Application of optimality theory to the analysis of Igbo syllable structures.

Cecilia Amaoge Eme and Maureen Chikeluba
Department of Linguistics
Nnamdi Azikiwe University, Awka
Anambra State, Nigeria

Abstract

This paper adopts the Optimality Theory (OT) in the analysis of the Igbo syllable structure. Using the OT framework, many Igbo polysyllabic words are analysed. The possible candidates are generated by GEN; the generated candidates are 'assessed' by the CON ranked in the order appropriate to the Igbo language. Finally, EVAL selects the optimal candidate, indicated by the pointing finger. The analysis shows that the theory (OT) is applicable to Igbo syllabification when the phonotatic constraints in the language such as NO CODA, NO CLUSTER, NO REP, VOW REC and ONSET are ranked in hierarchical order.

1.0 Introduction

Optimality Theory (OT) was introduced in the 1990s by Alan Prince and Paul Smolensky (1991; 1993). The model was elaborated in McCarthy and Prince (1993) and later in Prince and Smolensky (2004). The OT framework is widely used in phonological researches as well as in other areas of linguistic investigation such as morphology, syntax and semantics. Prince and Smolensky (1991; 1993) view OT as a theory of linguistic universals and universal grammar. For them, in the OT framework the grammars of all human languages share a set of constraints known as CON which, according to Trask (1996), is "assigned a pride of place in the OT framework."

The OT framework rests upon the principles that: universal grammar (UG) is made up of basically a set of constraints from which individual grammars are constructed to ensure well-formedness; the constraints in a grammar are generally not consistent in themselves, as they often make conflicting requirements; a grammar comprises constraints together with a general means of resolving conflicts in favour of analysis which best satisfies or least violates the conflicting constraints.
(http.://rm-f.net/pennywis/MITECS/Article/Smolensky2.html)

Goldsmith (1995) says that in Optimality theory, the output representation is selected by a set of well-formedness constraints that are ranked in a hierarchy of relevance, so that a lower ranked constraint may be violated in order to satisfy a higher ranked one. The main idea of the OT model is that the surface forms of language are realized from the resolution of conflicts between grammatical constraints. According to Mbah (2006:11), "The general idea of OT is that infinite set of candidate output forms given in input are

evaluated by grammar." For Kager (1999:15), "The central ideal of Optimality theory (OT) is that language is the domain of conflicting requirements, and grammars are language-specific ways to resolve such conflicts on the basis of a hierarchy of constraints.

These constraints are minimally violated since the form that surfaces is that form which incurs the least serious violation compared to a set of possible candidates. The seriousness of a violation is defined in terms of hierarchy of constraints, because the violation of higher ranked constraints is more serious and fatal. Thus, the violation of one higher ranked constraint is more serious than the violation of two or more lower ranked constraints. It should also be noted that since constraint ranking is language specific, syllabification is also language specific. See Figs 1 and 2 below. We list all the candidates vertically and the constraints horizontally. The constraints are arranged in a descending order from left to right such that the leftmost constraint is the highest ranked constraint while the rightmost constraint is the lowest ranked constraint. The cells contain violation marks incurred by each candidate for a constraint.

Constraints	C_1	C_2
Candidate (A)		**
Candidate (B)	*!	

Table 1: Table showing the candidates and constraints

The optimal candidate is (A) since it has no violation of the highest-ranked constraint (C_1), while its counterpart (B) has one violation which is fatal to it since the violation is of the highest-ranked constraint. Fatality is shown by the exclamation mark (!) while a violation is shown by an asterisk (*). We can observe that the optimal or best candidate in our tableau has two violations of (C_2); but this factor is insignificant, given that there is no candidate that has no violation of the two constraints. This shows that domination is strict to the extent that a candidate that incurs violations of some higher ranked constraint (on which another candidate incurs no violations) is mercilessly excluded, regardless of its relative well-formedness with respect to lower ranked constraint(s). According to De Lacy (2007:10), "Constraints are violable; the winner may - and almost certainly will- violate constraints". We must point out that constraints' ranking is language specific. A constraint that is ranked highest in one language could be ranked lowest in another. For instance, whereas NO CLST (NO CLUSTER) constraint that forbids consonant cluster is ranked among the highest in the Igbo language, it is ranked very low in English since the language permits consonant cluster. This is also true of NO CODA constraint that

forbids an Igbo syllable from ending in a consonant.

2.0 The basic tenets of OT and its essential components

According to Prince and Smolensky (1991; 1993), as cited in Goldsmith (1995: 357), "OT has four basic tenets". They are violability, ranking, inclusiveness and parallelism. On the issue of violability, OT operates on the principle that constraints are violable; but violations must be minimal. Ranking must be on language-specific basis; minimal violation (or best-satisfaction) of constraints is, as such, determined by this ranking. Concerning inclusiveness, OT has it that all the analyses of every candidate as based on the constraint hierarchy are admitted by the general considerations of structural well-formedness applicable to the particular language, without any form of repair strategies with regard to specific constraints. The principle of parallelism holds that the best-satisfaction of the constraint hierarchy is computed over the whole items on the hierarchy and the whole candidates in the set.

With the debut of OT in the early 1990s generative phonology (GP) has a matching competitor because of their obvious differences, though GP has contributed immensely in the phonological analysis of language. The phonological approach is moving away from rule-based theory to constraint-based one. The OT model of phonological analysis differs from the generative approach in the sense that whereas the generative framework embodies the derivation approach, OT uses a constraints-based approach. GP derives an output based on a series of processes that convert an underlying input to a surface phonetic output. It, therefore, embodies the derivation approach, whereby the output is usually the result of the application of a series of phonological rules that operate on an underlying form of a morpheme, generating at each stage of the derivation a specific output which in turn serves as an input to be operated upon by any following rules in the derivation process until the final output is achieved. By contrast, OT is a constraint-based approach which views constraints, generally governed by markedness principles, as universal and violable; the constraints being ranked relative to each other and according to their strength such that the optimal candidate best satisfies the constraints.

OT operates with three basic components which are the Generator, Evaluator and Constraints. They are usually and popularly referred to as the GEN, EVAL and CON respectively. GEN produces a number of potential outputs in that it generates the list of possible candidates that may come up as optimal candidate. EVAL spells out what it takes for an output to be optimal with respect to ranking of CON. It selects the optimal candidate from a set of candidates generated by GEN. EVAL acts as the policeman of the model, ruling which ranking of CON produces optimal output candidate (cf. Clark, Yallop & Fletcher, 2007).

According to Oyebade (2004:197) , EVAL determines the optimal candidate, which is

that candidate that best satisfies the constraint hierarchy; the 'best satisfaction' is seen as obedience to the highest ranked constraint or violation of lowest ranked constraint. Given two candidates, A and B, A is better than B on a constraint if A incurs fewer violations than B. Candidate A is better than B on an entire constraint hierarchy if A incurs fewer violations of the highest ranked constraint distinguishing A and B. A is optimal in its candidate set if it is better on the constraint hierarchy than all other candidates. For example, given constraints, C_1, C_2 and C_3, where C_1 dominates C_2, which dominates C_3 ($C_1 >> C_2 >> C_3$), A is optimal (shown with a pointing finger), if it does better than B on the highest ranking constraint which assigns them a different number of violations. If A and B tie on C_1, but A does better than B on C_2, A is optimal, indicated by the pointing finger, even if A has more violations of C_3 than B. The illustration is shown on the tableau below:

	C_1	C_2	C_3
☞ Candidate (A)	*	*	***
Candidate (B)	*	**!	

Table 2: A violation table

Once a candidate performs worse than another candidate on the highest ranking constraint distinguishing them, it incurs a crucial violation. There is no way for it to be optimal even if it out performs the other candidates on the rest of CON. Since it is that "shading emphasizes the irrelevance of the constraint to the fate of the candidate" (Goldsmith, 1995:358-359), a loser's cells are shaded after a crucial violation; the winner's when there are no more competitors.

CON can be defined as, "a structural requirement that may be either satisfied or violated by an output form" (Kager, 1999:5). CON are those rules in a language which the candidates generated by the GEN must obey for them to be well formed. If a form fully meets a structural requirement, it satisfies a constraint but if a form does not meet a necessary requirement, it violates a constraint. Every constraint is universal. As CON are the same in every language, what is particular to a language is the ranking. Thus, a language can have a particular hierarchy of universal constraints which another may not have since the constraint hierarchy adopted for a language is determined by the structural requirement of that language. Even if two of the constraints appear to be contradictory in a constraint hierarchy, as long as the right one is ranked higher than the other, both can co-exist in the same constraint hierarchy.

There are basically two different types of constraints: Faithfulness constraints, and Markedness (well-formedness) constraints. Faithfulness constraints ensure that there is no formal difference between an output form and its basic (underlying) form; such that segments that appear in the input must be preserved in the output. Examples of faithfulness constraints are MAX that forbids all deletions; IDENT (VOI) that declares that any segment that should appear in both input and output should have the same value of the voicing feature in both of its incarnations; and DEP which forbids all insertions.
On their part, markedness constraints enforce prosodic or segmental markedness, such as, 'syllables must have onsets' or 'syllables must not have coda.' All output are therefore evaluated and possibly penalized by markedness constraints if they exhibit certain configurations. Examples of markedness constraints stipulating what they either permit or forbid are shown below:

ONS	-Syllables must have onsets.
NO CODA	_Syllables must not have codas.
VOI	–Forbids voiced obstruents.
VTN	-Forbids voiceless obstruents.
NO REP	-Forbids replacement of sound segments by another.
NO CLST	- Forbids consonant cluster.

The syllable is a basic unit of speech studied at both phonetic and phonological levels of analysis. Just as the feet of metrical theory supply rhythmic organization to phonological strings, syllables can be viewed as the structural units providing melodic organization to such strings (Goldsmith, 1995:205-207). Meanwhile, the definition of syllable has been attempted by many authors through other different approaches: phonetically, phonologically, prominence theory, chest pulse theory, and sonority theory.

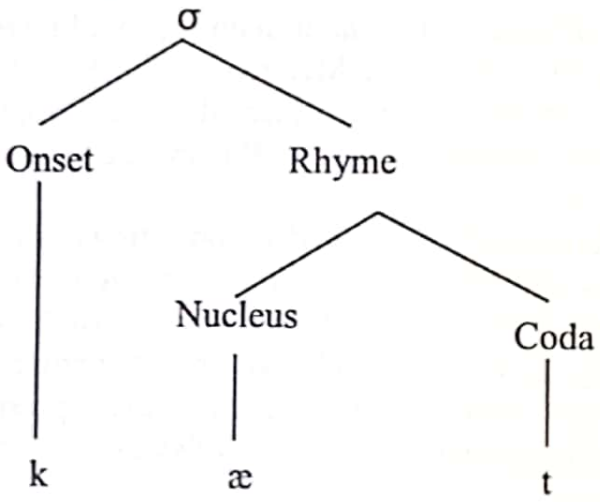
Phonetically, syllables "are usually described as consisting of a centre which has little or no obstruction to airflow and which sounds comparatively loud; before and after the centre there will be greater obstruction to airflow and/or less loud sound" (Roach, 2000:70). Phonologically, Laver (1994:114) defines the syllable as "a complex unit made up of nuclear and marginal element". According to the prominence theory which is based mainly on auditory judgement, the number of syllables in a word is determined by the number of peaks of prominence.

The chest pulse theory discusses the syllable in the context of muscular activities and lung movements in the process of speech. This approach, however, cannot account for cases when two vowels occur one after the other. For example, in words like 'seeing' or 'drying''; the second chest pulse might be almost irrelevant and thus lead erroneously to the conclusion that such English words consist of one syllable only. Another approach is presented by sonority theory according to which "the pulses of pulmonic air stream in

speech correspond to peaks in sonority" (Giegerich, 1992:132). The sonority of a speech sound is discussed as its relative loudness compared to other sounds.
The syllable is a well recognized unit in linguistic analysis which explains quite well the number of rhythmic units that will be perceived in a word or a longer utterance. This number is usually equal to the number of vowels in the utterance. Although it is usually easy to get agreement on the number of syllables present in a word, intuitions sometimes differ over where the boundaries between one syllable and another should be placed. The bulk of the present day phonological theory agrees that the syllable has constituent or hierarchical structure, rather than linear structure.

The syllable (conventionally marked as small Greek sigma σ) has two immediate constituents. They are the onset (O) which includes any consonant that precedes the nuclear element (the syllabic element), and the rhyme (R), which subsumes the nuclear elements (consonants) that might follow it. The rhyme, in turn, further branches into peak (P) also known as nucleus (N), and coda (Co). The peak (Nucleus), as the designation suggests, represents the 'nuclear' or most sonorous element in a syllable. The coda includes all consonants that follow the peak in a syllable.

Syllable structure may be represented graphically by means of a tree diagram as in the example for 'cat' /kæt/ shown below:



In the above illustration, the onset, peak and coda each consists of one segment: the consonant /k/ occupies the onset, the vowel /æ/ occupies the peak and the consonant /t/ is the coda of the syllable. However, there are syllables in English where either or both marginal elements (i.e. onset and/or coda) are absent. Only the peak is an obligatory element in the language, the onset and coda are optional. There are languages where the onset is obligatory, as well as such that allow no coda. A syllable that has no coda is called

an open syllable, while a syllable that has a coda is known as a closed syllable (cf. Anagbogu, Mbah and Eme, 2001).

3.2 The Igbo syllable structure

In every language, there is a pattern each syllable in that language would take. Sometimes, certain languages do not allow certain segments to begin or end a word. Some languages, like the Igbo language, do not accept consonant clusters. According to Emenanjo (1978), the Igbo syllable structure can be summarized as follows: $(C)^{T}_{S}$

(Where C=Consonant; ( ) = Optionality: This is to say that the onset is an optional element; S = Syllabic: The syllabic elements are vowels and the syllabic nasals. They are the tone-bearing units (TBUs) of the language. T=Tone. It is attached to TBUs only.) Core syllabification in Igbo is as follows:

V	i/ị 'you' ; o/ọ 'he/she/it'
CV	ri 'eat'; me 'do'
N	m 'me'

A combination of two or more of these syllables yields the polysyllabic words of the language. Extensive compounding, reduplication, affixation etc. can result in longer polysyllabic words than the instances we have given below:

VCV	ólú 'neck'; áká 'hand';
CVN	dúm 'all'; dím 'a title'
NCV	ḿbà 'no'; ńné 'mother'
VCVN	òdùḿ 'lion'; àniḿ 'female tortoise'
VCVCV	òkwùkwé 'faith'; ósísí 'stick'
VCVCVCV	ógólógó 'tallness'; ákịrịká 'dry leaves'

4.0 Applying OT to the Igbo syllable structure

In order to examine how optimality theory can be applied to the Igbo syllable structure, many Igbo words were collected and analysed. For want of space, we exemplify with the following nouns:

ēgō, ńnékwú, ìkùkù, ányàsì, àniḿ, ógwùmáàgàlà and ìkwìghìkwíghī.

The optimality theory can be applied to the syllable structures by generating the possible candidates, evaluating them with regard to the ranking of constraints, and establishing the optimal candidate. Let us consider the application to the items we have listed. The the optimal candidate. Let us consider the application to the items we have listed. The English gloss of the word, the constraints used, the ranking and the reason for the ranking are stipulated before each tableau for each item.

Item 1- égō 'money'

Constraints:

NO CODA- Syllables must not have codas.
ONS- Syllables must have onsets.
Ranking: NO CODA >> ONS
Reason: NO CODA is ranked highest because in Igbo closed syllables are not allowed and Igbo syllable may have an ONS.

égōō NO CODA >> ONS

/égo/		NO CODA	ONS
A	ég.o	*!	**
☞ B	é.go		**

Table 3 VCV

The optimal candidate here is "é. gō", indicated by the pointing finger. The minimal candidate is "ég.ō." This is because in the first syllable, it violates the highest ranked constraint (NO CODA); therefore is ruled out mercilessly. This is shown by the exclamation mark that accompanies the asterisk. The shaded parts show the irrelevance of the remaining constraint to the fate of the candidates.

Item 2- ńnékwú 'hen'
Constraint:
NO CODA- syllables must be open
NO CLST - forbids consonant cluster
NO REP- forbids replacement of a segment with another
ONS- syllables must have onsets
Ranking: NO CODA >> NO CLST >>NO REP>>ONS
Reason: Igbo forbids coda, cluster and replacement of a sound segment with another segment. However, since some sounds in the language have their optional variants, NO REP is ranked lower than NO CODA and NO CLST.
An Igbo syllable may not have ONS, hence it is the lowest ranked constraint among them.

ńnékwú NO CODA >> NO CLST >>NO REP>>ONS

/ńnékwú/		NO CODA	NO CLST	NO REP	ONST
a	ń.n.ékw.ú	*!*!			***
b	ń.né.kwú	*!			**
☞ c	ń.né.kwú				*
d	ńn.é.kwú	*!			**

Table 4. NCVCV

The optimal candidate here is ń.né. kwu while the minimal candidate is ń.ńé.kẇ.ú .The optimal candidate is recognized the pointing finger that is placed before it. Due to the violation of the highest ranked constraint (NO CODA) by the minimal candidate at the first and second syllables, it is therefore ruled out mercilessly. This is indicated by the exclamation marks that accompany the asterisks. The shaded areas indicate the irrelevance of the remaining constraints to the fate of the candidates.

Item 3 –ìkùkù (wind)
Constraints:

NO CODA syllables must be open
ONS syllables must have onsets.
VOW REC Each vowel sound produced must be recognized in a syllable.
Ranking: NO CODA >> VOW REC >> ONS
Reason: In Igbo language, closed syllables are not allowed and no one syllable should contain two or more outstanding vowel sounds; that is why NO CODA and VOW REC are ranked higher while ONST which an Igbo syllable may not have is ranked lower than NO CODA and VOW REC respectively.

ìkùkù: NO CODA >> VOW REC >> ONS

/ìkùkù/		NO CODA	VOW REC	ONS
a	ìk.ùkù	*!	*	
b	ìkù.kù		*	*
☞ c	ì.kù.kù			**

Table5: VCVCV

Here, the optimal candidate is "ì.kù.kù" which the pointing finger shows. "Ik.uku" is the minimal candidate because it violates the highest ranked constraint (NO CODA) and then is ruled out mercilessly. This makes the evaluation of VOW REC and ONS irrelevant and is shown by the cells being shaded. The exclamation mark which accompanies the asterisk indicates the outright ruling out of the candidate (NO CODA).

Item 4 ányàsị(night)

Constraints:

NO CODA_ syllables must be open.
VOW REC_ Each produced vowel sound must be recognized in a syllable.
ONST_ syllables must have onset.
Ranking: NO CODA >> VOW REC >> ONS
Reason: Igbo language forbids coda and demands that each produced vowel sound must be recognized in a syllable. Since an Igbo syllable may not have ONS, hence it is ranked lower than NO CODA and VOW REC.

Ányàs?NO CODA >> VOW REC >> ONST

	ányàs?	NO CODA	VOW REC	ONST
☞ a	á.nyà.sʔ			*
b	ányà.sʔ		*	*
c	ány.às ʔ	*!	*	

Table 6 VCVCV

"á.nyà.sị" is the optimal candidate here which is indicated by the pointing finger. The minimal candidate is "ány.àsị" because it violates the highest ranked constraint (NO CODA) in the first syllable. Therefore, this candidate is ruled out mercilessly. The exclamation mark that accompanies the asterisk shows that. The shaded areas show the irrelevance of the remaining constraints to the fate of the candidates.

Item 5 ànịḿ (female tortoise)

Constraints:

NO CODA syllables must be open
VOW REC Each produced vowel sound must be recognized in a syllable
ONS syllables must have onset.
Ranking: NO CODA >> VOW REC >> ONS

Reason: NO CODA is ranked higher than the ONS because in Igbo language, syllables are always closed. On the other hand, Igbo syllables may have an onset, or may not have it.

àṇḿ NO CODA >> ONST

àṇḿ		NO CODA	ONS
a	àn.ṇḿ	*!	
b	àṇ.ḿ		*
☞ c	à.ṇ.ḿ		* *

Table 7 VCVV

From what is presented in the diagram as shown by the pointing finger, the optimal candidate here is "à.ṇ.ḿ", while the minimal candidate is àn.ṇḿ". This is because the candidate "àn.ṇḿ" violates the highest ranked constraint (NO CODA) in the first syllable. Because of this violation, this candidate is ruled out rightly. The exclamation mark which follows the asterisk indicates that. The remaining constraints are not relevant to the fate of the candidates. The shaded parts show that.

Item 6 ógwùmáàgàlà (Chameleon) constraints;
NO CODA- syllables must be open.
NO CLST- Forbids consonant cluster.
VOW REC- each vowel sound produced must be recognized.
ONS- syllables must have onset.
Ranking: NO CODA >> NO CLST >> VOW REC >> ONS
Reason: Closed syllables are not allowed in Igbo. Therefore, NO CODA is placed higher than NO CLST. VOW REC is then ranked higher than ONS because Igbo forbids set of vowels in a syllable and ONS may or may not occur in a syllable

ógwùmáàgàlà – NO CODA >> NO CLST >> VOW REC >> ONS

ógwùmáàgàlà		NO CODA	NO CLST	VOW REC	ONS
A	ógw.ùmá.àg.àlà	*! *!		**	
B	ógwù.máà.gà.là		*	*	**
c	ó.gwù.má.àgà.là			*	*
☞ D	ó.gwù.má.à.gà.là				***

Table 8. VCVCVVCVCV

Following the diagram above, o.gwu.ma.a.ga.la is the optimal candidate. The finger points at it. The minimal candidate being ógw.ùmá.àg.àlà is ruled out rightly because it violates twice the highest ranked constraint (NO CODA) in the first syllable. The fatal violation is shown by the exclamation marks that come immediately after the asterisk. The rest of the cells for the minimal candidate are shaded showing that its evaluation for NO CLST, VOW REC and ONS are irrelevant.

Item 7 ìkwìghìkwíghī (owl)

Constraints
NO CODA – Syllables must be open
NO CLST – Consonants should not come consecutively
VOW REC – Each vowel sound produced must be recognized in a syllable.
ONS – Syllables must have onset.

Ranking – NO CODA >> NO CLST >> VOW REC >> ONS
Reason: Syllables are always closed in Igbo. That is why NO CODA is ranked higher than NO CLST. Because Igbo forbids more than one vowel to occur in a syllable, VOW REC is ranked higher than ONS which may or may not-occur in a syllable.

The optimal candidate according to the presentation above is ì.kwì.ghì.kwí.ghī which is indicated by the symbol of a finger pointing at it. ìkw.ì.ghì.kw.í.ghī on the other hand stands to be the minimal candidate which has the highest violation of the highest ranked constraint with ìkwì.ghì.kw.íghī but is ruled out because at the lowest constraint ONS, it has three violations while the later candidate has only two violations. The two named candidates have the same degrees of violations at all the constraints except ONS. Since ìkw.ì.ghì.kw.í.ghī is the minimal candidate, the rest of the cells are shaded showing that its evaluation for (ONS) is insignificant.

ìkwìghìkwíghī		NO CODA	NO CLST	VOW REC	ONS
A	ìkw.ì.ghì.kw.í.ghī	*! *!		**	***
B	ìkw.ghì.kw.íghī	*! *!		**	***
C	ì.kwì.ghì.kwí.ghī.				****
D	ìkwì.ghì.kwí.ghī				***

Conclusion

The paper has attempted an application of OT to the analysis of the Igbo syllable structure using mostly names. The analysis is made using the three basic components of OT which are: Generator (GEN) which generates the list of possible candidates that may come up as optimal candidate, Evaluator (EVAL) which spells out what it takes for an output to be optimal with respect to Constraint-ranking and Constraints (CON) which are
those rules in the language that the candidates generated by the GEN must obey for them to be well formed.

Each name mentioned is followed by certain rules (constraints) alongside with their respective evaluators. The constraints are therefore ranked hierarchically. For example,ń̄ị" the given constraints in fig 4. (NCVCV), NO CODA, NO CLST, NO REP and ONS where NO CODA dominates NO CLST which dominates NO REP and NO REP dominates ONS (NO CODA >> NO CLST >> NO REP >> ONS). The reason for the ranking is then given and finally in a tablau, the generated candidates and the constraints are presented with the syllable structure of each candidate shown in order to ascertain which violates the highest ranked constraint and which emerges as the optimal candidate.

From the analysis presented, it is observed that this theory (OT) can be applicable in the analysis of other phonological areas in the Igbo language such as vowel harmony, reduplication, toning etc. where certain phonotatic constraints exist, since it is constraint-based.

Although OT has many criticisms, most of them are based on fundamental misunderstanding of how it works. With a firm understanding of the OT framework scholars can apply the OT in the analysis of various aspects of the many languages of the world, including the Igbo language and other Nigerian languages.

References.

Anagbogu,P.N.,B.Mbah and C.Eme 2001. *Introduction to linguistics.* Awka: JFC Ltd.

Clark, J.C., C. Yallop and J. Fletcher. 2007. *An introduction to phonetics and phonology.*

(3rd edition). Cambridge: Blackwell Publishers.

De Lacy 2007. *Phonetics:An intrdoction*. Cambridge: Cambridge University Press.

Emenanjo, E.N. 1978. *Elements of modern Igbo grammar*. Ibadan: Oxford University Press.

Giegerich, A.C. 1980. *English phonology: An introduction*. Cambridge: Cambridge University Press.

Goldsmith 1995. *The handbook of phonological theory*. Cambridge: Blackwell Publishers.

Kager, R. 1999. *Optimality theory*. Cambridge: Cambridge University Press.

Laver, J. 1994. *Principles of phonetics*. Cambridge: Cambridge University Press.

McCarthy, J. and A/ Prince 1993. *Faithfulness and reduplication identity. Prosodic morphology. constraint interaction and satisfaction*. Constraint Book Manuscript, University of Massachusetts and Rutgers University.

Prince, A. and P. Smolensky. 1993. *Optimality theory: Constraint interaction in generative grammar*.Cambridge: Blackwell Publishers.

Roach, P.1996.*Phonetics and phonology*. Cambridge: Cambridge University Press.

Trask, R. L. 1996. *A dictionary of phonetics and phonology*. New York: Routledge .

http://rm-f.net/~pennywis/MITECS/Article/Smolensky2.html.
ROA=Rutgers optimality archieve,http//roa.rutgers.edu.

AWKA JOURNAL OF LINGUISTICS AND LANGUAGES

AJILL

Vol. 6, 2012

ISSN: 2006-120X