A Phonetic Analysis of Igbo Tone

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Abstract
This paper studies tone in Igbo, a West Benue-Congo language spoken predominantly in the southeastern part of Nigeria, from a phonetic perspective. The study examines the acoustics of Igbo tone by checking the effects of prevocalic consonants, vowel height and vowel quality on tone as well as the interaction of tone and intonation in the language under. A word list of 128CV tokens and 10 sentences was digitally recorded with an average of 3 repetitions. The digital recordings were made at a sample rate of 44,100Hz. The eight Igbo vowels were used to test the variations that were caused by vowel height and it was observed that vowels bearing high tones are higher than their low counterparts. The study also revealed that voiced consonants have greater perturbations on tones than their voiceless counterparts; Igbo local pitch effect is a lowering of the high tone of the initial pronominal element in interrogatives. This study will contribute to the understanding of the behaviours of tone in Igbo.

Index Terms: tone, intonation, pitch effect

1. Introduction
Igbo, a West Benue-Congo language (Williamson and Blench 2000), is spoken predominantly in the southeastern part of Nigeria. The Standard variety of the language is chosen for this present study. The Standard variety of Igbo has eight vowels. The vowels are grouped into two sets which are delineated along an important phonetic parameter. This results in vowel harmony (VH). The two harmony sets in Igbo are:

\[ [+\text{ATR}] \quad [-\text{ATR}] \]

\[ i \quad u \quad i \quad u \quad e \quad o \quad a \quad o \]

Igbo is a tone language because it manipulates tone contrastively. Two distinctive tones are often recognized in Igbo; in addition, there is a third tone, a downstepped high. The tones are marked as follows:

\[ [\text{'}] \quad \text{high}; \quad [\text{'}] \quad \text{low}; \quad [\text{'}] \quad \text{downstep} \]

Tone is an integral part of a word in Igbo. It is the interface of phonology and syntax in Igbo because it performs both lexical and grammatical functions. For instance, the application of pitch variations to certain lexical item yields different meanings. For example ‘\text{isi’ ‘head’}; \quad \text{isi’ ‘smell’}; \quad \text{isi’ ‘blindness’}; \quad \text{isi’ ‘to cook’}

(High tones are left unmarked. Macron is used here to represent downstep)

The grammatical functions of tone in Igbo are as follows:
1. Distinguishing statements from interrogatives
   A pronoun subject bears a high tone in statements but changes to a low tone in questions. For instance,
   \begin{align*}
   \text{Statement} & \quad \text{Question} \\
   a. \quad \text{Ọ gărà áhjà.} & \quad \text{Ọ gărà áhjà?} \\
   \text{S/he went to the market.} & \quad \text{Did s/he go to the market?} \\
   b. \quad \text{I sìrì nri.} & \quad \text{I sìrì nri?} \\
   \text{You cooked.} & \quad \text{Did you cook?}
   \end{align*}

2. Differentiating nominal constructions from verbal constructions
   The tones of a nominal construction differ from those of the related verbal construction. For example,
   \begin{align*}
   \text{Nominal Construction} & \quad \text{Verbal Construction} \\
   a. \quad \text{iśi ázù} & \quad \text{iśi ázù} \\
   \text{head of fish} & \quad \text{to cook fish} \\
   b. \quad \text{ọsìsì álkù} & \quad \text{ọsìsì álkù} \\
   \text{stick of palmnut} & \quad \text{cooking of palmnut}
   \end{align*}

3. Distinguishing cardinal numbers from ordinal numbers
   Okorji (1998) states that in cardinal numbers, both 1st Noun (N1) and 2nd Noun (N2) retain their inherent tones. In ordinal numbers, the last tone on N1 must be high (either a full high or a step). If the penultimate syllable and the last syllable in N1 are bearing low tones, the last low toned syllable of the N1 will be raised to a full high. On the other hand, if the penultimate syllable bears a high tone while the last syllable bears a low tone, the last low toned syllable of the N1 will be raised to a step. The reason for the last syllable of the N1 becoming high is to enable the tones on N2 to be step level.

   \begin{align*}
   \text{Examples,} \\
   \text{Cardinal Number} & \quad \text{Ordinal Number} \\
   a. \quad \text{užó isè} & \quad \text{úžó išè} \\
   \text{road five} & \quad \text{road fifth} \\
   \text{five roads} & \quad \text{the fifth road} \\
   b. \quad \text{àkwà ànö} & \quad \text{àkwà ànö} \\
   \text{bridge four} & \quad \text{bridge fourth} \\
   \text{four bridges} & \quad \text{the fourth bridge}
   \end{align*}

4. Differentiating a full sentence from a relative clause
   Tone distinguishes a sentence from a relative clause when the two have the same morphological pattern. Such as,
   \begin{align*}
   a. \quad \text{Okóró tóò ogoóò.} & \quad \text{Full sentence} \\
   \text{Okoro is tall.} & \quad \text{Relative clause} \\
   \text{Okóró [tóró jógójógó…} & \quad \text{The Okoro that is tall…} \\
   b. \quad \text{Amáákan déré ákwùkùwò.} & \quad \text{Full sentence} \\
   \text{Amaka wrote a book.} & \quad \text{Relative clause} \\
   \text{Amáákan [déréé [jákùkùwò…} & \quad \text{The Amaka who wrote a book…}
   \end{align*}
Quite a significant effort has been devoted to the study of Igbo phonetics. For instance, Ikekeonwu (1993) is a work on intonation and focus. The work reveals that intonation, high tone precisely, is employed to reflect focus. The high tone is borne by only one syllable in a tonal intonation group (TIG). The syllable with this focal high pitch (FHP) is usually higher than preceding high tones while high tones of succeeding words within the TIG are either downstepped, high or low tones.

Obianika (1999) tries to compare instrumental analysis with the auditory findings of tone in Igbo associative constructions.

The study records only the highest pitch of each syllable or vowel. It reveals that, for example, in ‘ji + ði’ and ‘bê + chi’the high tone of the second noun is lowered from a pitch above 250Hz to a pitch a little more than 200Hz.

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Uguru (2009) studies the interaction of tone and intonation in Ika. Ika is a dialect of Igbo. It is spoken mainly in the Ika North-East and Ika South Local Government Areas of Delta State and some parts of Edo State of Nigeria. Uguru’s work reveals that whereas other Igbo dialects manifest tone only, Ika dialect of Igbo manifests intonation in addition to tone. She observes six tune patterns in Ika. They are as follows:

- **HF ( )**: High fall tune pattern
- **LF ( )**: Low fall tune pattern
- **HR ( )**: High rise tune pattern
- **LR ( )**: Low rise tune pattern
- **RF ( )**: Rise fall tune pattern
- **FR ( )**: Fall rise tune pattern

Basically, the works that have been done on tone in Igbo address the issues of the behaviour of tone in associative constructions. This present study treats the effects of sound segments on tone. It looks into the effects that consonants and vowels have on tone in monosyllabic words. In studying tone, emphasis has always been laid on the vowels that bear tone. But Hombert’s (1977) study discloses that consonant types perturb pitch in Yoruba, as they have been shown to do in non-tone languages. Such perturbations, he says, may serve as one source of "tone-splitting" in languages which already have tone.

Ladefoged (2003:79), in affirmation of Hombert (1977), reveals that “It may be important to record the pitch during consonants (if, for example, you are studying the effect that consonants have on tones). The recording of the vowels may be distorted, but the consonants will show up better.” “It is against this backdrop that this present research tends to examine the acoustics of tone in Igbo pointing out the effects of consonants, vowel height and vowel quality on tone.

### 2. Research Questions

This study tends to answer the following questions:

1. How do voiced prevocalic consonants affect tone in Igbo?
2. What are the effects of voiceless prevocalic consonants on tone in Igbo?
3. What are the effects of vowel height on tone in Igbo?
4. Are there any effects which vowel quality has on tone in Igbo?
5. What is the interaction of tone and intonation in Igbo?

### 3. Methodology

In order to answer the research questions, a word list of 128CV tokens, (8 consonants x 16 vowels) and 10 sentences (5 declaratives + 5 interrogatives) was read by two adult male native Igbo speakers and was digitally recorded. The 16 vowels comprise 8 vowels multiplied by 2. Each token was read 3 times. The recording was done in two parts. One part of the recording was done with the Edirol and copied onto my computer while the other part was recorded directly onto the computer using Praat and the Shure microphone.

The recording sample rate was 44,100Hz. The choice of the rate is because that rate, according to Ladefoged (2003:95), is commonly available as it is derived from the standard sample rate for an audio CD, which is 44,000Hz. The default values of frequency deviation were set at 30Hz and the tracking threshold at 0% (See Ladefoged, 2003 for pitch options). A recording set at the default values above has a number of advantages. There will be clean recording with little background noise. Also pitch will be reported without any missing points.

The recording was done with the Edirol and copied onto my computer using Praat and the Shure microphone. The sound recordings were saved in Praat. Since this research involves tone and the speech signals need to be seen, the sound recordings were analysed using a computer software package – Praat version 5.1.25 developed by Paul Boersma and David Weenink. Pitch and formant trackings could be performed with Praat.

### 4. Discussion

#### 4.1 The effects of consonants on tone

In an effort to capture the effect of voicing contrast at different frequencies, four sets of words were analyzed. The first set contains voiced consonants with +ATR vowels; the second set contains voiced consonants with –ATR vowels; the third set contains voiceless consonants with +ATR vowels; while the fourth set contains voiceless consonants with –ATR vowels.

The contrasts were conducted with prevocalic consonants. The analyses were conducted with the bilabial, alveolar and velar plosives but only the bilabial plosives are shown here. The upper case U, I and O respectively.
Figures 1-4 show the effects consonants could have on tone. A good look at the diagrams reveals that /b/, which is a voiced sound segment, affects the behaviours of tone. For instance, in figure 1, the vowels of ‘bi’ and ‘bu’ that were realized on high tone became slightly lowered. The same thing applied to the vowels of ‘bi’ and ‘bu’ in figure 2. They were realized on high tone but became slightly lowered due to the influence of the preceding voiced consonant. The case is quite different in figures 3 and 4. The tones borne by the vowels in ‘pi’, ‘pu’, ‘pi’ and ‘pu’ retained their high tones. The tones were not affected in any way; the reason being that /p/ is a voiceless sound segment.

4.2 The effects of vowel height on tone

Vowel heights in Igbo are high, mid and low. High vowels in Igbo are ‘i’, ‘j’, ‘u’ and ‘j’; mid vowels are ‘e’, ‘o’ and ‘o’; ‘a’ is the low vowel. Figures 5-8 show the Igbo vowels when combined with /p/ and /b/. Figures 5 and 7 contain the Igbo
vowels realized on high tone while figures 6 and 8 are diagrams of the vowels realized on low tone. It could be seen from the diagrams that the vowels maintained their height irrespective of the tone they bore.

4.3 The effects of vowel quality on tone
Vowel charts of the eight vowels with the voiceless velar plosive /k/ are presented below:

Figures 9-12 illustrate the combinations of /k/ with the Igbo vowels. Figure 9 shows that /i/ has the highest F1 and the highest high tone while /u/ has the lowest F1 and reduced high tone. In figure 10, /u/ has the highest F1 and the greatest low tone while /o/ has the lowest F1 and least low tone. It could be averred from figure 11 that /u/ has the highest F1 and the highest high tone while /e/ has the lowest F1 and reduced high tone. Figure 12 reveals that /i/ has the highest F1 and the greatest low tone while /u/ has the lowest F1 and the least low tone; /e/ and /o/ are almost on the same scale.

4.4 The interaction of tone and intonation

The pitch tracks in figures 13 and 14 reveal the tonal differences in declarative and interrogative sentences. The emphasis is on the subject pronouns. In figure 13, the pitch is high showing a high tone in the Sentence Initial Position (SIP) while figure 14 shows a low pitch which suggests a low tone at the SIP.

5. Findings and conclusions
The graphs show that the perturbation caused by /b/ on a following high tone is greater than that on a following low tone. /b/ reduces the high tone of +ATR vowels but increases the low tone of +ATR vowels. But then, high tones are quite higher than their contrasting low tones. The effect of /p/ on a following tone is insignificant. For vowel height, vowels bearing high tones are higher than their low counterparts. Concerning vowel quality, there are tonal fluctuations.

Tone performs a grammatical function of distinguishing declaratives from interrogatives in Igbo. Igbo local pitch effect is, therefore, a lowering of a high tone in Sentence Initial
Position (SIP) for question formation. For the declarative/interrogative pitch analysis systems, it is observed that the pitch tracks for the second to the last words are almost identical. The only difference is observed at the SIP. The Praat program suggests that there is a high pitch on the initial pronominal element of the declarative while in the interrogative, we could see a very rapid fall in pitch.

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7. References