A non-linear representation of Igbo vowels and phonological processes

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Abstract
The non-linear approach of feature geometry is greatly discussed in this paper. This approach involves two components of speech production namely: the laryngeal features and the supralaryngeal features. The laryngeal features concentrate on the vocal folds etc. while the supralaryngeal features focus on the upper vocal tract. Basically, the data for this study were got from existing works in the literature on Igbo. The words were subsequently transcribed and analysed phonetically. The paper examines the way Igbo vowels and phonological processes can be accounted for, using feature geometry. Thus, this examination of various Igbo words showed that feature geometry studies vowels using three parameters – coronal vs. dorsal, +ATR vs. -ATR and round vs. unround. The phonological processes of assimilation, palatalization and nasalization were duly examined. It was observed that assimilation in Igbo involves mainly vowels; palatalization generally involves a front vowel following a consonant while nasalization, which involves a nasal segment passing on its nasal quality to a vowel, is perseverative in Igbo.

Introduction

Phonological phenomena are no longer seen as operating on one linear sequence of segments, called phonemes or feature combinations but rather as involving some parallel sequences of features which reside on multiple tiers. Basically, feature geometry (FG) is the non-linear framework of phonological representation which would be discussed in this paper. It is an offshoot of Distinctive Feature Theory. Distinctive Features, according to Halle and Clements (1983:6), are a "… set of (articulatory and acoustic) features sufficient to define and distinguish, one from the other, the great majority of the speech sounds used in languages of the world." The aim of distinctive feature is to classify sound segments according to their contrastiveness. In other words, the features that make one sound segment distinct from the other.

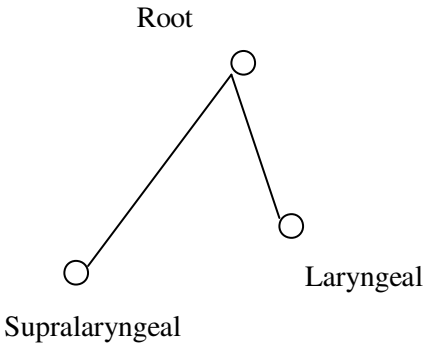
Feature Geometry (FG) is a type of distinctive feature theory. In this approach, every sound segment is made up of two basic components: (1) Laryngeal features (2) Supralaryngeal features. The laryngeal features concentrate on the vocal folds etc. while the supralaryngeal features focus on the upper vocal tract. That is, what happens from the soft palate upwards. Laryngeal features simply suggest what happens at the larynx. The larynx incorporates the vocal folds. It is the configuration of the vocal folds that determines whether a sound will be voiced or voiceless. Phonation takes place in the larynx. Conversely, supralaryngeal features presuppose

the happenings above the larynx. When the production of sound segments involves the soft palate, the tongue, the lips etc., we say that such segments produced depict supralaryngeal features.

In other words, laryngeal and supralaryngeal features constitute the basis in the production of speech sounds of a language. Let us take for example, in the production of [ṽ] - nasalized voiced labiodental fricative, laryngeal feature shows that the vocal folds are apart but they are in undulatory position. They are affected by subglottal pressure. This implies that the segment produced is voiced. The supralaryngeal features that are involved are the upper teeth and the lower lip and the soft palate (soft pal.). The soft palate is involved because it determines orality and nasality. When it is raised, it blocks the nasal cavity and air passes through the oral cavity. This happens for the production of oral sounds. On the other hand, the soft palate lowers to allow air into the nasal cavity. When this happens, air passes through the nasal cavity for the production of nasal sounds. So, in the production of [ṽ] the soft palate lowered to allow partial passage of air into the nasal cavity and at the same time air passed through the oral cavity.

In FG the properties of sound are arranged in a hierarchy of features (cf. Williamson 1999, Huber 2006, Harris 2007) observes that FG is the theory in which a fully hierarchical approach is used. These features are directly or indirectly attached to the root nodes. We have earlier noted that every speech sound must have laryngeal and supralaryngeal features; so, the laryngeal node and supralaryngeal node will be connected to the root node. These are represented as follows:

(fig.1)



This paper adopts the structural framework of Newman (1997). To Newman, FG is likened to the ingredients of sounds. Igbo words were collected from existing literature on Igbo, transcribed and analysed phonetically. The tone-marking convention employed in this paper is the one which leaves high tones unmarked, uses

the grave accent (̀) for low tones and the raised macron (ˊ) for the step tone. The set of symbols used is that of the International Phonetic Association's Alphabet (the letters IPA are used to refer to the Association and also to its alphabet) revised to 2005.

Components of speech production

The components of speech production in FG are the laryngeal node and the supralaryngeal node. These are discussed below:

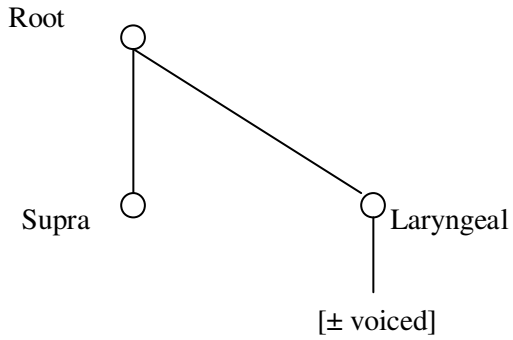
The Laryngeal Node

The laryngeal node is normally used to show voicing. That is, the larynx basically determines the voiced/voiceless contrast between sounds during their production. In the production of voiced segments, the vocal folds within the larynx vibrate but during the production of voiceless speech sounds, the vocal folds are kept apart such that they do not vibrate.

The feature [± voiced] is a terminal feature. Terminal features, according to Newman (1997:12), refer to "Properties of sounds which are not themselves articulators but are present as part of a sound." The terminal feature [± voiced] will appear under the laryngeal node. Consequently, terminal features do not further expand into other features.

Let us represent [± voiced]

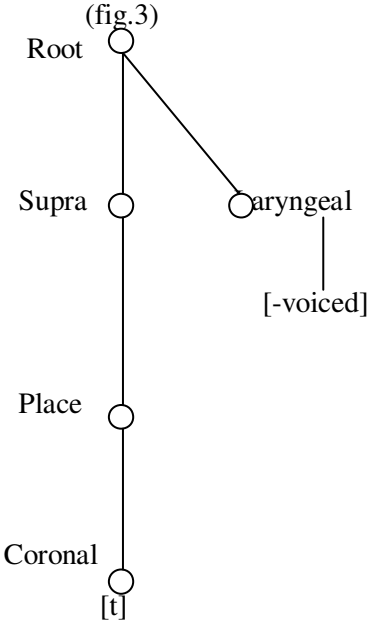
(fig.2)



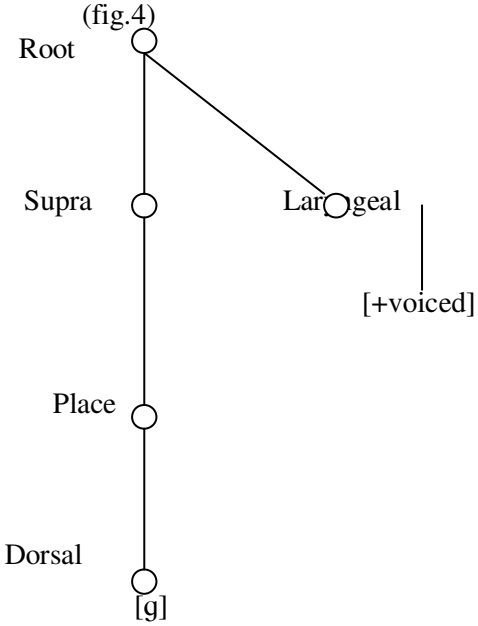
From the above representation, we observe that [± voiced] is a terminal feature and it sprouts from the laryngeal node.

The above notion is illustrated with the representations of [t] and [g] below:

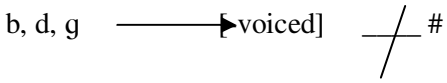
(fig.3)



(fig.4)

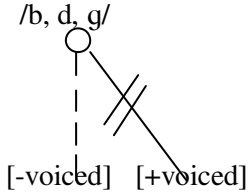


It has been noted that the laryngeal node is used to show voicing. But there is an important point to note here. That is, the issue of phonological processes which convert voiceless sounds into the corresponding voiced sounds and vice versa. Let us take German for example, the voiced stops – /b, d, g/ become the voiceless counterparts – /p, t, k/ in Word Final Position (WFP). *Land* in German meaning 'country' has an underlying [d] but [t] exists in the surface structure. This is as a result of [d]'s occurrence at WFP. The phonological rule can, then, be expressed as:



Using FG, the German example can be represented thus:

(fig.5)
Word Final
/b, d, g/



The above representation suggests that the stops are originally voiced but due to their occurrence at the WFP, they become voiceless. The broken line represents a new linkage to the laryngeal node while the double lines over [+voiced] line show delinking.

Other aspects of the laryngeal node are 'spread' and 'constricted glottis'. They are also marked by [±]. Newman (1997:15) gives an explanation of these two features. He observes that [+spread] sounds are produced with the vocal cords drawn wide apart while [-spread] sounds are produced without this gesture. Therefore, [+spread] sounds are aspirated consonants, 'breathy' voiced consonants, voiceless vowels, voiceless glides. [-spread] are other sounds.

He also notes that [+constr] sounds are produced with the vocal cords drawn tightly together whereas [-constr] sounds are produced without such a gesture. [+constr] refers to the glottal stop [ʔ], ejectives [k', s'], implosives [ɓ, ɗ, ɠ], glottalized or laryngealized sounds. [-constr] refers to all other sounds. Clements (2000:130) observes that "the feature [±constricted glottis] commonly distinguishes implosives and ejectives from other types of stops. It is necessary to mention that 'constr' is an abbreviated form of constricted glottis.

The Supralaryngeal Node

The place node extends from supralaryngeal (supra) node. The soft palate (soft pal) node also extends from the supralaryngeal node. Therefore, the supra node splits into two other nodes – the place node and the soft pal. The two nodes – the place and the soft pal nodes – are discussed under the supra node.

The Place Node

The place node extends from supralaryngeal (supra) node. This assembles pieces of information relating to the place of articulation. FG recognizes basically four major articulators defining four major places of articulation. These are:

1. the pharynx/tongue root
2. the back of the tongue
3. the front of the tongue
4. the lips

FG uses the terms labial, coronal and dorsal for these places of articulation. Newman (1997:6-7) explains these terms thus:

Labial: sounds produced using the lips. The lips are the active articulators. The sounds include bilabial and labiodental sounds.

Coronal: sounds involving the front of the tongue (including the blade and the tongue tip) as an active articulator. The sounds involved are interdental, dental, alveolar, palato-alveolar and palatal sounds. Front vowels are also considered coronal.

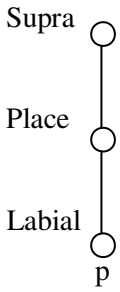
Dorsal: sounds involving the body of the tongue as an active articulator. The sounds include velar, glottal and uvular sounds. Non-front vowels are also dorsal.

It is worthy of mention that the term 'active articulator' is used in order to show that other articulator (s), if any, is passive.

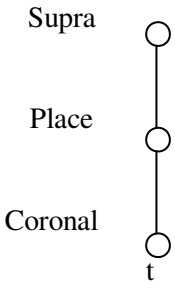
Let us examine the following sounds – /p, t, k/

They can be represented in FG thus:

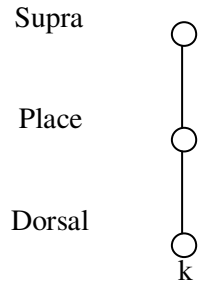
(fig.6)



(fig.7)



(fig.8)



There are more places of articulation than mentioned. The argument is that these three places of articulation appear primarily in the recognition of restrictions to the occurrence of consonants in a morpheme in many languages. For instance, we may have a situation where two labial consonants are not permissible or two coronals may not follow each other or not more than one dorsal will occur in a morpheme.

Newman (1997) distinguishes six places of articulation using stops in the Kashaya Pomo language (Amerindian). These six places of articulation fit perfectly into the three places of articulation presented by FG. They are represented as follows:

Traditional label	Symbol	FG's Place of Articulation
Labial	p	Labial
Dental	t̪	Coronal
Alveolar	t	Coronal

Palatal	c	Coronal
Velar	k	Dorsal
Uvular	q	Dorsal

The Soft Palate Node

The soft palate/velum gives the distinction between oral and nasal/nasalized speech sounds. When it is lowered, air passes through the nasal cavity. This gives rise to the production of nasal sounds. It can also be raised for air to pass through the oral cavity. Oral sounds are produced through this configuration of the velum. [± nasal] is the feature used to represent orality vs. nasality. There is a situation whereby air partially passes through the nasal cavity during the production of oral sounds. Such sounds are called nasalized speech sounds. Also, nasal quality of a segment can be transferred to a preceding or following oral sound and this also leads to nasalized speech sounds. For example:

English		French		
sin	[s ˜ɪ n]	bon	'good'	[b ɒ̃]
pan	[p^{h} æ̃ n]	mon	'my'	[m ɒ̃]
tan	[t^{h} æ̃ n]	sainte	'saint'	[s ɛ̃ t]

Igbo

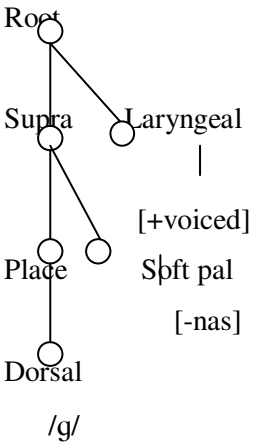
Okorji (1999:233) gives a few instances of nasalization in Umuchu dialect of Igbo. They are as follows:

vụ	/ṽù/	(of eggs)	'hatch'
sụ	/s̃ù/	(of grass)	'cut'
zụ	/z̃ú/		'train or breed'
sie	/ʃ̃ié/		'smell or rub'
zie	/ʒ̃ié/	(of nose)	'blow'
ha	/ɦ̃á/		'make rain'
re	/ɻ̃é/		'burn'

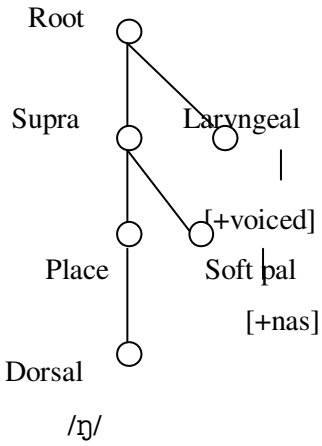
It is necessary to mention here that nasalization is not distinctive in Standard Igbo but in some dialects of Igbo. Basically, it is distinctive in Inland East Igbo (IEI) and Inland West Igbo (IWI) dialect clusters. Owerri dialect is a member of IEI clusters while Umuchu variant is a member of IWI clusters.

Let us illustrate what we have discussed using FG approach:

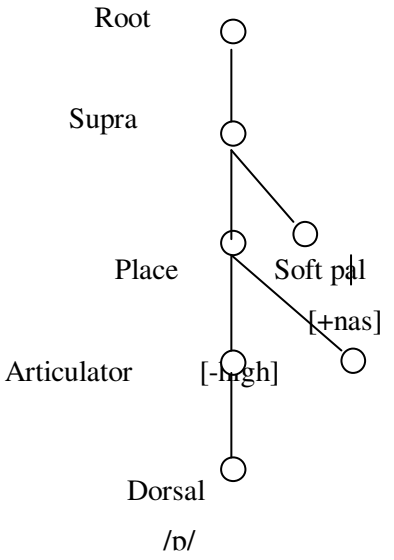
(fig.9)



(fig.10)



(fig.11)



In fig.9, /ɡ/ is a velar sound and an oral sound. In fig. 10, /ŋ/ is a velar sound and a nasal sound. In fig.11, /ɒ/ is a vowel i.e. an oral sound. The articulator node shows that the sound is a vowel. It is a low vowel hence, the feature [-high]. Also the feature [+nas] indicates that the vowel is a nasalized one.

Vowels

Eight vowels exist in the Igbo language. They include: /i, ɪ, e, a, ʊ, u, o, ɔ,/. The vowels can be seen in words like:

Speech sound	Phonemic representation	Orthographic representation	Gloss
/i/	/ikwe/	ikwè	mortar
/ɪ/	/ɪgba/	ìgbà	musical drum
/e/	/esu /	esu	millipede
/a/	/azʊ /	azụ̀	fish
/ʊ/	/ʊkwa/	ụkwà	breadfruit
/u/	/uri /	ùrì	candle
/o/	/okwute/	òkwuté	stone
/ɔ/	/ɔgʊ/	ọgụ̀	hoe

In FG, there are three basic divisions under which vowels are discussed. These are:

(a) Coronal vs. dorsal
(b) +ATR vs. –ATR (Advanced Tongue Root)
(c) Round vs. unround

Coronal vs. dorsal

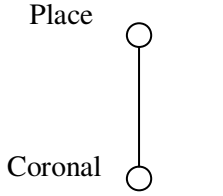
Vowels are made with an expulsion of air through the mouth without any obstruction of the sort one finds with consonants. There are no easily identifiable places of articulation for vowels as for consonants (like labial, dental, alveolar etc.), because the tongue does not make contact with any of these parts of the vocal tract. With vowels, the tongue body is involved but without coming into contact with the roof of the mouth.

The features [± front] and [± back] traditionally used to distinguish vowels. Front vowels would, then, be [+front, -back], the central vowels would be [-front, -back], and back vowels would be [-front, +back]. Alternatively, the feature [± back] would be used in our analysis of Igbo vowels. This is because there are no central vowels in the language. We would, then, use the feature[± back] to capture the difference between front vowels and back vowels.

In Igbo, front vowels include / i, ɪ, e, ɛ, a/ while back vowels are / u, o, ɔ/. The diphthongs /aɪ/ and /aʊ/ are combinations of front and back vowels. Using the feature [± back], front vowels become [-back] while back vowels become [+back]. We shall assign the front vowels to the coronal node and back vowels to the dorsal node.

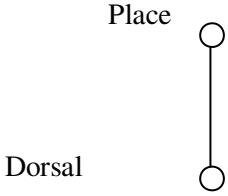
One might, therefore, represent the vowels in FG as shown below:

(fig.12)



/ i, ɪ, e, a/

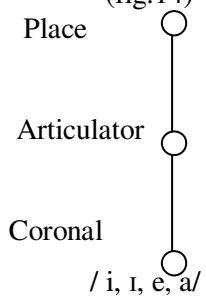
(fig.13)



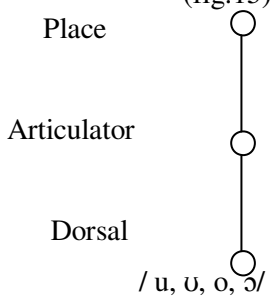
/ u, ʊ, o, ɔ/

When one comes to include all the vowel features in the FG representations, it proves convenient to present a modified version of the diagrams in figs. 12&13. The modified version of FG assumes an articulator node, intermediate between the place and the coronal/dorsal nodes, as shown below:

(fig.14)



(fig.15)

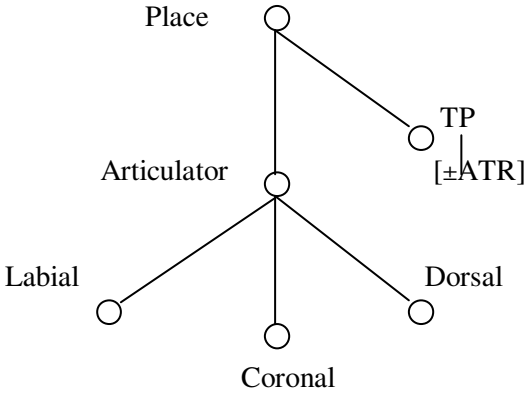


Advanced Tongue Root (ATR)

The feature [ATR] is basically a way of distinguishing the difference between high vowels and front vowels. The features [±high] and [±low] are employed in expressing the differences in height of vowels. ATR is usually involved in the discussion of a characteristic system of vowel harmony. Clements (2000) notes that in vowel harmony systems, all (or a subset of) vowels in the word tend to agree in a given distinctive feature.

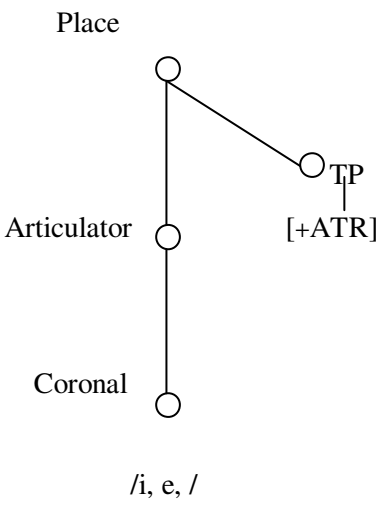
[+ATR] vowels are made by drawing the root of the tongue forward. [-ATR] sounds do not involve this gesture. [+ATR] vowels are /e, i, o, u /. [-ATR] vowels are /a, ɪ, ɔ, ʊ /. [±ATR] is a terminal feature under the tongue position node. Tongue Position (TP) is a separate node under place node. The above information can be illustrated as shown below:

(fig.16)

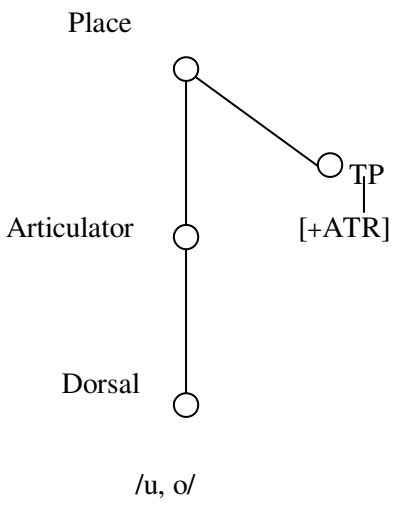


Igbo vowels can be represented using the above geometry as:

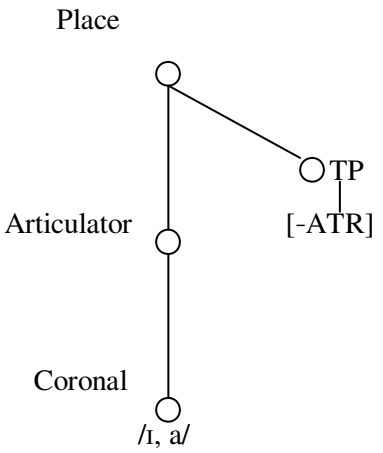
(fig.17)



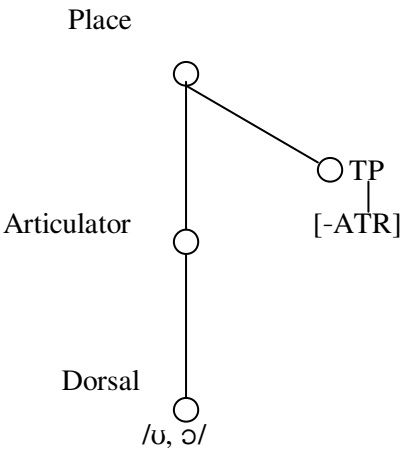
(fig.18)



(fig.19)



(fig.20)



From the above diagrams, one can observe that fig.17 has the coronal node which shows that the vowels – /i, e,/ are front vowels. It also has the feature [+ATR] showing that the vowels belong to the [+ATR] group. Dorsal node in fig.18 indicates that the vowels /u, o/ are back vowels. They also belong to the [+ATR] as shown from the TP node.

In fig.19, there is the coronal node showing that the vowels – /ɪ, a/ are front vowels. The terminal feature [-ATR] from the TP indicates that the vowels belong to the [–ATR] group. /ʊ,ɔ/ in fig.20 are back vowels hence, the dorsal node. They also belong to the [–ATR] group.

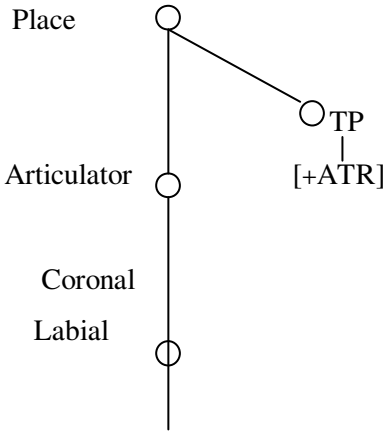
Roundness

Roundness suggests the movement of the lips together with the movement that occurs because of the lowering and raising of the jaw. Ladefoged (2007:13) notes that "this movement is called lip rounding." He goes further to posit that "vowels may be described as being rounded or unrounded."

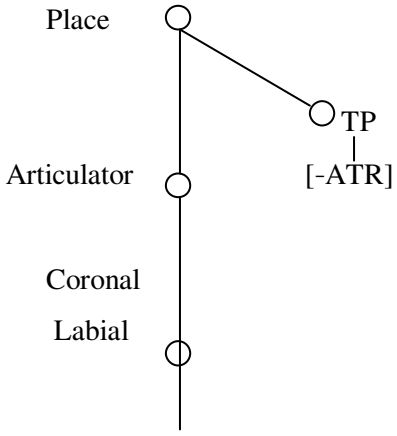
In addition, Newman (1997:73) is of the view that rounded sounds are produced with the lips in a rounded position and usually protruding. Unrounded sounds are produced without such rounding or protrusion. Round vowels in Igbo include /u, ʊ, o, ɔ/ while unrounded vowels are /i, ɪ, e, a/. The rounded vowels are back vowels while the unrounded vowels are front vowels. [±round] will be a terminal feature under the labial node, since the feature describes a configuration made by the lips.

Let us illustrate [±round] using Igbo vowels.

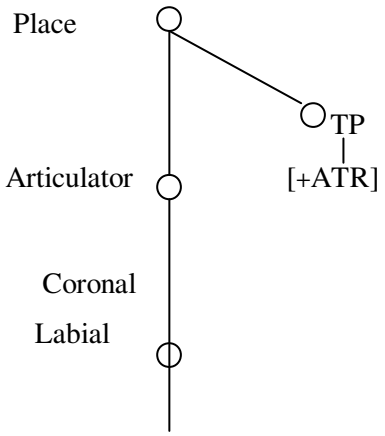
(fig.21)



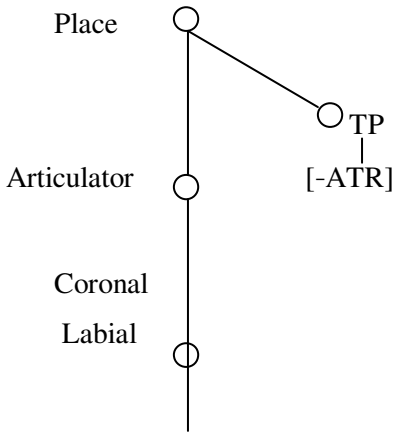
(fig.22)



(fig.23)



(fig.24)



It is observed, from the above diagrams, that the primary articulator node is either the coronal or dorsal node, with the labial node adding a secondary articulation.

Phonological Processes

The phonological processes that will be discussed in this section are assimilation, palatalization and nasalization.

Assimilation

Assimilation is a process by which a speech sound that is realized in one way when it is in isolation is realized differently as a result of being near some other phoneme belonging to a neighbouring word. For a detailed discussion on assimilation, see Roach (1991), Clark, Yallop and Fletcher (2007).

In English and a few African languages, assimilation usually affects consonants. Clark, Yallop and Fletcher (2007:90) confirms this notion by positing,

> "Traditional use of the term assimilation focuses on the more obvious or more easily symbolized consequences of co-articulatory effects, and for this very reason the term is widely known, especially with reference to consonants."

Conversely, it has been observed that assimilation in African languages (Nigerian languages in particular) basically involves vowels. Copious examples from some Nigerian languages would confirm this.

Yoruba

Progressive Assimilation

owo ile ⟶ owoole 'house rent'
ile ise ⟶ ileeʃɛ 'work place'
ku ise ⟶ kuuʃɛ 'well done'

Regressive Assimilation

Ara oko ⟶ arooko 'an uncivilized person'
aṣọ oke ⟶ aʃooke 'a type of cloth'
iyana eko ⟶ ijaneeko 'junction to Lagos'

(Ikekeọnwụ, 2006, adapted from Bamgboṣe, 1990)

Koring

Progressive Assimilation

guva olumu ⟶ guvaalumu 'pluck an orange'
kija ode ⟶ kidʒaade 'rope for climbing'

Regressive Assimilation

ezugbọ elekọl ⟶ ezugbeelekɔl 'bush pig'
lakpu ẹkẹrẹ ⟶ lakpɛɛkɛrɛ 'knot in wood'
ugbu ọnọọ ⟶ ugbɔɔnɔɔ 'dead person'

Igbo

Progressive Assimilation

isi a ⟶ isi i 'this head'
ewu a ⟶ ewu u 'this goat'
ego a ⟶ ego o 'this money'

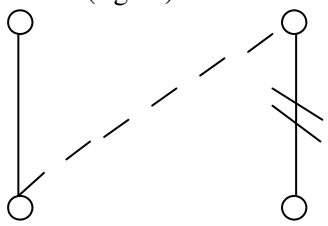
Regressive Assimilation

isi oke ⟶ isooke 'head of rat'
ụdị akpa ⟶ ʊdaakpa 'type of bag'
aka ukwu ⟶ akuukwu 'big hand'

(Culled from Ikekeọnwụ, 2006)

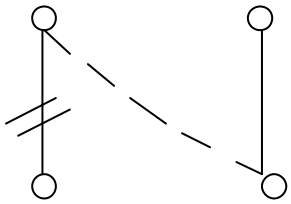
In FG framework, progressive assimilation involves the substructure shown below:

(fig.25)



FG Schema for progressive assimilation
Alternatively, a very general representation of regressive assimilation in FG is

(fig.26)



FG Schema for regressive assimilation

Fig.25 presupposes that when the assimilation involves some phonetic property passing from one segment to the following segment, we speak of progressive assimilation. While fig.26 suggests that when the assimilation involves some phonetic property passing from one segment to a preceding segment, then we speak of regressive assimilation.

Palatalization

This is the change of a consonant's place of articulation from non-palatal to palatal (or palato-alveolar). Eme (2008:62) notes succinctly that palatalization is, "simply the raising of the front part of the tongue towards the hard palate during the production of a sound that does not primarily involve such a raising."

Palatalization generally involves a front vowel or the palatal glide [j]. For instance, when a velar consonant changes to a palatal before a front vowel, the velar, in effect, takes on the place of articulation of the front vowel. All front vowels are [-anterior] and they are attached to the coronal node. Palatals are [-anterior] but velars are [+dorsal]. Therefore, palatalization occurs when a velar sound loses the feature [+dorsal] and takes on [+coronal]. The diacritic mark that represents palatalization is [^{j}]. Palatalized stops and liquids exist in Aku and Udi dialects of Igbo. For example:

pio ire	[p^{j}io ire]	'come in'
lia	[l^{j}ɪa]	'break/tear'

Similarly, in Nupe, some consonants are palatalized before front vowels. As in:

eg $_{y}$i	[eg^{j}i]	'child'
eg^{y}e	[eg^{j}e]	'bear'

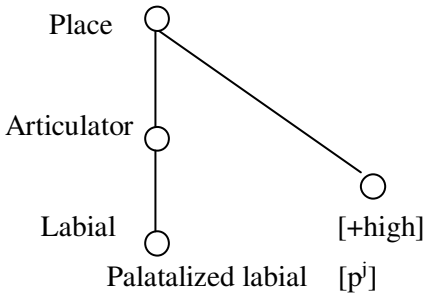
The phonological rule for palatalization is

C ⟶ palatal / ____ front vowel[i, e]

Palatalization can be represented using FG thus:

(fig.27)

[p^{j}io ire]



Nasalization

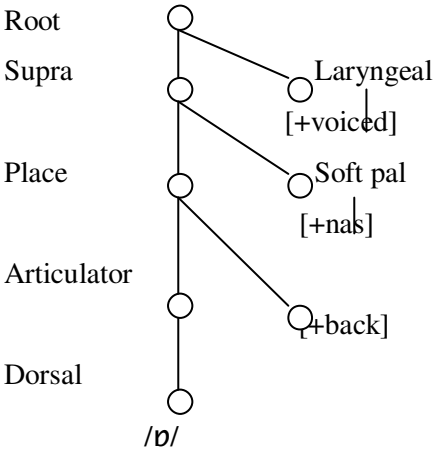
Nasalization is language universal. It occurs when air passes through the nasal cavity during the production of oral speech sounds. Also, a segment can pass on its nasal quality to another segment that either precedes or follows it. The direction of nasality differs from language to language. That is, the directionality of influence of nasalization could be from left to right or vice versa. When the direction is from left to right, it is called perseverative. Alternatively, the direction could be from right to left. When this happens, it is referred to as anticipatory. While nasalization is anticipatory

in English, it is perseverative in Igbo. Instances of nasalization in Igbo and English include:

Igbo			English	
ọnya	[ɔɲ̃ã]	'trap'	pin	[p ̃in]
ọnwa	[ɔŋwã]	'moon'	ten	[tɛ̃n]
anya	[aɲ̃ã]	'eye'	song	[sɔ̃ŋ]

Let us illustrate what we have discussed using FG approach

(fig. 28)



(fig.29)

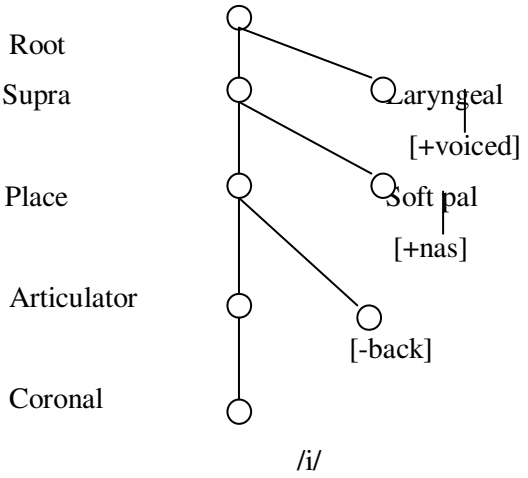


Fig.28 is a back vowel hence, the feature [+back]. Fig.29 is a front vowel, therefore, the articulator node spreads into the terminal feature [-back].

Conclusion

The study has attempted a brief phonology of the Igbo language using a non-linear approach known as feature geometry(FG). FG is a type of distinctive feature theory which organizes features into hierarchical arrays. In FG, speech sounds are accounted for under laryngeal and supralaryngeal features. Laryngeal features concern themselves with the things that happen in the larynx while supralaryngeal features are the things that happen in the upper vocal tracts i.e. from the soft palate to the lips.

FG is to a large extent dynamic or multi-faceted since it can effectively account for Igbo vowels using three parameters – coronal vs. dorsal, +ATR vs. -ATR and round vs. unround; and phonological processes such as: assimilation, palatalization and nasalization. In FG, bundles of features are not needed to refer to the basic places of articulation. In affirmation to the last notion, Newman (1997: 35)

asserts "The usefulness of the 'geometry' idea is that it helps to organize information in a convenient way".

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