Wm. E. Welmers, pp. 109-121. Studies in African Linguistics, Supplement 6. Los Angeles: UCLA African Studies Center.
- Hyman, L.M. 1973. "The role of consonant types in natural tonal assimilations." In Larry M. Hyman (ed.), *Consonant Types and Tone*, pp. 153-179. Southern California Occasional Papers in Linguistics, No.I. Los Angeles: University of Southern California Linguistics Program.
- Hyman, L.M. 1975. *Phonology: Theory and Analysis*. New York: Holt, Rinehart and Winston.
- Lhote, E., J.M. Diaz de Leon, S. Vinter, and V.E. Omozuwa. 1986. "Mise en évidence de fonctions d'ancrage et de déclenchement en perception de parole." 15e journées d'études sur la aasole. Groupement des Acousticiens de Langue Française, pp. 129-133. Aix-en Provence.
- Omozuwa, V.E. 1987a. "L'edo: approches phonologiques, acoustiques, et perceptuelles du système phonémique et du système tonémique." Unpublished Doctoral Thesis, Université de Franche-Comté, Besançon, France.
- Omozuwa, V.E. 1987b. "Les spécificités du relief tonal en edo: contribution à l'étude du 'downdrift' et du 'downstep'". Annales Litteraires de l'Université de Besançon 353:177-201.
- Wescott, R.W. 1962. A Bini Grammar. Part I. Phonology. East Lansing, MI: African Studies Center, Michigan State University.
- Wescott, R.W. 1965. "Speech-tempo and the phonemics of Bini." *Journal of African Languages* 4/3:182-190.