Journal of Child Language Acquisition and Development – JCLAD
Vol: 8 Issue: 4 144-161, 2020, December
ISSN: 2148-1997

Acquisition of complex coda and sonority among selected bilingual Nigerian children

Grace Boluwatife Olarewaju[1]
University of Ibadan
Adesina B. Sunday[2]
University of Ibadan

Received : 03.12.2020
Accepted : 25.12.2020
Published : 30.12.2020

Abstract

This study examined the role of sonority in the acquisition of complex coda by Yoruba-English bilingual children with a view to determining the way children rank constraints to arrive at their outputs. The study adopted Optimality Theory as the theoretical framework. A wordlist of about 100 words, complemented by relevant pictures, was used to collect the data for analysis. Spontaneous speeches were also collected. Ten Yoruba-English bilingual children made up the population. The data got were phonologically and acoustically analyzed. The children's grammar showed a preference for less sonorous consonants over highly sonorous consonants in coda clusters through deletion and substitution of segments. They also showed a preference for single consonants that are not highly sonorous at the coda. They violated *COMPLEX-CODA and sometimes NOCODA. The grammar of the Yoruba-English bilingual child does not allow for the formation of coda clusters. This may be as a result of the influence of the indigenous language.

Keywords: Sonorous consonants, Coda clusters, Yoruba-English bilingual child, Optimality Theory, Children's grammar

1. Introduction

Effective communication, which is a necessity in any human society, is made possible through the use of language. Language cannot be divorced from human interaction and society. This necessitates the need to acquire language. Human beings have the innate ability to acquire language as proposed by Noam Chomsky (Chomsky, 1975; Sunday, 2020). This inborn ability has made the process of language acquisition easy for normally developing children. Human beings acquire language at various stages of life but this study focused on bilingual first language acquisition.

Language acquisition deals with the processes involved in language development. It refers to a natural process whereby children develop language ability in their first language effortlessly, as they do not need to

[1] Bio: Grace Boluwatife Olarewaju is a PhD student in the Department of English, University of Ibadan, Ibadan, Nigeria. Her research interests cover Child Language Acquisition and English Phonology and Phonetics.

[2] Bio: Adesina Bukunmi Sunday is a Senior Lecturer in the Department of English at University of Ibadan, Ibadan, Nigeria. He specializes in Neurolinguistics, English Phonology and Phonetics, and Pragmatics. He has published in reputable journals, like *English Today*, *Journal of Pragmatics*, *HUMOUR: International Journal of Humor Research,* and *SKASE Journal of Theoretical Linguistics.* Corr. author: sinadaybuk@gmail.com

deliberately learn the grammar of the language (Adegbite, 2009; Meisel, 2011). In the study of language acquisition, children have been discovered to be able to learn as many languages as they are exposed to. As a result of this, children become bilinguals/multilinguals at a very young age. This produces what is called Bilingual First Language Acquisition (BFLA). This is the subconscious simultaneous acquisition of two languages by children who have been consistently exposed to both languages (Itani-Adams, 2007; Ramirez and Kuhl, 2016). The phonological repertoire of bilingual children is determined by the languages that they are exposed to (Gildersleeve-Neumann et al., 2008). There is no limit to this repertoire.

In discussing the phonology of any language, the syllable is germane, particularly when speech is the focus. This is because it gives insights into the phonotactics of the language. Syllables are made up of speech sounds or phonemes; the arrangement of the phonemes is determined by the language. Languages vary as to which type of speech sounds are allowed to occur in which position of the syllable. The syllable is made up of onset, nucleus/peak and coda. Only the nucleus/peak is obligatory. At times, the nucleus/peak and coda are collapsed to form rhyme, in which case, the syllable now has two components, namely onset and rhyme (Gussenhoven and Jacobs, 2005; Clark, Yallop, and Fletcher, 2007; Gut, 2009).

To determine how bilingual children acquire a language that permits the production of complex coda, this study investigated the production of complex coda by Yoruba-English bilingual children. The Yoruba syllable does not permit consonant cluster. Conversely, English permits optional consonants of up to four in the coda position. The way a Yoruba child acquires English coda will reveal some insights on cluster acquisition and the manipulation of two different syllable systems by a child. The purpose of this study is to unravel how children rank and re-rank constraints in their production of complex coda and their judgement of sounds based on the level of sonority.

For ease of understanding, there is a need to briefly examine the English and Yoruba phonological systems.

1.1. *Phonology of Yoruba*

Yoruba phonology has been greatly studied by language scholars over time (Oyebade, 2010). Yoruba, like every other language, has its sound system. The Yoruba sound system contains eighteen consonants, seven oral vowels, and five nasal vowels. The consonant sounds in Yoruba are /b, t, d, k, ɡ, kp, ɡb, f, s, s̩, h, m, n, r, l, w, j/. The Yoruba vowel system consists of seven oral vowels and five nasal vowels. The oral vowels are /i, e, e̩, a, o̩, o, u/. The nasal vowels are /ĩ, ɛ̃, ã, õ, ũ/ (Oyebade, 2010; Arokoyo, 2012; Ogundepo, 2015). Yoruba does not distinguish between long and short vowels. The Yoruba sound system does not permit clusters (Ogundepo, 2015).

According to Wachuku (2008:131), "the syllable structure refers to the way vowels and consonants are arranged to form a syllable." That is the specific arrangement of consonants and vowels to form a syllable with adherence to what is permissible in the language. The grammar of Yoruba permits only open syllables. This means that it does not permit syllables to have codas.

By implication, Yoruba disallows consonant clusters. The Yoruba syllable structure permits V, VCV, CV, and CVN structures. The syllable bears the tone in the language. The language has monosyllabic, disyllabic and polysyllabic words (Abiodun, 2010; Orie, 2012; Arokoyo, 2012).

1.2. Phonology of English

The English language has twenty-four consonants and vowels. The vowels comprise twelve monophthongs, eight diphthongs and five triphthongs (Ladefoged, 2001; Osisanwo, 2012). The consonant sounds in English are /p, t, k, b, d, g, f, v, ɵ, ð, s, z, ʃ, ʒ, h, m, n, ŋ, r, l, w, ʧ, ʤ, j/. The English vowel system consists of twelve monophthongs /i, i:, e, u, u:, a, æ, ɔ, ɔ:, ʌ, ɜ:, ə/. These monophthongs are further classified into long and short vowels. It also contains eight diphthongs /ei, iə, eə, ai, au, əu, uə, ɔi/ and five triphthongs /eiə, aiə, ɔiə, əuə, auə/ (Roach, 1997; McCully, 2009).

1.3. Syllable and Sonority

As noted by Gut (2009), the phonotactic structure of syllables is usually described with reference to the sonority of the phonemes involved. The sonority of a sound refers to the relative loudness of one sound in comparison to other sounds and speech sounds are often described in terms of their degree of sonority (Giegerich, 1992; Ladefoged, 1993). The sonority of English speech sounds is represented on a sonority scale (Gut, 2009). In the formation of syllables, speech sounds are organized based on two criteria, which are Sonority Sequencing Principle and Sonority Distance. The arrangement of segments on the sonority scale ranges from the sounds with a high degree of sonority to sounds that are less sonorous.

Oral stops		Fricatives		Nasals	Liquids		Semi-Vowels	Vowels	
Voiceless	Voiced	Voiceless	Voiced					High	Low
p	b	f	v	m					
t	d	t	ð	n			j	¡	a
k	g	s	z	ŋ	l	r	w	u	ɑ

s o n o r i t y →

Figure1. Sonority scale
Source: Adapted from Giegerich (1992:133)

The sonority scale presented above reveals the role of natural classes in the description of sonority. These natural classes have distinctive features that make it easy to describe them in any phonological analysis. According to Chomsky and Halle (1968), distinctive features are the minimal elements of which phonetic, lexical, and phonological transcription are composed, by combination and concatenation (Sunday, 2014). Some of the distinctive features relevant to this study are examined here. The classification is based on the works of scholars such as Chomsky and Halle (1968), and Schane (1973) and Giegerich (1992):

i. SONORANT: Vowels, nasals, liquids and semi-vowel are [+sonorant] while stops, fricatives, affricates and laryngeal glides are [-sonorant].

ii. CONTINUANT: [+continuant] are approximants and fricatives while stops and affricates (oral and nasal) are [-continuant].

iii. CONSONANTAL: The sounds that are [+consonantal] are stops, fricatives, affricates, nasals and liquids while laryngeal glides, vowels, and semi-vowels are [-consonantal].

iv. SYLLABIC: This feature is needed to differentiate syllabic nasals and liquids from their non-syllabic counterparts. Vowels, syllabic nasals, and syllabic liquids are [+ syllabic] while obstruents, non-syllabic nasals, glides, and non-syllabic liquids are [-syllabic].

v. VOCALIC: [+vocalic] are vowels and liquids while [-vocalic] are glides, nasal, obstruents, devoiced vowels and devoiced liquids.

vi. NASAL: Nasal consonants are [+nasal] while oral consonants are [-nasal].

1.4. Theoretical Framework: Optimality Theory

Optimality Theory (OT) is a theory that accounts for the workings of every language. It assumes that constraints, which are violable, are essentially universal; as such, are present in every language. In other words, constraints are universal. However, the point of divergence in languages is the order in which the constraints are ranked in each language. This theory, as proposed by Alan Prince and Paul Smolensky (1993), reflects the resolution of conflicts among competing constraints (Kager, 1999; Oyebade, 2008; Sunday, 2013a; 2013b; 2013c; Sunday and Oyatokun, 2016; Sunday and Olarewaju, 2020).

There are core mechanisms in OT. These are Generator (GEN) and Evaluator (EVAL). GEN generates output forms based on the linguistic input. EVAL evaluates the candidates generated by GEN to choose the most harmonic candidate. It selects the optimal candidate by considering a set of ranked, violable constraints. The role of EVAL is to assess the harmony of outputs with respect to a given ranking of constraints. Some constraints are considered to be more important than others as a result of domination (dominance relation). These mechanisms are interrelated (McCarthy and Prince, 1995; Kager, 1999).

Constraints (CON) are used to test the well-formedness of the set of candidates in relation to what is acceptable in the grammar of each language. Constraints are hierarchically ordered from the highest to the lowest and they can be violated. There are two major types of constraints: faithfulness and markedness. Faithfulness constraints require the mapping of the input form to the output form, while markedness constraints forbid grammatically ill-formed structures (McCarthy, 2002).

2. Methodology

The methodology of the research should be detailed very clearly referring to relevant theories.

2.1. Participants

The data used for analysis were collected from ten Yoruba-English bilingual children between the ages of one year, seven months (1;7) and five years (5;0) at the start of the data collection. Yoruba is predominantly spoken in the south-western part of Nigeria. The participants were selected from different schools across different local government areas in Ibadan, the capital of Oyo State, south-western, Nigeria.

2.2. Socio-demographic Analysis of the Participants

The participants were three males and seven females. They were in the age range of 1 year, 7 months and five years. All of them were Yoruba-English bilinguals. The participants were put in five groups, made up of two participants each (1; 7, 2, 3, 4, and 5). The first group was for children that were one year, seven months old. The second group was for the respondents who were two years old. The third group catered for the respondents who were three years old. Those children who were four years old formed the fourth group. The last group consisted of the children who were five years old. Each of the groups comprised two children.

Table 1
Demography of the Participants

Subject	Age (at the outset)	Languages	Group
S1	1 year, 7 months	English and Yoruba	1
S2	1 year, 7 months	English and Yoruba	
S3	2 years, 3 months	English and Yoruba	2
S4	2 years, 1 month	English and Yoruba	
S5	3 years, 1 month	English and Yoruba	3
S6	3 years	English and Yoruba	
S7	4 years	English and Yoruba	4
S8	4 years	English and Yoruba	
S9	5 years	English and Yoruba	5
S10	5 years	English and Yoruba	

2.3. Data collection and processing

The respondents were visited three times a week for data collection. The entire study lasted eight weeks. Age and simultaneous bilingualism were the criteria employed in grouping the participants. For accuracy and reliability of data, strictly simultaneous bilingual children were sampled; they were bilingual in Yoruba and English before the age of three years. The study employed both longitudinal and cross-sectional designs. A wordlist of about 100 words, complemented by relevant pictures, was used to elicit the data for analysis from the participants. Additional data were collected from spontaneous speech of the respondents. The words were tested across the different age groups to know the structures that each group had acquired at their different ages. For each word, two tokens were got from two subjects across all age groups. The forms presented were chosen based on the age of the subject who produced it and the similarity between the two tokens got from the subjects who represented a particular group. The subjects' renditions are generally presented under each tableau to show the progressive nature of the grammar of the children.

2.4. Data analysis

Perceptual and acoustic analyses were carried out, with Optimality Theory used for explanation of the observable patterns. The syllable patterns made by the children were grouped into stages in line with to the available age groups. Instances of occurrences of each syllable were then identified. The items that were repeated by the participants were not considered for analysis, except if there was variation in their renditions. Phonetic transcription was done for the sake of accurate description.

2.5. Realization of Coda Clusters

This section captures the analysis and interpretation of the data collected. Both regular patterns and variations in the renditions of the participants were identified. Nineteen English words were used to test the acquisition of coda clusters by the children: *drink, translation, instruct, aspect, point, hand, thank, jump, translation, strange, want, socks, round, front, branch, flask, plant, task,* and *strength.* Only one category of coda clusters was tested: two-consonant clusters. Different structures were considered in order to test if onset clusters affect the production of coda clusters in words that have coda clusters.

For the OT analysis, the following constraints were deployed:

a) ONSET: This constraint was suggested by Prince and Smolensky (1993) and it stipulates that every syllable must have an onset. A syllable must begin with a consonant. This constraint captures the universal preference of language for CV syllables (McCarthy, 2008).

b) NOCODA: This constraint was also proposed by Prince and Smolensky (1993) and it prohibits closed syllables while maximizing open syllables. A syllable must not end with a consonant sound. It stipulates that syllables do not have codas.

c) MAX (or MAX-IO): This requires the input segments to appear in the output. It forbids deletion of segments (Kager, 1999).

d) *COMPLEX-ONSET: It does not permit clusters at onset (McCarthy, 2008).

e) *COMPLEX-CODA: It forbids complex stringing of sounds at coda (McCarthy, 2008).

3. Findings

3.1. CC-Clusters

The section presents the analysis of English words with two final-consonant clusters. The analyses of four of these words are presented below.

3.2. Analysis of 'jump'

Jump is phonemically represented as /ʤʌmp/. It is graphically represented based on the hierarchy of the sounds on the sonority scale as:

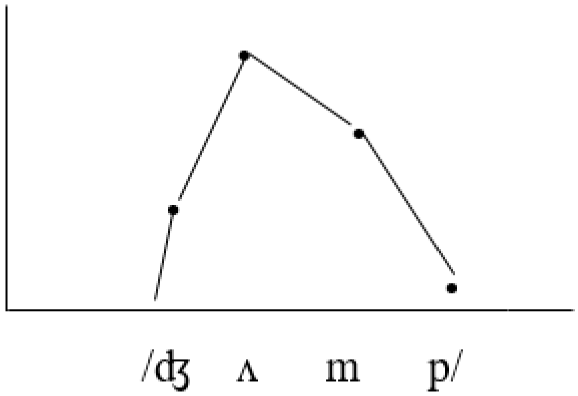

Figure 2. Sonority Scale of *jump*

The sonority scale shows that /ʤ/ is less sonorous than /ʌ/, which is more sonorous than /m/ and /p/.

With respect to the acquisition of the CVCC-cluster, the children in groups 1, 2, and 3 (60% of the participants) could not properly articulate *jump* as [ʤʌmp] but as [ɛʃ] while the other four subjects pronounced it as [ʤɔmp]. Those who pronounced /ʤʌmp/ as [ɛʃ] reduced the entire syllable into something different from the input, thereby reducing it from its original CVCC structure to a CV type. The syllable was replaced with two new sounds: the open-mid front unrounded vowel /ɛ/ and the voiceless postalveolar fricative /ʃ/. The latter sounds are sonorous sounds; as such, this may be responsible for the replacement. It also shows that only the subjects who were between ages three and five have acquired the CVCC syllable type. The OT account of *jump* as pronounced by the participants is shown below:

Tableau 1
The emergence of /ɛʃ/

Input / ʤʌmp/ → Output / ɛʃ/

/ ʤʌmp/	*COMPLEX-CODA	*MAX	ONSET	NOCODA
(i) ʤɔmp	*!	*!		
(ii) ʤʌmp	*!	*!		
☞(iii) ɛʃ			*	*

Constraint ranking: *COMPLEX-CODA>> *MAX >> ONSET >> NOCODA

Optimal candidate: /ɛʃ/

Tableau 1 above presents the analysis for the production of /ʤʌmp/ with respect to the emergence of the optimal candidate for the majority of the participants. The constraints involved in the analysis are *COMPLEX-CODA, *MAX, ONSET, and NOCODA. The grammar showed a preference for non-clusters over clusters. And this is essentially the same in Levelt, Schiller, and Levelt's (2000) study. The participants also simplified the word using both deletion and substitution. There is actually no correlation between the output form and the input form. The constituents are entirely replaced with other sounds. Candidate (i) and candidate (ii) are similar except for difference in the vowel used. They violate the highest ranked constraints, thus incurring a fatal violation for each of the constraints. However, they both obey ONSET and NOCODA. Candidate (iii), which is the optimal candidate, obeys the two highly ranked constraints and violates the two constraints that are lowly ranked. The voiced palato-alveolar affricate /ʤ/ in the onset position and the open central neutral vowel /ʌ/ are replaced with the half-open front spread vowel /ɛ/ with the features [+ vocalic, + sonorant, -consonantal], while the bilabial nasal /m/, with features [-continuant, + sonorant], and the voiceless bilabial plosive /p/, with features [+obstruent, -continuant, +consonantal, -voice], that made up the /-mp/ cluster were replaced with the voiceless palatal-alveolar fricative /ʃ/ with features [+ continuant, -sonorant]. The production shows the constraint ranking as: *COMPLEX-CODA >> *MAX >> {ONSET >> NOCODA}.

Below is the Praat image of /ɛʃ/:

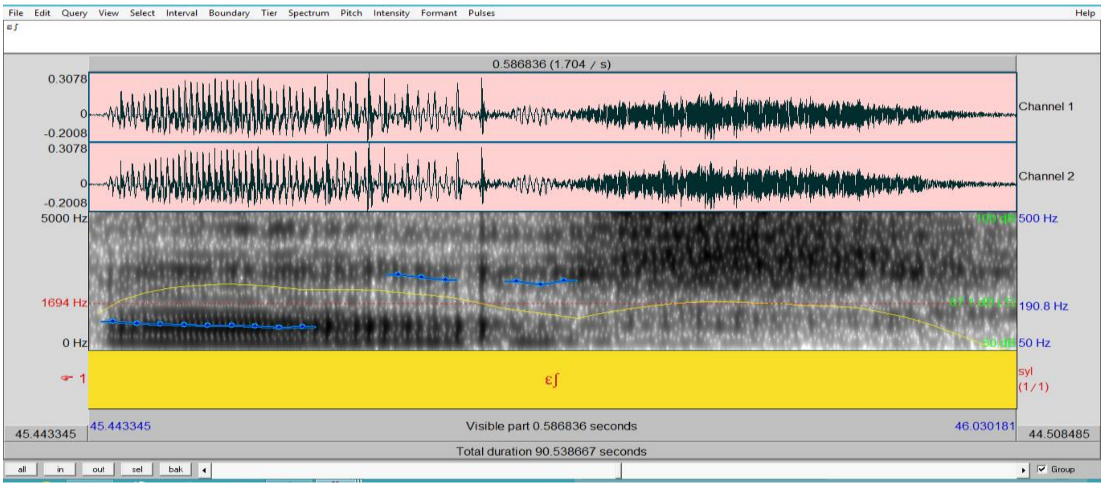

Figure 3. Praat image of jump

This Praat image shows the frequency and intensity values for jump as pronounced by a year, seven months old subject which is a representation of the production of the subjects in groups 1, 2, and partly 3. This monosyllabic word has an intensity value of 67.1 dB and a frequency of 190.8 Hz. The values are given to guide in the interpretation of the spectrogram.

3.3. Analysis of 'translation'

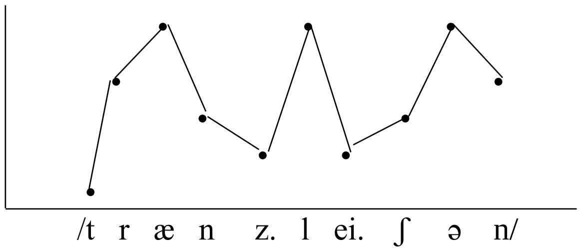

Figure 4. Sonority scale of *translation*

The scale is a graphical representation of the level of sonority of each of the speech sounds that make up the syllables in *translation*. The sonority scale reveals that /t/ is less sonorous than /r/, which is less sonorous than /æ/, which is more sonorous than /n/ and /z/. In the second syllable, /l/ is less sonorous than /ei/. In the third syllable, /ʃ/ is less sonorous than /ə/, which is more sonorous than /n/. It can be deduced that plosives and fricatives are lowly ranked on the sonority hierarchy, nasals are ranked higher than plosives and fricatives, while glides and vowels are highly ranked.

The first syllable in the word *translation* has the CCVCC structure. In the production of *translation,* five (50%) participants realised it as [t^hæleɪʃən], one (10%) participant pronounced it as [t^hænleɪʃən] and four (40%) participants produced it as [t^hrænzleɪʃən].

Tableau 2
The emergence of /t^hæ.lei. ʃən /

Input /trænz.lei. ʃən/ → Output /t^hæ.lei. ʃən /

/trænz.lei. ʃən/	*COMPLEX-ONSET	*COMPLEX-CODA	NOCODA	MAX
☞ (i) t^hæ.lei. ʃən			*	*
(ii) trænz.lei. ʃən	*!	*!	**	

Constraint ranking: *COMPLEX-ONSET >> *COMPLEX-CODA >> NOCODA >> MAX
Optimal candidate: /t^hæ.lei. ʃən /

Tableau 2 above shows the constraint ranking for the production of *translation* by the majority of the participants. Particular focus is on the first syllable, which has a complex coda. The constraints involved are *COMPLEX-ONSET, *COMPLEX-CODA, NOCODA, and MAX. They are hierarchically ranked as: *COMPLEX-ONSET >> *COMPLEX-CODA >> NOCODA >> MAX.

These participants prefer unmarked structure in the onset position. Candidate (i) violates highly ranked constraints: *COMPLEX-ONSET and *COMPLEX-CODA. The former forbids clusters in the onset, while the former bans clusters from appearing in the coda position. The first syllable in translation has an initial CCVCC structure which is simplified in the optimal output form to a CV structure. In onset position, the voiced alveolar trill /r/ is deleted, while the voiceless alveolar stop, which is the least sonorous of the pair, is retained. Similarly, the alveolar nasal /n/, with features [-continuant, +sonorant], and the voiced alveolar fricative /z/, with features [+ continuant, -sonorant, +voice], were deleted in coda position. Candidate (i) emerged as the optimal candidate despite its violation of NOCODA and MAX. Candidate (ii) fatally violates highly ranked constraints *COMPLEX-ONSET and *COMPLEX-CODA. Consequently, it is outright eliminated from further evaluations.

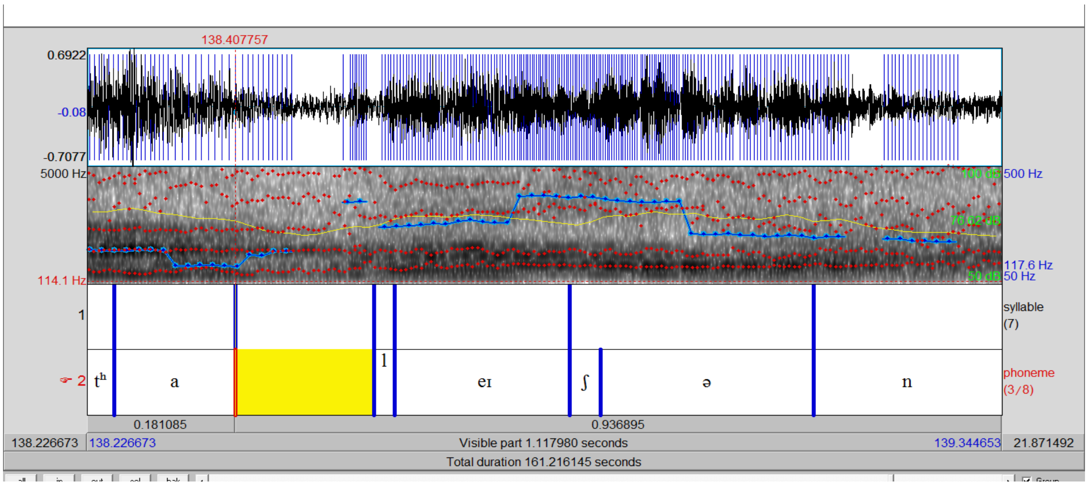

Figure 5. The spectrogram of translation

This image above is a spectrogram of translation as produced by a participant in group 1 and it is a representation of most of the children's rendition of the word.

3.4. *Analysis of 'front'*

Front is phonemically represented as /frʌnt/ and it is graphically represented on the sonority scale as:

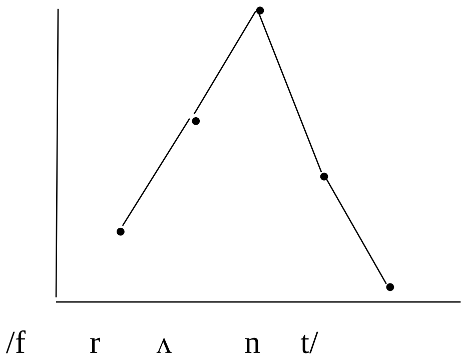

Figure 6. Sonority Scale of *front*

Journal of Child Language Acquisition and Development – JCLAD
Vol: 8 Issue: 4 144-161, 2020, December
ISSN: 2148-1997

The sonority scale shows that /f/ is less sonorous than /r/, which is less sonorous than /ʌ /. While /n/ is less sonorous than /ʌ/, it is more sonorous than /t/. /ʌ/ has the highest degree of sonority.
Four (40%) out of the children used for this research pronounced *front* as [tʰɔt], while another two (20%) pronounced it as [frɔt] and others (40%), who were older, with almost adult proficiency, pronounced it as [frɔnt]. Those who pronounced it as [tʰɔt] were between ages of 1 years, 7 months and 2 years, 3 months at the time of data. Those who pronounced the word as [tʰɔt] reduced the entire syllable into something different from the input, thereby reducing it from its original CCVCC structure to a CVC type. The syllable was replaced with new sounds at onset and coda. For the complex coda [-nt], the voiceless alveolar stop /t/, with features [+obstruent, +consonantal, -sonorant], which is the less sonorous sound, is retained while the alveolar nasal /n/, with features [-obstruent, +consonantal, +sonorant, +continuant, +nasal], is deleted. The OT account of *front* is shown below:

Tableau 3
The emergence of [tʰɔt]

Input / frʌnt / → Output [tʰɔt]

/ frʌnt /	*COMPLEX-ONSET	*COMPLEX-CODA	ONSET	NOCODA	MAX
☞ (i) tʰɔt				*	**
(ii) frʌnt	*!	*!		*	
(iii) frɔnt	*!	*!		*	*

Constraint ranking: *COMPLEX-ONSET >> *COMPLEX-CODA >>ONSET>> NOCODA >> MAX
Optimal candidate: [tʰɔt]

Tableau 3 above presents the constraint ranking for the emergence of [tʰɔt] as the optimal candidate. The constraints involved are *COMPLEX-ONSET, *COMPLEX-CODA, ONSET, NOCODA, and MAX. The subjects, in simplifying the coda cluster /-nt/, deleted the sound with high sonority /n/ while retaining the one that is less sonorous /t/. This nasal-stop cluster obeys the sonority condition which prescribes that the first consonant in a complex coda must be less sonorous than the second. The grammar of the children in these age groups (1; 7 - 2; 3) selects the sound that is least sonorous in a cluster situation at coda position. This phenomenon is observed in the works of Levelt et al. (2000) and Kappa (2002). The subjects' preferred means of satisfying *COMPLEX-CODA is through deletion. In the bid to obey *COMPLEX-CODA, the production is unfaithful to the input form and, as such, violates MAX. Any attempt by the subjects to preserve both consonants at the coda position will result in the violation of the highest ranked constraint *COMPLEX-CODA, which will lead to the disqualification of the candidate. This is the case with candidates (ii) and (iii). By violating *COMPLEX-CODA, candidates (ii) and (iii) are knocked out of the competition. Candidate (i) emerges as the optimal candidate, having obeyed the highest ranked constraint, but violates constraints *NOCODA, ONSET, and MAX.

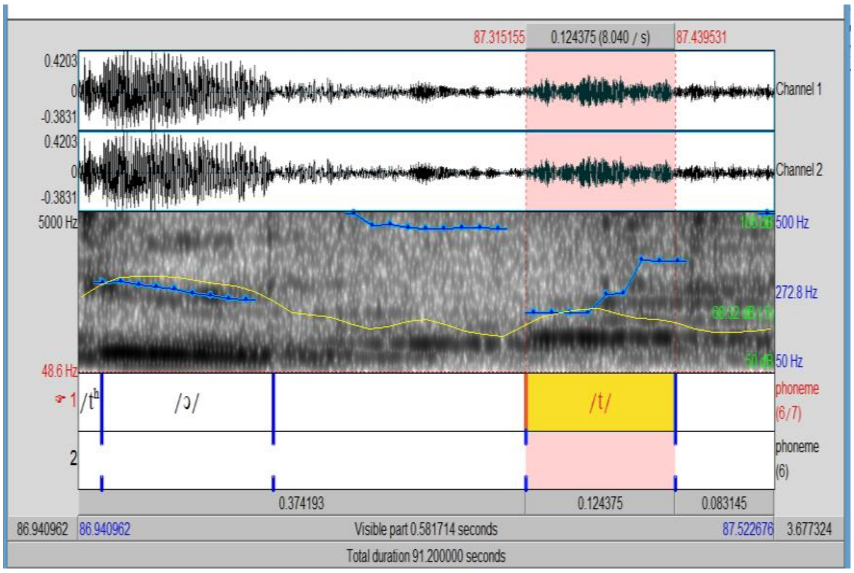

Figure 7. Praat image of *front*

The waveform illustrates the production of *front* as enunciated by one of the subjects and it represents the production of the majority of the participants, especially those in groups 1, 2, and 3.

3.5. *Analysis of 'branch'*

This is the phonemic representation of /brɑːnʧ/ and it is graphically represented on the sonority scale as:

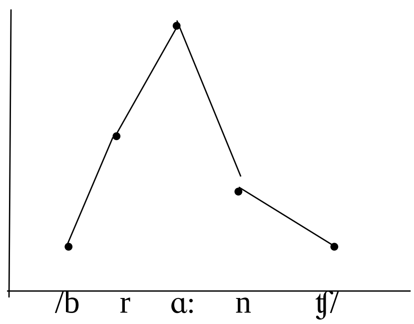

Figure 8. Sonority Scale of *branch*

The sonority scale shows that /b/ is less sonorous than /r/, which is less sonorous than /ɑː/. While /n/ is less sonorous than /ɑː/, it is more sonorous than /ʧ/.

In the rendition of *branch,* two of the groups (40%) pronounced it as [tʰA:t], while the production of the word by those in the third group (20%) was not clear, thus could not be presented. The other two groups (40%) pronounced it as [brɑːnʧ] because they can be said to have attained adult-like use of the language. Those who pronounced it as [tʰɑːt] reduced the entire syllable into something different from the input form, thereby reducing it from its original

CCVCC structure to a CVC type. They simplified the structure through deletion and substitution. For the complex coda [-nʧ], the alveolar nasal /n/ with features [+consonantal, +sonorant, +nasal], which is the more sonorous sound, is deleted, while the post-alveolar affricate /ʧ/, with features [+obstruent, +consonantal, -continuant, +coronal, -voice], is deleted and replaced with /t/, with features [+obstruent, +consonantal, -voice]. The subjects' grammar shows a preference for less sonorous sounds over sounds that are highly sonorous. The OT account of *branch* is shown below:

Tableau 4
The emergence of [t^hɑ:t]

Input /brɑ:nʧ/ → Output [t^hɑ:t]

/brɑ:nʧ/	*COMPLEX-CODA	*COMPLEX-ONSET	ONSET	NOCODA	MAX
☞ (i) t^hɑ:t				*	**
(ii) brɑ:nʧ	*!	*!		*	

Constraint ranking: *COMPLEX- CODA >> *COMPLEX-ONSET >>ONSET>> NOCODA >> MAX
Optimal candidate: [**t^hɑ:t**]

Tableau 4 above shows how [t^hɑ:t] emerged as the optimal candidate. The constraints involved are *COMPLEX-CODA, *COMPLEX-ONSET, ONSET, NOCODA, and MAX. In order to simplify the cluster /-nʧ/, the alveolar nasal /n/, with features [+consonantal, +sonorant, +continuant, +nasal], and the voiceless post-alveolar affricate /ʧ/, with features [+obstruent, +consonantal, -sonorant, -continuant, +coronal, -voice], were deleted and replaced with a less sonorous sound /t/, with features [+obstruent, -continuant, -voice]. This is in accordance with the sonority condition, which states that the first consonant in a complex coda must be less sonorous than the second. In the bid to obey *COMPLEX-CODA, the subjects' output is unfaithful to the input form, thereby violating MAX.

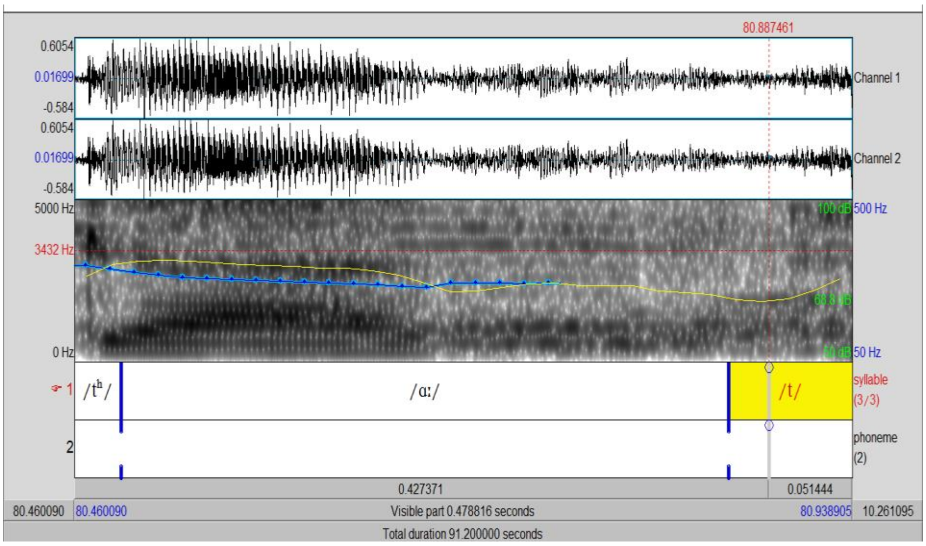

Figure 9. Praat image of *branch*

The image in Figure 9 is a waveform of branch as produced by the subjects in group 1 and group 2, which is a reflection of the children's speech production.

3.6. Analysis of 'socks'

The phonemic representation of socks is /sɔks/; it is graphically illustrated on the sonority scale as:

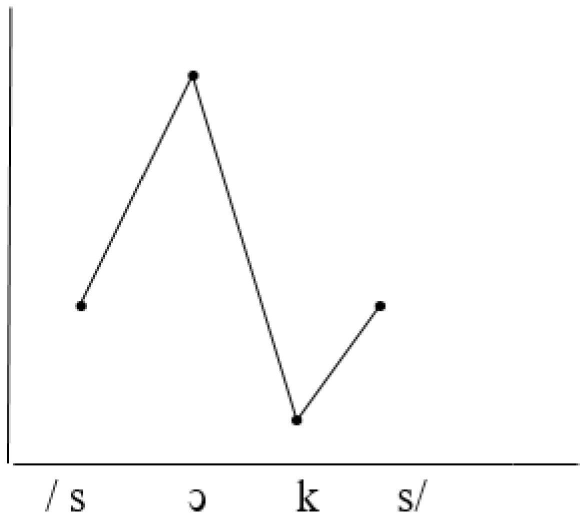

Figure 10. Sonority Scale of *socks*

The sonority scale shows the sonority hierarchy of each sound that make up the word. Going by the graphical representation above, the voiceless alveolar fricative /s/ is less sonorous than /ɔ/, which is often described as open back rounded vowel. The voiceless velar stop /k/ is lowly ranked on the sonority scale.

Socks was pronounced as [tʰɔk] rather than /sɔks/. The participants who pronounced it as [tʰɔk] simplified the word by deleting one of the sounds that make up the cluster at coda [-ks]. The voiceless velar stop /k/, with features [+obstruent, +consonantal, -sonorant, -voice], which is the less sonorous sound of the two, is retained, while the voiceless alveolar fricative /s/, with features [+consonantal, -sonorant, +continuant, -voice], is deleted and replaced with /t/, which has features [+obstruent, +consonantal, -sonorant, -voice]. The subject's grammar shows a preference for less sonorous sounds over highly sonorous sounds. The OT account of *socks* is shown below:

Journal of Child Language Acquisition and Development – JCLAD
Vol: 8 Issue: 4 144-161, 2020, December
ISSN: 2148-1997

Tableau 5
The emergence of [tʰɔk]

Input /sɔks/ → Output [tʰɔk]

/sɔks/	*COMPLEX-CODA	*COMPLEX-ONSET	ONSET	NOCODA	MAX
(i) sɔks/	*!			*	
☞ (ii) tʰɔk				*	**

Constraint ranking: *COMPLEX- CODA>>*COMPLEX-ONSET>>ONSET>> NOCODA >> MAX
Optimal candidate: [tʰɔk]

As seen in Tableau 5, candidate (i) violates the highest ranked constraint, thereby incurring a fatal violation. Conversely, candidate (ii) violates two lowly ranked constraints, NOCODA and MAX, but did not violate the highly ranked constraints. However, in spite of the violation of two constraints, candidate (ii) emerges as the optimal candidate. In the bid to simplify the coda cluster /-ks/, the voiceless velar stop /k/, with features [+obstruent, +consonantal, -sonorant, -voice], was retained, while the voiceless alveolar fricative /s/, with features [+consonantal, +continuant, -voice], was deleted. This is in tandem with Salami's (2004) study that establishes the fact that children employ different phonological processes, such as deletion, to reduce existing structures into their preferred structures. In the bid to obey *COMPLEX-CODA, the subject's output is unfaithful to the input form, thereby violating MAX. Below is the spectrograph of *socks*:

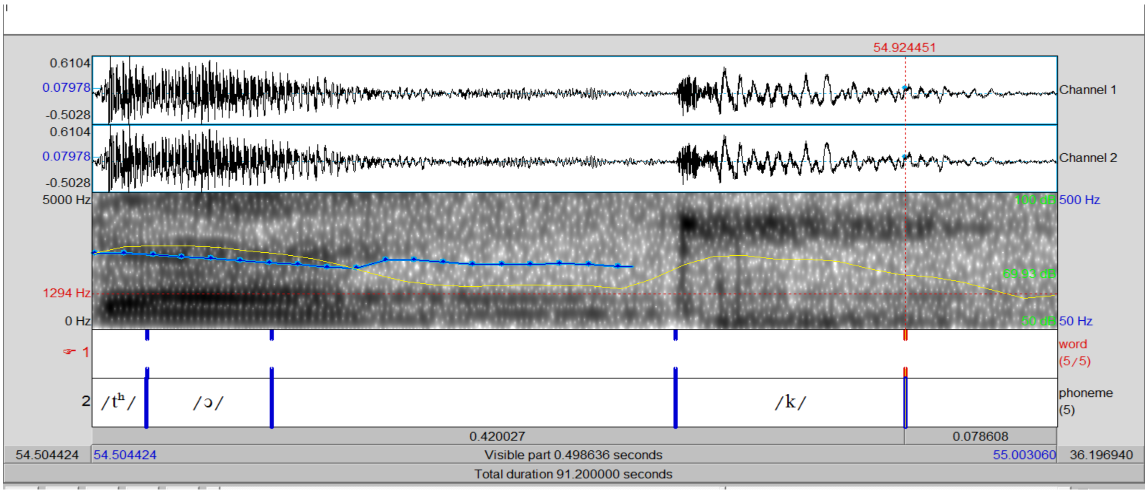

Figure 11. Praat image of *socks*

The waveform indicates that each segment is produced with a different degree of prominence with the nucleus of the syllable having the highest degree of prominence.

4. Conclusion

This paper examined the production of consonant clusters at the coda position in relation to sonority by Yoruba-English bilingual Nigerian children. The analysis revealed that the grammar of the children is quite different from that of adults, in that it does not permit complex stringing of consonants at the coda position. The children showed a preference for single consonants at the coda. This choice is made based on the levels of sonority of the sounds. The children constantly violated *COMPLEX-CODA, which forbids the existence of more than one consonant at the coda (Kager, 1999), and sometimes violated NOCODA. They were able to do this through constraint re-ranking. The subjects also showed a preference for less sonorous consonants over highly sonorous ones. The observed pattern changes as the children mature physiologically. However, some differences may occur as a result of other factors, like speech deficiency, interference and lack of exposure to novel words in English. The findings of this study have implications for early childhood education, as they reveal the kinds of words that are suitable for teaching bilingual children, the findings could also assist speech therapists in designing rehabilitation materials suitable for addressing speech disorders that affect consonant clusters.

References

Abiodun, M. (2010). *Basic linguistics for Nigerian languages*. Ed. Yusuf, O. Ijebu-Ode: Shebiotimo Publications. 38-65.

Adegbite, W. (2009). *The psycholinguistics of English language in Nigeria*. Ibadan: Kraft Books limited.

Arokoyo, B. E. (2012). A comparative phonology of the Olukumi, Igala, Owe and Yoruba languages. *Towards proto-Niger Congo: comparison and reconstruction*. Paris. 18-21.

Chomsky, N. (1975). *Reflections on language and mind.* New York: Pantheon.

Chomsky, N. & Halle, M. (1968). *The sound pattern of English.* New York: Harper & Row Publishers.

Clark, J., Yallop, C., & Fletcher, J. (2007). *An introduction to phonetics and phonology.* Malden, MA: Blackwell Publishing.

Giegerich, H. (1992). *English Phonology: an introduction.* Cambridge: Cambridge University Press.

Gildersleeve-Neumann, C., Kester, E., Davis, B., & Pena, E. (2008). English speech sound development in preschool-aged children from bilingual English-Spanish environments. American speech-language-hearing association. *American Speech-Language-Hearing Association* 39, 314-328.

Gussenhoven, C., & Jacobs, H. (2005). *Understanding phonology.* 2nd Edition. London: Hodder Arnold

Gut, U. (2009). Introduction to phonetics and phonology. In *Textbooks in English Language and Linguistics (TELL).* Hube, M. & Mukherjee, J. (eds). Germany: Peter Lang.

Itani-Adams, Y. (2007). One child, two languages: Bilingual first language acquisition in Japanese and English. Thesis. University of Western Syndney. Retrieved April 4, 2018, http://www. jstor.org/stable.

Kager, R. (1999). *Optimality Theory.* Cambridge: Cambridge University Press.

Kappa, J. (2002). On the acquisition of syllabic structure in Greek. *Journal of Greek Linguistics* 3, 1-52.

Ladefoged, P. (1993). *A course in phonetics*. 3rd edition. USA: Harcourt Brace & company.

Ladefoged, P. (2001). *Vowels and consonants.* UK: Blackwell Publishers.

Levelt, C., Schiller, N., & Levelt, W. (2000). The acquisition of syllable types. *Language Acquisition*. Vol 8(3), 237-264. Retrieved from http://www.informaworld.com/smpp/title-content+775653668.

McCarthy, J. J. (2002). *A thematic guide to Optimality Theory.* Cambridge: Cambridge University Press.

McCarthy, J. J. (2007). *Doing Optimality Theory: applying theory to data.* Malden, MA: Blackwell Publishing.

McCarthy, J., & Prince, A. (1995). Faithfulness and reduplicative identity *University of Massachusetts occasional papers in linguistics* 18. J. Beckman, L.W. Dickey and S. Urbanczyk. Eds. Amherst, MA: GLSA. 249-384.

McCully, C. (2009). *The sound structure of English: an introduction.* New York: Cambridge University Press.

Meisel, J. M. (2011). *First and second language acquisition: parallels and differences.* Cambridge: Cambridge University Press.

Ogundepo, A. O. (2015). A contrastive study of English and Yoruba morphological. European Centre for Research Training and Development. *UK International Journal of English Language and Linguistics Research* 3(4), 1-8.

Orie, O. O. (2012). Two cases of adaptation mismatches in Yoruba loan phonology. *Selected proceedings of the 42nd annual conference on African linguistics.* In R.M. Michael et al (Eds). Somerville, MA: Cascadilla proceedings project. 99-111.

Osisanwo, A. (2012). *Fundamentals of English phonetics and phonology*. Lagos: Femolus-Fetop Publishers.

Oyebade, F. (2008). *A course in phonology*. Ijebu-Ode: Shebiotimo.

Oyebade, F.O. (2010). Yoruba phonology. In Yusuf, O. (Ed.) *Basic linguistics for Nigerian Languages*. Ijebu Ode: Shebiotimo. 228-246.

Prince, A., & Smolensky, P. (1993). Optimality Theory: constraints interaction in Generative Grammar. Report no. Ruccs-TR 2, Now Brunswick, NJ: Rutgers University Center for Cognitive Science.

Ramirez, N. F., & Kuhl, P. K. (2016). *Bilingual language learning in children.* University of Washington. Retrieved March 20, 2018, from https://ilabs.uw.edu/Bilingual_Language_Learning_in_Children.pdf.

Roach, P. (1997). *English phonetics and phonology.* Cambridge: Cambridge University Press.

Salami, O. L. (2004). A natural analysis of the acquisition of English consonants by a Yoruba child. In K. Owolabi & A, Dasylva (Eds.) *Forms and functions of English and indigenous languages in Nigeria: a* festschrift in honour of Ayo Banjo. Ibadan: Group Publisher. 593-611.

Schane, S. (1973). *Generative phonology.* New Jersey: Prentice-Hall Inc.

Sunday, A. B. (2013a). Constraints ranking among bilingual Nigerian adult aphasics. *International Journal of English Linguistics.* 3(1), 46-59.

Sunday, A. B. (2013b). Segmental phonology of bilingual Nigerian adult Wernicke's aphasics. *World Journal of English Language.* 3(1), 50-61.

Sunday, A. B. (2013c). The segmentals of bilingual Nigerian adult Broca's aphasics. *International Journal of Applied Linguistics & English Literature.* 2(3), 83-94.

Sunday A. B. (2014). Deletion, aspiration and nasalisation rules in Nigerian English. *Ibadan Journal of English Studies.* 10, 21-39.

Sunday A. B. (2020). Issues in neurolinguistics. In A. Osisanwo, W. Bamgbade, E. Igwebuike and A. Tella (Eds.) *Applied linguistics, linguistic variations and English usage in the Nigerian context: a festschrift for Moses Alo.* Ibadan: University Press Ltd pp. 17-31.

Sunday, A. B., & Oyatokun, O. O. (2016). Optimality theoretical analysis of word-stress in educated Nigerian English. *Skase Journal of Theoretical Linguistics* 13(1), 87-106.

Sunday A. B. & G. B. Olarewaju (2020). Sonority and acquisition of onset clusters among Yoruba-English Bilingual Children. *Journal of English Scholars Association of Nigeria* 22(2), 26-52

Wachuku, U. (2008). *An introduction to the phonetics and phonology of English.* 2nd edition. Owerri: Alphabet Nigeria publishers.