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Markedness in the Acquisition of Kiswahili Phonology: An Optimality Theory Perspective

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Abstract

Child language acquisition process is, among other factors, determined by the degree of linguistic markedness of the structures under acquisition. In the acquisition of phonology, phonological markedness has been posited to affect both the rate and route of acquisition. Marked phonological structures are those which are difficult to articulate or perceive, rare in phonemic inventories and in typological occurrence, structurally complex and cross linguistically avoided or banned. The inverse is true for the unmarked which typically enhance the acquisition process. However, there are different phonological variables determining markedness across languages and children besides variation in both constraint choice and ranking. The paper addresses these questions by examining the acquisition of Kiswahili phonemic inventory and the syllable structure. This is a longitudinal study of two children aged one to five years old observed for four years. The data was obtained from parental diary, audio recordings and observations. It is argued that unmarked structures (the voiceless, plosives, coronals and CV syllables) are acquired faster and dominate the lexicon. In Optimality Theory (OT- Prince & Smolensky, 1993/2004), linguistic markedness is recast into markedness constraints which demand surface forms to be structurally unmarked. The study identified universal constraints responsible for the acquisition of Kiswahili phonology and the language particular ranking of those constraints. The findings show that markedness constraints are typically ranked higher above the faithfulness constraints in the initial stages of acquisition. The acquisition process is viewed as a gradual demotion of the markedness constraints over faithfulness constraints with sufficient exposure to adult input. Furthermore, markedness constraints against voiced and prenasalised fricatives, coda and syllabic consonants, remain undominated in the constraint hierarchy at age five in spite of adult input having such marked structures. The degree of markedness of the structure, determines how fast it is acquired.

Keywords: Child language, acquisition, markedness, constraints, optimal, harmony

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1. Introduction

Child language acquisition is of immense interest not only to linguists but to the general public largely because of the centrality of language in day-to-day communication. Our humanity and our very existence are intimately tied with our language. It is not surprising that among the first issues that linguists were concerned about was the design features of language which makes us unique arguing that our ability to acquire and possess language is what makes us human (Chomsky, 1965). For linguists, interest in child language acquisition stems from the fact that it does not just explain our uniqueness (language being species specific), but it offers an opportunity to test and validate linguistic theories. There is a consensus that phonological theory and child language have a symbiotic relationship because they inform each other (Chomsky, 2004; Hayes, 2004; Fikkert, 2007). In addition, child language sheds light on what aspects of speech are likely to be lost and recovered faster among the atypical population. This was captured quite early by Jakobson (1941) in his work 'Child Language, Aphasia and Phonological Universals' in which he argues that adult grammars are governed by 'laws of irreversible solidarity'. These 'laws' were later referred to as implicational universals in child language studies. For example, the acquisition of fricatives presupposes the acquisitions of stops. This implication is irreversible and is manifested across languages; fricatives tend to be acquired after plosives. Jakobson's observation is supported by findings from this study.

Similarly, child language studies give insight into our mind, what knowledge of language entails and the 'Continuity Hypothesis'. It is argued that there is continuity between child and adult phonology to the extent that they should differ in a very limited way (Fikkert, 2007). The recurrent overriding question in child language studies has been why children across cultures and facing very different ambient languages, seem to acquire it so fast and effortlessly. This happens in the absence of instruction, modified input and negative feedback from adults. Any child without neurophysiological disorders will master this feat regardless of their level of intelligence, personality, cultures, memory, among other factors (Meisel, 2011).

In essence, every study on language acquisition is directly or indirectly confronted with this enduring question and any adequate linguistic theory must provide an answer to this question to meet the criteria of 'adequacy' (Chomsky, 1999, 2000). It is no accident that early works on child language focused on these questions by developing theories of language structure and use that should mirror the ease with which children acquired their first or native language. Consequently, competing theories emerged, among them; the rule-based derivation (Generative Theory), Natural Generative Grammar, Connectionist and Usage based, Learnability and constraint-based Optimality Theory (OT), (Smith, 1973; Stampe, 1973; Plunkett, 1998; Tomasello, 2000; Tesar & Smolensky, 2000; Gnanadesikan, 2004; Hayes, 2004, among others). We briefly examine the generative and constrained-based OT mainly because they are the most dominant theories that have shaped the current debate on child language acquisition.

In Generative Theory, language acquisition involves getting the phonological rewrite rules of the native language for mapping the underlying forms on to the surface. In Chomsky's (1965) argument, all children are endowed with a biologically predetermined language learning faculty the I-Language and a universal template (Universal Grammar- UG) that enables them acquire any language with utmost rapidity. This happens in spite of what he refers to as 'impoverished' and 'degenerate' input data or what has popularly been referred to as 'the poverty of the stimulus'. However, generative grammar ascribed to a child many complex rules that does not match the ease with which children acquired their first language (L1). Often, the child had more rules than what is attributed to adults, contradictory rule ordering paradoxes and rule duplications (Menn, 2004; Gnanadesikan, 2004).

In Natural Generative Phonology (NGP), Stampe (1973) attempts to solve the problems of linear rule ordering paradoxes, duplication and 'conspiracies' in Generative Phonology, by converting generative rules to 'innate processes'. This is because linear rule-ordering fails to capture the fact that some rules operate simultaneously (e.g., nasal place assimilation which takes place alongside post-nasal voicing) and so it is not clear which rule should be ordered first. In duplication of rules, multiple rules were posited for the same process, i.e., avoidance of marked sequence of a nasal followed by a voiceless obstruent. NGP was meant to show that certain phonological processes are possible while others are impossible. In Stampe's view, acquiring a language proceeds in the same way as natural processes which are under UG. However, his approach was faulted for introducing an extra level of representation, lacked 'discovery, experimentation and hypothesis testing'. It was dismissed as too deterministic (Kiparsky & Menn, 1977). It also failed to handle the U-shaped acquisition route (Becker & Tessier (2011) in which a child produced an error-free form, then unlearns it only to re-learn it later and process such as consonant harmony in children that depends on a natural process.

As a consequence, the generative phonologists revised their proposals replacing rules with Principles and Parameters (PP). The key tenets are that principles are inviolable while parameters are violable and may vary among languages thus responsible for language typology. The parameters have a binary setting mode, a child's task was assumed to be easier like switching from 'off' to 'on', based on evidence from their native language. Similarly, they were part of UG which limits the class of possible grammars as parameters come with a 'default' setting. Children learned parameters only because principles were given for free as part of UG. However, PP could only account for acquisition involving privative features such as voicing and was criticized for parametrization of a complex child language acquisition process.

The foregoing shortcomings led to the emergence of constraint-based theories of phonology of which Optimality Theory (hereafter, OT; Prince & Smolensky, 1993/2004) is central. OT puts emphasis on input-output mapping thus mirror acquisition because the child has to process the input data and generate output surface forms. The key tenets of OT that are directly relevant to child acquisition is the claim that a language is a system of conflicting constraints that are phonetically grounded (determined by our articulatory and physiological abilities and limitations). These constraints are universal and thus found in every language and that differences among languages are due to the different rankings of these constraints. The child, therefore, is born

with these universal constraints innately and acquisition process involves ranking these constraints appropriately based on ambient language (Gnanadesikan, 2004). In an OT grammar, constraints come in two forms; markedness that demand wellformedness on surface forms, and faithfulness that demand faithful mapping between the input and output forms. Markedness constraints demands change, that output forms meet certain structural wellformedness, conflicting with faithfulness which militates against any surface change for purposes of maintaining contrast.
The concept of markedness was first mentioned intuitively by Trubetskoy in the late 30s, then, Jakobson (1941) and formalized in Chomsky and Halle (1968) seminal work 'The Sound Patterns of English'. They offer what is described as the 'intrinsic content' of markedness in phonological features. Odden (2017) argues that markedness is about formal properties of language on one hand and functional probability of occurrence on the other. De Lacy, (2006) provides what he calls a theory of 'markedness' arguing that structures that are avoided are marked' while those that are generated are unmarked'. He defines them thus (de Lacy, 2006:4)

> Unmarked elements can be the sole output of processes, fail to trigger alternations, and undergo processes alone. In contrast, 'marked' elements are rarely the output, are often the only triggering elements, and are often exempt from undergoing processes.

Markedness relations can be expressed as a hierarchy based on some dimension, such as Place of Articulation (POA-hierarchy). Markedness relations are not universally invariant, there could be reversals in the hierarchy or conflation, and even preservation of the marked for contrast purposes. He categorizes markedness into two; Competence markedness (I-Language mechanism) and Performance markedness (p-Markedness). The I-Language, in our case, is the phonological component of the language faculty; speakers' internalized knowledge about the language. Performance refers to everything outside the I-Language, how language is used i.e., mechanisms of perception and limits on the phonetic implementation (de Lacy, 2006:11). The p-Markedness is responsible for typological and inventory occurrences. In this study, we adopt both concepts and we shall simply use the cover term 'markedness'. This paper is organized as follows; Section 2 provides data and methodological issues, section 3 focuses on the analysis, section 4 provides the results and discussion while section 5 sums up with the conclusion.

2. Methodology and Data

This is a longitudinal study of two children acquiring Kiswahili as their first language. The data for the study was collected for a period of four years from the time when the subjects were one year old up to the period when they attained five years of age.

2.1. Participants

The participants who provided data were two female children as subjects. They are siblings and were coded as MS1 for the first born and MS2 for the second born. They had no known neurophysiological disorders nor language and speech pathology. Their developmental milestones were similar and their

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cognition normal. They were exposed to one language right from birth up to their pre-school years. During this period, they constantly had three main interlocutors; their parents (both teachers) and a caregiver. The three spoke Kiswahili at home in the presence of the two children. Their playmates and neighbours also used Kiswahili because of the cosmopolitan nature of the neighbourhood. Both their rural and urban homes were inhabited mainly by speakers of different Kenyan languages, hence the main medium of communication was Kiswahili because it is the lingua franca in both rural and urban homes. Due to such a language ecology, there was no exposure to any other language. Generally, the language used at home (including visitors) and outside the home environment was Kiswahili. Note that the two children were two years apart; the first born was three years when the younger was one year old.

2.2. Data Collection

Data collected was both in the form of audio and text (written text) collected over a period of four years. Speech tokens were recorded when the subjects are engaged in natural conversations at home. They were not aware of being observed or recorded. Two main instruments were used: parental diary and audio recorder. Parental diary recorded any observable change and speech of interest in the utterances of the children. This tool was used as need arises noting the date, time and context of the utterance and any accompanying paralinguistic cues. The audio recording was done every fortnight strictly in the house. During this period, the parent could start a conversation to induce the subjects to speak. Similarly, the recording parent could ask questions that lead to specific responses containing the target sounds, syllables or prosodic words. The audio files were transferred to the Praat software (Boersma & Weenick, 2015) for verification of speech based on phonetic features, (because the markedness of a sound is determined by its phonetic/phonological features), for example, the formant values of vowels and spectrographic characteristics of consonants such as VOT in plosives. However, because this is purely a phonological study, no acoustic speech analysis was done using the software.

A third tool, a syllable/word list, supplemented the two tools mentioned above. The word list was generated from the parental diary and audio recorder. In this case, the parent asked the children to repeat specific words by prompting. This was done to verify the children's utterances and confirm if there are any or existing variations in the child's output. In the table (Appendix 1) a sample of the data is provided. For each word, there are two output tokens, one for each subject.

Seven stages are identified in the developmental path of the subjects. Each stage is indicated by an initial Y (for year) followed by numerals; the first indicates the year and the second, the month (typically, 6 months). This is because studies indicate that it is only after about six months that there is noticeable difference in developmental grammar. However, after three years, most sounds and syllables are in place and therefore, noticeable progress is only visible after about a year. In the data, (see Appendix 1), the stages after three years follow this pattern (a year apart; Y3, Y4, Y5).

2.3. Data Analysis

The child data in Appendix 1 were analyzed using OT formalism by first determining the constraint for each emergent grammar, their Kiswahili specific constraint hierarchy and finally, a comparative assessment of the optimal candidate (the true attested output form). The paper assumes some basic understanding of OT architecture especially with regard to constraint determination, their ranking, construction of the tableaux and evaluation of candidate harmony. Note that, in this study, unassimilated(non-nativized) loanwords, especially from Arabic (the dominant donor language), are not considered because they have a transitional syllable structure and/or deviate from the core grammar of standard Kiswahili

2.3.1. Acquisition of the Kiswahili Phonemic Inventory

Standard IPA transcription protocol is used. In transcription, the phonemic symbol [c] is used and not [ʧ] as some authors have done due to the influence of English pronunciation of the sound. In most Eastern Bantu generally, the [c] of 'chama' is actually a palatal plosive and not a post-alveolar affricate as it is the case in English. Evidence for this argument comes from Nasal Place Assimilation (NPA) in which the palatal nasal stop [ɲ] assimilates to the palatal plosive [c] resulting in the voiced prenasalised palatal stop [ᶮɟ]. Similarly, in this study, [c] as a voiceless plosive is shown to be acquired early alongside the voiceless coronal (alveolar) plosive [t]. Note also that the [ᶮɟ] is a singleton (single phoneme) and not a sequence of two consonants according to syllabic phonotactics of the language.

The study assumes the following phonemic inventory of standard Kiswahili (Mgullu, 2001). Standard Kiswahili has five pure vowels and five long counterparts of the same (ten monophthongs) as follows; /a/, /e/, /i/, /o/ and /u/ on one hand, and /a:/, /e:/, /i:/, /o:/ and /u:/ for the long vowels respectively. The language has a three-vowel height system comprising of three height contrasts of low, mid and high. The language has thirty consonants spread across the different places of articulation as follows; bilabials: /p/, /b/, /m/, /ᵐb/; labio-dentals: /f/, /v/; interdentals: /θ/, /ð/; alveolars: /t/, /d/, /n/, /l/, /r/, /s/, /z/, /ⁿd/, /ⁿz/; post-alveolar: /ʃ/; palatals: /c/, /ɟ/, /ɲ/, /j/, /ᶮɟ/; velars: /k/, /g/, /ɣ/, /ŋ/, /ᵑg/; labio-velar /w/ and one glottal sound /h/. Note that the five prenasalised consonants are phonemic, they are fully contrastive/distinctive in the language. (cf. Chacha, 2007, for an argument to include them in the IPA chart). These phonemes are plotted in the following vowel and consonant charts.

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Table1
Kiswahili Vowels

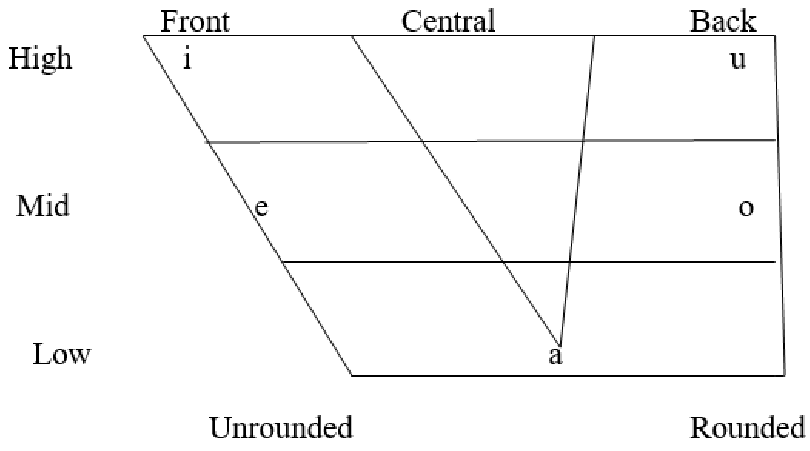

Table 2
Kiswahili Consonants (Ladefoged & Maddieson, 1996; Mgullu, 2001) adapted with modifications

	Bilabial	Labio-dental	Inter-dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Plosives	p b			t d		c ɟ	k g	
Fricatives		f v	θ ð	s z	ʃ		ɣ	h
Nasals	m			n		ɲ	ŋ	
Liquids				l, r				
Glides						j	w	
Pre-nasals	^{m}b			^{n}d, ^{n}z		^{ɲ}ɟ	^{ŋ}g	

The consonant inventory shows that the language has five prenasalised sounds; four are prenasalised stops and one prenasalised fricative /^{n}z/. By the age of one year, all the vowels had been acquired and five consonants i.e., the /p/, /m/, /t/, /j/ and /n/. The first two sounds are universally acquired first (MacWhinney, 1995; Clark, 2003; Lust, 2007) because from sucking, the muscles moving the jaws and lips are said to be adapted; children are physiologically able to handle these bilabial sounds. As for the other three, they are all coronals and studies have shown that that they are the unmarked place of articulation (Paradis & Prunet, 1991; Kang, 2000; de Lacy, 2004, 2006; Flack, 2007) based on universal markedness hierarchy or scale (Lombardi, 2002; de Lacy, 2006). The data shows that children have all vowels acquired before the consonants.
In the tableau (tableaux/tableaus for plural), the vertical solid lines indicate domination, dotted lines mean there is no crucial domination while shaded cells mean that the optimal (winner) is already determined by constraint above (before them). After each tableau, a brief explanation of the OT analysis is done as a convention. It is here argued that markedness constraints invariably

outrank faithfulness constraints. In the analysis, therefore, it is proposed that the markedness constraints ONSET (demands that syllables have onsets), *OBS_{VOI} (which demands that obstruents are not be voiced) and *VOWEL (long) (*[V_{LONG}]) (which bans long vowels) are top ranked dominating MAX-IO (demanding no deletion) and IDENT-IO (demanding no feature change). We use the input word /va:/ 'dress up'.

Tableau 1a /va:/ → [pa] 'dress' (v)

/va:/	ONSET	*$OBS_{VOI/CONT}$	*$V_{[LONG]}$	MAX-IO	IDENT-IO
a. ☞[pa]					**
b. [pa:]			*!		*
c. [va:]		*!	*		
d. [a]	*!			*	*

At one year, the child produces the voiceless plosive [p] and the short vowel [a] for [va:] because at this stage, long vowels and fricative consonants are considered marked and are not yet acquired. The optimal candidate (true attested form indicated by 'pointing finger ☞') produced by the child is candidate (a) [pa], candidate (b) is suboptimal because it has a long vowel not yet acquired, (c) loses because it has a voiced fricative which is very marked (fricatives are generally acquired last and voiced sounds are considered marked if they are obstruents).

At one year and half, the subjects demote the markedness constraint against long vowels while promoting the faithfulness constraint demanding similar length feature correspondence between input and output. This results into [pa:] as shown in the following tableau.

Tableau 1b: /va:/ → [pa:] 'dress' (v)

/va:/	ONSET	*$OBS_{VOI/CONT}$	$IDENTV_{[LONG]}$	MAX-IO	*V_{LONG}
a. ☞[pa:]					*
b. [pa]			*!		
c. [va:]		*!			*
d. [a]	*!		*	*	

After two years and half, the markedness constraints against fricatives (*[OBS_{CONT}]) is demoted below the faithfulness constraints IDENT $_{[CONT]}$ as part of the learning process in an OT grammar. The child produces the fricative [f] and due to the demands of ONSET constraint, that dominates DEP-IO (no insertion), the child inserts the palatal glide [j] to satisfy the ONSET requirements producing [fa.ja]. This is shown in tableau 1c as follows.

Tableau 1c: /va:/ → [fa.ja:] 'dress' (v)

/va:/	ONSET	*$OBS_{VOI\&CONT}$	$IDENT_{CONT}$	IDENT-$V_{[LONG]}$	MAX-IO	DEP-IO
a.☞[fa.ja]				*		*
b. [pa]			*	*!		
c. [va:]		*!				
d. [a]	*!			*	*	

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The final optimal candidate similar to adult grammar is attained at four years when the markedness constraint against voiced fricatives ([*$OBS_{VOI/CONT}$) is demoted while faithfulness constraint; $IDENT_{VOI/CONT}$ is promoted above it. The result is as follows;

Tableau 1d: /va:/ → [va:] 'dress' (v)

/va:/	ONSET	$IDENT_{CONT/VOI}$	*$OBS_{VOI/CONT}$	IDENT-$V_{[LONG]}$	MAX-IO	*V_{LONG}
a. ☞[va:]			*			*
b. [pa]		*!*		*		
c. [fa:]		*!				*
d. [a]	*!			*	*	

The sound [j] appears to be the preferred epenthetic segment replacing many phonemes such as /l/, /c/, /r/, /h/, /s/ and / ɡ/ among others. This is expected considering that it is a coronal and specifically, a palatal. There is a preference for palatals over alveolars.
On the other hand, by the age of five years, the subjects had not acquired the voiced fricatives /ɣ/ and /ð/. Fricatives as said to be phonologically marked compared to other manner of articulation classes of sounds. The fact that they are voiced enhances this markedness further. It is no wonder that the two fricatives are acquired last. In the data, it is apparent that the two subjects could not master the voiced interdental fricative at five years old. This is because they ranked OBS_{VOI} markedness constraint higher up in the constraint hierarchy.
In the following tableau, the subjects' inability to produce the prenasalised stop [ᵐb] is due to initial ranking of $COMP_{SEG}$ high in the hierarchy thus; ONSET, *OBS_{VOI}, *$COMP_{SEG}$ ≫ MAX-IO, DEP-IO.

Tableau 2a: /ðaᵐbi/ → [pi] 'sin'

/ðaᵐbi/	ONSET	*OBS_{VOI}	*$COMP_{SEG}$	MAX-IO	IDENT-IO
a. ☞[pi]				**	*
b.[ðaᵐbi]		*!	*		
c. [tabi]		*!			**
d. [i]	*!			***	**

The optimal candidate is one which satisfies the three top-ranked markedness constraints by being voiceless, having an onset and avoiding the complex (contour) segment altogether thus realized as [pi]. By the age of two years, the child has demoted the general OBS_{VOI} to a lower level but a specific $OBS_{VOI/CONT}$ relativized to the fricatives is still top ranked. This implies that the child can produce [p] but not the interdental [ð] as shown in tableau 2b.

Tableau 2b: /ða^{m}bi/ → [tapi] 'sin'

/ða^{m}bi/	ONSET	*OBS$_{VOI\&CONT}$	*COMP$_{SEG}$	*OBS$_{VOI}$	MAX-IO	IDENT-IO
a.☞[tapi]						***
b. [ða^{m}bi]		*!	*	**		
c. [tabi]				*!		**
d. [i]	*!				***	

To produce [tabi] at two years, the child has to demote the markedness constraint against voiced stops further down the hierarchy below IDENT-IO$_{VOI}$. This is shown in tableau 2c.

Tableau 2c: /ða^{m}bi/ → [tabi]] 'sin'

/ða^{m}bi/	ONSET	*OBS$_{VOI\&CONT}$	*COMP$_{SEG}$	IDENT-VOI	MAX-IO	*OBS$_{VOI}$
a.☞[tabi]				*		*
b. [ða^{m}bi]		*!	*			**
c. [tapi]				**!		
d. [i]	*!				***	

At three years of age, the subjects produced the complex segment [^{m}b], implying that they had also demoted the markedness constraint against such contour segment; *COMP$_{SEG}$ while elevating the faithfulness constraint IDENT$_{COMPSEG}$ above the former as in tableau 2d. The cover term is used for identity constraint; IDENT-IOvoice, continuant and complex segment.

Tableau 2d: /ða^{m}bi/ → [ta^{m}bi] 'sin'

/ða^{m}bi/	ONSET	*OBS$_{VOI\&CONT}$	IDENT-IO	*COMP$_{SEG}$	MAX-IO	*OBS$_{VOI}$
a.☞[ta^{m}bi]			**	*		*
b. [ða^{m}bi]		*!	*	*		**
c. [tapi]			***!			
d. [i]	*!				***	

At four years of age, the two subjects display variable ranking of the IDENT-IO constraint by giving priority to different aspects of the feature values of faithfulness; MS1 satisfies IDENT-$_{VOI}$ at the expense of IDENT$_{CONT}$ while MS2 does the reverse as shown in tableaux 2e & 2f respectively. Similarly, while MS1 satisfies *OBS$_{CONT\&VOI}$, by avoiding a fricative altogether, MS2 satisfies it partially by using the voiceless fricative thereby satisfying IDENT$_{CONT}$ as well.

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Tableau 2e: /ða^{m}bi/ → [da^{m}bi] 'sin'

/ða^{m}bi/	ONSET	*OBS$_{CONT\&VOI}$	IDENT$_{VOI\&/CONT}$	*COMP$_{SEG}$	MAX-IO	*OBS$_{VOI}$
a.☞[da^{m}bi]			*	*		**
b. [ða^{m}bi]		*!	*	*		**
c. [tapi]			**!*			
d. [abi]	*!				*	

The tableau 2e indicates that MS1 has one violation mark for IDENT-$_{CONT}$ but respects the [+voice] specification. In 2f below, MS2 violates the voicing feature but satisfies the continuant requirement by having a voiceless fricative [θ] instead of the voiced fricative [ð] as optimal

Tableau 2f: /ða^{m}bi/ → [θa^{m}bi] 'sin'

/ða^{m}bi/	ONSET	*OBS$_{VOI\&CONT}$	IDENT$_{VOI\&CONT}$	*COMP$_{SEG}$	MAX-	*OBS$_{VOI}$
a.☞[θa^{m}bi]			*	*		*
b. [ða^{m}bi]		*!	*	*		**
c. [θapi]			**!*			
d. [abi]	*!				*	

Note that at age five, MS1 converges at the same level with MS2, by having the constraints and ranking shown in tableau 2f. The voiced interdental fricative is not yet acquired because the markedness constraint against a voice continuant that is not a sonorant, is still an undominated constraint in the subjects' constraint hierarchy.
Finally, we analyze another sound that was not acquired by age five; the rarest and probably, the most difficult sound to articulate; the voiced velar fricative [ɣ]. It occurred only once in adult input and worse, it was mispronounced as it often occurs among many adult speakers of Kiswahili. In the analysis, we examine only two stages because the subjects' outputs are very close to the near similar form [gari] that they acquire fully at five years old, however, the final form of [ɣali] is not the adult norm but an intermediate form of [gari] reported at four years.

Tableau 3a: /ɣali/ → [ji] 'expensive'

/ɣali/	ONSET	*DORSAL	*LIQUID	*GLIDE$_{COR}$	MAX-IO	IDENT-IO
a. ☞[ji]				*	**	*
b. [ɣali]		*!	*			
c. [gali]		*!	*			*
d. [ja]				*	**	**!

At five years of age, the subjects could only produce [gali] as the optimal candidate implying that markedness constraints against dorsals and liquids have been demoted from being top ranked. However, a specific constraint against voiced velar fricative must be undominated to prevent [ɣ] while promoting $\text{IDENT}_{\text{DOR}}$ and $\text{IDENT}_{\text{LATERAL}}$ together with MAX-IO as shown in tableau 3b. Note that in the initial state of the aquisition process, all markedness constraints outrank faithfulness constraints.

Tableau 3b: /ɣali/ → [gali] 'expensive'

/ɣali/	ONSET	*DOR CONT/VOI	IDENTDOR /LAT	MAX-IO	*GLIDE COR	*LIQUID	*DORSAL
a.☞[gali]						*	*
b. [ɣali]		*!				*	*
c. [gari]			*!			*	*
d. [ja]				*!*	*		

The fact that at five years old, both subjects ranked the markedness constraint $\text{*DORSAL}_{\text{CONTINUANT}}$ as top ranked implied that they could not acquire the voiced dorsal continuant fricative [ɣ]. But based on the concept of minimal violation in OT, they opt to produce a near similar dorsal plosive [g] that posses two of the features in the substituted fricative; [+voice] and [+dorsal] thus violating only one identity constraint; $\text{IDENT}_{\text{CONT.}}$ Note that the dominated and general *DORSAL allows for the emergence of [k] or [g] as optimal in place of [ɣ].

2.3.2. Acquisition of Kiswahili Syllable Structure

The Kiswahili core syllable structure can be divided into four types; the universal and canonical [CV] -Consonant Vowel, onsetless [V] -Vowel alone, [CCV] -typically Consonant Glide Vowel and the [N] -syllabic nasal structure. This structure is typical of most Eastern Bantu languages including Luhya, Gikuyu, Taita, among others (Maddieson & Ladefoged, 1993; Nandelenga, 2015). Only nasals function as syllabic consonants occupying the peak (nucleus) of the syllable because they are the least marked sonorant consonant (Rice & Avery, 1991; Rice, 2007). The subjects invariably acquired the [CV] syllable first regardless of the input from the ambient language. This syllable is said to be the most unmarked across languages, in fact all languages have a [CV] structure and in a few, the only type allowed (Blevins, 1995, 2004; Levelt & de Vijver, 2004; Zec, 2007; Goldsmith, 2011). In an OT analysis, it implies that markedness constraints such as ONSET, *CODA, $\text{*COMPLEX}_{\text{ONSET}}$, and *PEAK-C dominate faithfulness constraints MAX-IO, DEP-IO and IDENT-IO. These are the universal constraints that will be used in analyzing the data by ranking them in a Kiswahili specific constraint hierarchy. Initially, subjects rank markedness constraints above the faithfulness thus; ONSET, *CODA, $\text{*COMP}_{\text{ONSET}}$, *PEAK-C ≫ MAX-IO, DEP-IO. Syllable break is indicated by a period in accordance with the IPA notation.

Tableau 4a: /mtoto/ → [to] 'a baby'

/mtoto/	ONSET	*CODA	*COMP$_{ONSET}$	*PEAK-C	MAX-IO	DEP-IO
a. ☞[to]					***	
b. [m̩.to.to]				*!		
c. [mto]			*!		**	
d. [tot]		*!			**	
e. [o.to]	*!				**	

Tableau 4a shows that [to] is the optimal candidate when all markedness constraints are top ranked which ensures that only the [CV] syllable structure can emerge at one year old. However, with more evidence from adult data, the subjects reduce violations of MAX-IO by producing [to.to] but the ranking remains because only [CV] syllables are permitted based on the ranking.

At age five, the subjects could not produce the expected syllabic nasal because they still rank the markedness constraint PEAK-C as undominated constraint. Their ranking does not converge with the adults' ranking but there is less violation of faithfulness (none for MAX-IO and one for DEP-IO) constraints as depicted in the tableau 4b that has an extra candidate (f).

Tableau 4b: /mtoto/ → [mu.to.to] 'a child/baby'

/mtoto/	ONSET	*CODA	*COMP$_{ONSET}$	*PEAK-C	MAX-IO	DEP-IO
a. ☞[mu.to.to]						*
b. [m̩.to.to]				*!		
c. [mto]			*!		**	
d. [tot]		*!			**	
e. [o.to]	*!				**	
f. [to]					**!*	

By producing [mu.to.to] the subjects are being faithful to the unmarked core [CV] syllabe type which they acquire easily and very fast. In an input with an initial onsetless syllable, the subjects produce [CV] syllables before converging on the optimal [V] syllable structure. This provides evidence that [CV] is acquired before the [V] syllable type. To rule out [c] in favour of [j] in the following analysis, subjects need a markedness constraint *CORONAL$_{[-SONORANT]}$ but violating the feature [OBSTRUENT] in the word /aca/ 'abandon, leave, let go' in tableau 5a.

Tableau 5a: /aca/ → [ja] 'let go/leave'

/aca/	ONSET	*CODA	*COR$_{[-SON]}$	IDENT$_{OBS}$	MAX-IO	DEP-IO
a. ☞[ja]				*	*	
b. [a.ca]	*!		*			
c. [ca]			*!		*	
d. [ja.ca]			*!			*
e. [ac]	*!	*			*	

At two years, the subjects were producing the target word with the onsetless initial syllable. This is because they revised their constraint ranking demoting the markedness constraints ONSET and *COR$_{[-SON]}$ so that they can be violated at no cost to the harmony of the output candidate. This is apparent in tableau 5b in which the optimal candidate is the attested form.

Tableau 5b: /aca/ → [a.ca] 'let go/leave'

/aca/	IDENT$_{OBS}$	*CODA	MAX-IO	DEP-IO	*COR$_{[-SON]}$	ONSET
a. ☞[a.ca]					*	*
b. [ja]	*!		*			
c. [ca]			*!		*	
d. [ja.ca]			*!	*		*
e. [ac]		*!			*	

The optimal candidate is the expected form, a testimony of the efficacy of the constraint choice and its ranking. However, it remains to be seen if the same constraints can account for the acquisition of the [CCV] syllable structure. An anti-consonant cluster markedness constraint is introduced and another constraint that militates against labio-velar [w] and syllabic consonants as was the case in tableaux 4 above.

Tableau 6a: /mwana/ → [ma] 'a child'

/mwana/	ONSET	*CODA	*COMP$_{ONSET}$	*PEAK-C	*LABIO$_{VELAR}$	MAX-IO	DEP-IO
a. ☞[ma]						***	
b. [mu.wa.na]					*!		*
c. [m̩.wa.na]				*!	*		
d. [mwa.na]			*!		*		
e. [wan]		*!			*	**	
f. [a.na]	*!					**	

By age five, the [CC] consonant cluster is acquired, implying that the markedness constraints *COMP$_{ONSET}$ and *LABIO$_{VELAR}$ are now low ranked in the constraint hierarchy and can be violated to produce the most harmonic and optimal candidate.

Tableau 6b: /mwana/ → [mwa.na] 'a child'

/mwana/	ONSET	*CODA	*PEAK-C	MAX-IO	DEP-IO	*LABIO$_{VELAR}$	*COMP$_{ONSET}$
a.☞[mwa.na]						*	*

b.[mu.wa.na]					*!	*	
c.[ma]				*!**			
d. [m̩.wa.na]			*!			*	
e. [wan]		*!		**		*	
f. [a.na]	*!			**			

The tableau shows that once *COMPONSET is dominated by some faithfulness constraint, the input [CC] typically [CG] consonant cluster will be mapped faithfully on to the surface.
Finally, the adult data (*see* Appendix 2) reveals that there are syllabic consonants which are invariably nasals. However, the subjects' final grammars at five years of age indicate that this syllable type is not acquired by then. Crosslinguistically, syllabic consonants are considered marked and typologically quite rare in syllabic inventories. Often, very few consonants qualify as syllabic peak. Failure to acquire syllabic nasals is due to the undominated markedness constraint PEAK-C, as shown in the following tableau.

Tableau 7a: /nne/ → [ne] 'four'

/nne/	ONSET	*CODA	*COMPONSET	*PEAK-C	MAX-IO	DEP-IO
a. ☞[ne]					*	
b. [n̩.ne]				*!		
c. [nne]			*!			
d. [i.ne]	*!					*
e. [e]	*!				**	

At five years old, the subjects had demoted ONSET to the low rank but still retained PEAK-C, therefore, they could not acquire the syllabic nasal as shown in tableau 7b.

Tableau 7b: /nne/ → [i.ne] 'four'

/nne/	*CODA	*COMPONSET	*PEAK-C	MAX-IO	DEP-IO	ONSET
a. ☞[i.ne]						*
b.[n̩.ne]			*!			
c.[nne]		*!				
d. [ne]				*!		
e. [e]				*!*		*

The same findings are obtained when the input form is /mtoto/ which is realized by the subjects as [mu.to.to] and not the expected [m̩.to.to] in which the nasal is syllabic.

3. Results and Discussion

The following section discusses the findings from the analysis showing what is of interest to the key questions concerning child language acquisition raised in the introduction section. The role of markedness is revisited with specific reference to markedness hierarchies assumed in the study based on crosslinguistic findings (Lombardi, 2002; de Lacy, 2004, 2006; Rice, 2007)

3.1. The Phonemic Inventory

Acquisition of the phonemic inventory is correlated with acquisition of the system of contrast. The child has to determine the contrasts that exists in the ambient language. Contrasts that are typologically frequent are acquired early. In the study, the three vowels [a], [i] and [u] are acquired first. By age one, the subjects had fully acquired all the short vowels. They could use them in producing their first syllables and words. The most contrastive peripheral vowels [a, i, u] are the most distinct and consequently acquired ahead of the mid vowels. This is due to their extreme dispersion in the vowel space, therefore, least likely to be confused (Flemming, 2006).

Similarly, Beckman (2004) argues that these three are the unmarked (the high and low). At one year and half, the subjects had acquired the length contrast but produce them variably due to likely maturation and other factors. The markedness constraint *[LONG] ensures that children acquire the short vowels before the long ones. In terms of markedness, *[LONG] 〉 *[-LONG] 'reads more marked than'. In OT terms, the children rank the markedness constraint *[+CONSONANTAL] above *[-CONSONANTAL], thus acquiring vowels before consonants. Phonetically, producing vowels is less effortful due to the open vocal tract than the constriction associated with consonants which requires muscle coordination and synchronizing articulators. In addition, [m] and [p] are acquired early because they contrast in voicing and orality, but also because they are in contrast with other consonants in terms of place and manner of articulation. Maximal perceptual contrast would favour the two bilabial stops because they enhance perceptual distinctiveness with low articulatory effort (Flemming, 2006). Among consonants, three parameters have been proposed to determine their markedness based on specific features. Acquisition is thus viewed as the unfolding of preexisting feature hierarchy with positive evidence (Fikkert, 2007:540) The markedness hierarchies are based on place of articulation, manner of articulation and voicing (phonation). These three parameters provide us with universal markedness hierarchies as follows (Note ' 〉' reads; more marked than)

Place of Articulation (POA) Markedness Hierarchy (Lombard, 2002; de Lacy, 2006; Rice, 2007)

| Dorsal 〉 Labial 〉 Coronal 〉 Laryngeal |

$\longleftrightarrow$

Most marked Least marked

Voicing (Phonation) Markedness Hierarchy

| Voiced 〉 Voiceless |

Manner of articulation (MOA) Markedness Hierarchy

|Fricative 〉 Liquid 〉 Nasal 〉 Plosive|

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The fact that the dorsal, voiced velar fricative [ɣ] is not acquired at all at five years of age can be read off from the three subhierachies above. It is a dorsal (being velar), voiced and also a fricative, and therefore, as predicted by the hierarchies above, it should be the most likely to be acquired last. The analysis reveal that markedness constraints are initially ranked higher than faithfulness ones in which marked structured are banned or difficult to articulate. The consonant that is acquired first is the voiceless plosive [p] which is the least marked in terms of voicing and also in terms MOA hierarchy. The nasal [m] and [n] follow. From the point of view of MOA, they are considered unmarked among the class of sonorants (Rice, 2007). However, functional reasons have been argued to be the reason why the bilabial nasal stop [m] is acquired first across languages (Blevins, 2004; de Lacy, 2006; Smith, 1973, 2009).

In terms of POA, coronals were acquired quite fast in line with what has been termed 'coronal unmarkedness' (Paradis & Prunet, 1991; de Lacy, 2006). In acquisition rate and segmental epenthesis, the unmarked sound is preferred. Lombard (2003), de Lacy (2006) and Rice (2007) observe that epenthesis is a valid markedness diagnostic. The data shows that the coronal glide [j] is the preferred epenthetic segment by subjects. Majority of languages tend to have a high number of coronals in their phonemic inventories (Paradis & Prunet, 1991; Rice, 2007) and the same is observed in the subjects' consonant inventory. Among the early coronals were; [n], [t], [c], [j], and [ʃ]. Though fricatives are typically late in acquisition, the coronal [θ] was acquired first among all fricatives. The results are in accord with the predictions of the markedness hierarchies provided above and crosslinguistic studies (de Lacy, 2006; Bavin, 2009).

Generally, plosives are acquired ahead of nasals, which in turn precede the liquids and, finally, the fricatives. All voiceless plosives were acquired before their voiced counterparts (see [p] vs [b], [t] vs [d], [k] vs [ɡ]). The same scenario obtains for fricatives. All the consonants that were not acquired by age five were fricatives and, in addition, they were all voiced; [ð], [ɣ] and [^{n}z]. The markedness of the latter is enhanced by being a complex segment as well. This lends some credence to the markedness hierarchy above.

However, it is important to note that hierarchies do conflict and one may be more visible in one sound than the other. This may explain why the simplex /z/ a voiced coronal is acquired earlier than [ð] also a voiced coronal fricative. The data established that frequency plays a critical role because children can only acquire what they hear and how often they are exposed to it. This is a case of 'performance' markedness that has to do with frequency of occurrence that makes one sound marked than another. The role of frequency has been shown to be critical in other studies too (Bybee, 2001; Levelt & de Vjver, 2004). While voiced velars are generally difficult to produce phonetically, the study also reveals that the voiced velar fricative is too infrequent in adult input to be acquired. Throughout data collection, only one word containing the voiced velar fricative [ɣ] was used in the presence of subjects. Frequency effects may, therefore, contribute to the absence of [ɣ] in the subjects' phonemic inventories at age five.

3.2. The Syllable Structure

The analysis reveals that the [CV] syllable type was the most prevalent and preferred regardless of the input form. This type has been described as 'an absolute universal' in the sense that it occurs in all languages (Blevins, 1995; Carlisle, 2001; Goldsmith, 2011). In fact, some languages are said to have only this type (Hawaian and Hua) and it is the only type that is not banned by any language (Prince & Smolensky, 2004; Levelt & de Vijver, 2004). The preference for a [CV] type is due to both ease of articulation and perception. The subjects faithfully ranked markedness constraints; ONSET, *CODA and *COMP$_{\text{ONSET}}$ above some faithfulness constraints which ensure that only the [CV] syllable type can surface optimally. The [V] syllable structure followed only if the input was onsetless and after the ONSET constraint was demoted to a lower rank in the constraint hierarchy of the language.

Note that [CV] syllable type was preferred even with inputs beginning with a vowel in the initial stages of acquisition. The [CCV] was acquired only after the other two syllable types: [CV] and [V] were in place. This was only possible after the constraint against onset cluster was demoted below faithfulness constraints (MAX-IO and DEP-IO) that oppose insertion or deletion to repair the cluster. Both children never acquired the syllabic nasal due to the undominated markedness constraint *PEAK-C that forbids consonants from occupying the peak of the syllable. Similarly, most adults have difficulties producing a syllabic sound as noted during data collection and often insert a vowel after the nasal. In terms of the feature-based markedness theory, the unmarked status of a syllable nucleus is [-CONS]. Therefore, markedness may play a role in syllable acquisition based on the following hierarchy.

Syllable Structure Markedness Hierarchy

| N̩ 〉 CCV 〉 V 〉 CV |

While ONSET and *COMP$_{\text{ONSET}}$ were eventually ranked low to allow for the emergence of onsetless syllables and [CC] onset clusters, the *CODA constraint was never demoted. This is a universal ranking for all Bantu languages because their syllables are strictly open. Similarly, another reason why the subjects eventually produced CCV is because the language allows a specific type of CCV structure (the CGV-consonant, glide vowel). A markedness subhierarchy is proposed to account for the preference of CG among Eastern Bantu languages based on Nandelenga (2015).

CCV Markedness subhierarchy

| *CO 〉 *CN 〉 *CL 〉 *CG |

Most marked Least marked

The markedness *CO reads; no Consonant Obstruent onset, *CN reads; no Consonant Nasal onset, *CL reads; no Consonant Liquid onset while *CG reads; no Consonant Glide onset cluster. The subjects produced only one type of onset cluster; the [CG] because this is the least marked onset cluster based on the markedness subhierarchy above. Among other factors, such an onset cluster respects the Sonority Sequencing Principle (SSP) by ensuring a rising sonority in the onset cluster regardless of the initial consonant in the [CG] cluster. This is because the glide has the highest inherent sonority index among all the consonants in any languages' phonemic inventory. Note that the subjects could have ranked the constraints in the same order thus: *CO ≫ *CN ≫ *CL ≫ *CG which implies that the constraint against a consonant glide sequence is low ranked and, therefore, violable. This explain why [CG] onset cluster is not only acceptable, but also the preferred onset cluster type in the child's developmental grammars.

4. Conclusion

The acquisition of Kiswahili phonology, like any other language, is determined by universal constraints that are ranked in a language specific hierarchy. In OT, language acquisition is a process of constraint re-ranking given new input and in the face of new data or evidence. In initial stages, both subjects rank markedness constraints above faithfulness constraints. The result is acquisition of unmarked phonological forms. This often leads to neutralization of contrast (see both /ɣali/ 'expensive' and /ɡari/ 'a vehicle' being mapped on to [kali] at age three by both subjects). Progress along the development path is a matter of demoting the markedness constraints allowing more marked structures to emerge and, therefore, allowing more contrast. The study shows that there is a strong continuity between child and adult grammars. Constraints attributed to both are the same, the only difference is their ranking. Children are able to attain adult phonological norm and grammar by re-ranking the constraints as they approximate to the target form. This is in acord with the Gradual Learning Algorithm (GLA) and Constraint Demotion Algorithms (CDA) learnability modelling (Tesar & Smolensky, 2000) which simulates constraint demotion in the acquisition process. Child language acquisition in OT grammar involves gradual demotion of markedness constraints while promoting the faithfulness constraints above the markedness constraints. This is the stage at which the child's phonological grammar converge with the adult input by producing adult's marked phonological structures.

The fact that only the voiced fricatives [ɣ], [ð] and [^{n}z] are not acquired at age five shows that indeed manner of articulation (MOA) markedness of the form under acquisition is a key variable in determining the acquisition process. These findings are in accord with studies on other languages (Gnanadesikan, 2004; Fikkert, 2007, among others). Indeed, Fikkert (2007:539) posits that "Markedness has always played a key role in accounting for acquisition patterns. Researchers usually find that children start out producing relatively simple and unmarked phonological patterns, which become more marked in the course of development". Both competence-based markedness (determined by the I-language) and performance markedness (determined by factors external to the language) are central. Yet with little exposure to the voiced fricative sounds, the subjects could not acquire them. This is in line with observations by Zamuner et al; (2004) that high frequency words produced accurately and with high phonotactic probability led to faster acquisition. This may explain why the infrequent [ð] and [ɣ] and the poorly articulated syllabic nasals were not yet acquired at the age of five years. That a key property of language is 'cultural transmission' is made manifest; children acquire the language they hear, they do not inherit the language of their parents. In the current study, both parents were native Luhya (Bantu, Kenya) speakers, but the subjects acquired Kiswahili, the language they hear around them.

Back to the key question linguists must answer mentioned in the introductions, the results may provide an account as to why children acquire their first language so fast and effortlessly. This lies in the universality of constraints which are also similar in both adults and children. Because they are innate, they are given for free by UG. The child has a simple task of re-ranking them as evidence may demand. Problematic cased in which different repair mechanisms target the same marked form are handled through a ranked system of constraints avoiding rule duplication issues of the generative tradition. The child is able to acquire any language so easily because of the shared universal constraints which are also operative in in all languages. This may provide an account as to why children from diverse cultures and languages acquire their first language so effortlessly without any instruction and irrespective of the 'impoverished' adult input.

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References

Bavin, E. (2009). *The Cambridge handbook of child language*. Cambridge: Cambridge University Press.

Becker, M., & Tesser, A. (2011). Trajectories of faithfulness in child-specific phonology. *Phonology, 28(2), 163-196.* Cambridge: Cambridge University Press.

Beckman, J. (2004). Positional faithfulness. In J. J. McCarthy (Ed.), *Optimality theory in phonolog*y, (pp. 310-342). Malden Mass.: Blackwell.

Blevins, J. (1995). The syllable in phonological theory. In J. Goldsmith (Ed.), *The handbook of phonological theory*. Cambridge Mass: Blackwell.

Blevins, J. (2004). *Evolutionary phonology: The emergence of sound patterns*. Cambridge: Cambridge University Press.

Boersma, P., & Weenick, D. (2015). *Praat: Doing phonetics with a computer*. Version 6.0.37, retrieved 14 March 2016 from http://www.praat.org/

Bybee, J. (2001). *Phonology and language use*. Cambridge: Cambridge University Press.

Carlisle, R. (2001). Acquisition of syllable universals. *International Journal of English Studies*, 1(1), 1-19.

Chacha, L. (2007). Prenasalization and the IPA. *UCLA Working Papers in Phonetics*, pp.58-67.

Chomsky, N. (1965). *Aspects of a theory of syntax*. Cambridge, MA: MIT Press.

Chomsky, N. (1999). On the nature, use and acquisition of language. In W. C. Ritchie & T. K. Bhatia (Eds.), *Handbook of child language acquisition*, (pp. 33-54). San Diego: Academic Press.

Chomsky, N. (2000). *New horizons in the study of language and mind*. New York: Cambridge University Press.

Chomsky, N. (2004). Key note lecture, *GLOW 2004*. Thessaloniki Greece.

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

Clark, E. (2003). *First language acquisition*. Cambridge: Cambridge University Press.

de Lacy, P. (2004). Markedness conflation in Optimality theory. *Phonology,* 2(2), 1-55.

de Lacy, P. (2006). *Markedness reduction and preservation in phonology*. Cambridge: Cambridge University Press.

Dinnesen, D. (2004). A review of Rene Kager, Joe Pater & Wim Zonneveld (2004). *Phonology* 21(3), 431-440.

Flack, K. (2007). *Sources of phonological markedness*. Ph.D. Dissertation, Umass, Amherst.

Fikkert, P. (2000). 'Acquisition of phonology'. In L. Cheng & R. Sybesma (Eds.), *The First Glot International State-of-the-Article Book: The Latest in Linguistics,* pp. 221–250.

Fikkert, P. (2007). Acquiring phonology. In de Lacy (Ed.), *The Cambridge handbook of phonology,* (pp.539-554). Cambridge: Cambridge University Press.

Flemming, E. (2006). *The role of distinctiveness and constraints in phonology*. Ms MIT.

Gnanadesikan, A. (2004). Markedness and faithfulness in child phonology. In R. Kager, J. Pater & W. Zonneveld (Eds.), *Constraints in phonological acquisition*, (pp.73-108). Cambridge: Cambridge University Press.

Goldsmith, J. (2011). The syllable. In J. Goldsmith, J. Riggle & L. C. Yu (Eds.), *The handbook of phonological theory (*2nd ed.), (pp.164-196). Malden MA: Blackwell.

Hayes, B. (2004). Phonological acquisition in Optimality theory: The early stages. In R. Kager, J. Pater & W. Zonneveld (Eds.), *Constraints in phonological acquisition*, (pp.158-203). Cambridge: Cambridge University Press.

Jakobson, R. (1941). *Child language, aphasia and phonological universals*. The Hague: Mouton.

Kang, Y. (2000). *The phonetics and phonology of coronal markedness and unmarkedness.* MIT Ph.D. Dissertation.

Kiparsky, P., & Menn, L. (1977). On the acquisition of phonology. In J. McNamara (Ed.), *Language learning and thought*, (pp.47-78). New York: Academic Press.

Ladefoged, P., & Maddieson, I. (1996). *The sounds of the world's languages*. Malden Mass: Blackwell.

Levelt, C., & de Vijver, R. (2004). Syllable types in cross-linguistic and developmental grammars. In R. Kager, J. Pater & W. Zonneveld (Eds.), *Constraints in phonological acquisition*, (pp.204-218). Cambridge: Cambridge University Press.

Lombardi, L. (2002). Coronal epenthesis and markedness. *Phonology,* 19, 219-251.

Lombardi, L. (2003). *Markedness and the typology of epenthetic vowels.* Rutgers: [ROA]

Lust, B. (2007). *Child language: Acquisition and growth*. Cambridge: Cambridge University Press.

Maddieson, I., & Ladefoged, P. (1993). Phonetics of partially nasal consonants. In M. K. Huffman & R. Krakow (Eds.), *Nasals, nasalization and the velum*. (pp.251-301). San Diego: Academic Press.

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

Menn, L. (1976). *Pattern, control and contrast in beginning speech: A case study in the development of word form and word function*. UIU PhD Dissertation.

Mgullu, R. S. (2001). Mtalaa wa isimu: Fonetiki, fonolojia na mofolojia ya Kiswahili. Nairobi: Longhorn Publishers.

Nandelenga, H. (2015). The Lubukusu syllable structure in Optimality Theory. *The International Journal of Humanities and Social Studies,* 3 (3), 86-101.

Odden, D. (2017). Markedness in substance free and substance dependent phonology. In B. Samuels (Ed.), *Beyond markedness in formal phonology*, (pp.1-22). Amsterdam: John Benjamins Press.

Paradis, C., & Prunet, J. (Eds.). (1991). *The special status of coronals: Internal and external evidence*. San Diego: Academic Press.

Plunkett, K. (1998). Language acquisition and connectionism. *Language and Cognitive Processes,* 13(2-3), 97-104.

Prince, A., & Smolensky, P. (1993/2004). *Optimality theory: Constraint interaction in generative grammar*. Rutgers University. Malden Mass: Blackwell.

Rice, K. (2007). Markedness in phonology. In P. de Lacy (Ed.), *The Cambridge handbook of phonology,* (pp.79-98). Cambridge: Cambridge University Press.

Saxton, M. (2017). *Child language*. Thousand Oaks: Sage Publications.

Smith, N. (1973). *The acquisition of phonology: A case study*. Cambridge: Cambridge University Press.

Smith, N. (2009). *Acquiring phonology: A cross-generational case study*. Cambridge: Cambridge University Press.

Stampe, D. (1973). *A dissertation on Natural phonology*. University of Chicago. PhD.

Tesar, B., & Smolensky, P. (2000). *Learnability in Optimality theory*. Cambridge MA: MIT Press.

Tomasello, M. (2000). First steps toward a usage-based theory of language acquisition. *Cognitive Linguistics*, 11(1-2), 61-82.

Zamuner, T., LouAnn, G., & Hammond, M. (2004). Phonotactic probabilities in young children's speech production. *Journal of Child Language,* 31, 515-536.

Zec, D. (2007). The syllable. In de Lacy (Ed.), *The Cambridge handbook of phonology,* (pp.161-194). Cambridge: Cambridge University Press.

Appendix 1: Developmental Milestones & Data

Note the subj=subjects, [-] implies the subject has acquired the target form in the preceding stage or previous stages. The period indicates syllable boundary. The gloss and the orthographic representation appear in Appendix 2: The Input (OR), Output (PR) and the Gloss. Note: OR=Orthographic Representation, PR=Surface (Phonetic) Representation.

Subj	**Tokens**	**Y1**	**Y1:6**	**Y2**	**Y2:6**	**Y3**	**Y4**	**Y5**
MS1	[ma.ma]	[mama]	[-]	[-]	[-]	[-]	[-]	[-]
MS2	[ma.ma]	[mama]	[-]	[-]	[-]	[-]	[-]	[-]
MS1	[ba.ba]	[papa]	[papa]	[baba]	[-]	[-]	[-]	[-]
MS2	[ba.ba]	[papa]	[papa]	[baba]	[-]	[-]	[-]	[-]
MS1	[m̩.to.to]	[to]	[toto]	[itoto]	[mutoto]	[mutoto]	[mutoto]	[mutoto]
MS2	[m̩.to.to]	[to]	[toto]	[utoto]	[mutoto]	[mutoto]	[mutoto]	[mutoto]
MS1	[sa.ha.ni]	[ni]	[jani]	[ja:ni]	[ca:ni]	[ʃa:ni]	[sa:ni]	[sahani]
MS2	[sa.ha.ni]	[ni]	[jani]	[a:ni]	[ca:ni]	[ʃa:ni]	[sa:ni]	[sahani]
MS1	[ɲu.ᵐba]	[pa]	[jupa]	[uba]	[u:ba]	[u:ᵐba]	[[ɲuᵐba]	[-]
MS2	[ɲu.ᵐba]	[pa]	[jupa]	[cuba]	[cu:ba]	[u:ᵐba]	[[ɲuᵐba]	[-]
MS1	[ca.ku.la]	[ja]	[uja]	[akuja]	[cakuja]	[cakula]	[-]	[-]
MS2	[ca.ku.la]	[ja]	[uja]	[akuja]	[cakuja]	[cakula]	[-]	[-]
MS1	[ma.ti.ti]	[ti]	[titi]	[atiti]	[matiti]	[-]	[-]	[-]
MS2	[ma.ti.ti]	[ti]	[cici[	[aθiθi/ʃiʃi]	[maiti]	[-]	[-]	[-]
MS1	[la.la]	[ja]	[aja]	[jaja]	[laja]	[lala]	[-]	[-]
MS2	[la.la]	[ja]	[jaja]	[jaja]	[jala]	[lala]	[-]	[-]
MS1	[ga.ri]	[ji]	[aji]	[jaji]	[kaji]	[kali]	[gali]	[gari]
MS2	[ga.ri]	[ji]	[jaji]	[kaji]	[kaji]	[kali]	[gali]	[gari]
MS1	[ða.ᵐbi]	[pi]	[api]	[tapi]	[tabi]	[taᵐbi]	[daᵐbi]	[θaᵐbi]
MS2	[ða.ᵐbi]	[pi]	[api]	[tapi]	[tabi]	[taᵐbi]	[θaᵐbi]	[θaᵐbi]
MS1	[sa.fi]	[pi]	[api]	[capi]	[ʃapi]	[ʃafi]	[safi]	[-]
MS2	[sa.fi]	[pi]	[api]	[capi]	[fafi]	[ʃafi]	[safi]	[-]
MS1	[me.za]	[me]	[meca]	[meca]	[meʃa]	[mesa]	[meza]	[-]
MS2	[me.za]	[me]	[meca]	[meca]	[meʃa]	[mesa]	[meza]	[-]
MS1	[va:]	[pa]	[pa:]	[paja]	[faja]	[fa:]	[va:]	[-]

MS2	[va:]	[pa]	[pa:]	[paja]	[faja]	[fa:]	[va:]	[-]	
MS1	[ŋo.^{m}be]	[pe]	[mope]	[obe]	[o:be]	[o: ^{m}be]	[o: ^{m}be]	[ŋo^{m}be]	
MS2	[ŋo.^{m}be]	[pe]	[ope]	[obe]	[o:be]	[o: ^{m}be]	[o: ^{m}be]	[ŋo^{m}be]	
MS1	[ɣa.li]	[ji]	[jaji]	[aji]	[kaji]	[kali]	[gali]	[gali]	
MS2	[ɣa.li]	[ji]	[jaji]	[jaji]	[kaji]	[kali]	[gali]	[gali]	
MS1	[n̩.ne]	[ne]	[ne]	[nene]	[ene]	[ine]	[ine]	[ine]	
MS2	[n̩.ne]	[ne]	[ne]	[nene]	[ene]	[ine]	[ine]	[ine]	
MS1	[mwa.na]	[ma]	[mama]	[mana]	[ana]	[muwana]	[muana]	[mwana]	
MS2	[mwa.na]	[ma]	[mama]	[mana]	[ana]	[muwana]	[muana]	[mwana]	
MS1	[sa.li.mi.a]	[ma]	[ija]	[mija]	[ami:ja]	[ʃa:milia]	[samilia]	[salimia]	
MS2	[sa.li.mi.a]	[ma]	[ija]	[mija]	[ami:ja]	[camilia]	[samilia]	[salimia]	
MS1	[ka.la.mu]	[mu]	[amu]	[a:mu]	[ka:mu]	[kajamu]	[kalamu]	[-]	
MS2	[ka.la.mu]	[mu]	[amu]	[a:mu]	[ka:mu]	[kajamu]	[kalamu]	[-]	
MS1	[hu.ju]	[u]	[u.u]	[ju:]	[juju]	[uju]	[uju]	[huyu]	
MS2	[hu.ju]	[u]	[ju:]	[ju:]	[juju]	[uju]	[uju]	[huyu]	
MS1	[a.ca]	[ja]	[ca]	[aca]	[-]	[-]	[-]	[-]	
MS2	[a.ca]	[ja]	[ca]	[caca/jaca]	[-]	[-]	[-]	[-]	
MS1	[e.^{m}be]	[pe]	[pepe]	[epe]	[ebe]	[e$_{m}$be]	[-]	[-]	
MS2	[e.^{m}be]	[pe]	[pepe]	[jepe]	[jebe]	[e$_{m}$be]	[-]	[-]	
MS1	[fu.^{n}za]	[ja]	[ca]	[uca]	[fuca]	[fuʃa]	[fu^{n}ɟa]	[fu^{n}ɟa]	
MS2	[fu.^{n}za]	[ja]	[ca]	[uca]	[fuca]	[fuʃa]	[fu^{n}ɟa]	[fu^{n}sa]	
MS1	[ɟa.na]	[ja]	[jana]	[cana]	[cana]	[ʃana]	[ɟana]	[-]	
MS2	[[ɟa.na]	[ja]	[jana]	[cana]	[ʃana]	[ʃana]	[ɟana]	[-]	

Appendix 2: The OR, PR Data and the English Gloss

Input (OR)	Output (PR)	English Gloss	Input (OR)	Output (PR)	English Gloss
1. mama	[ma.ma]	Mother	13. safi	[sa.fi]	Clean
2. papa	[pa.pa]	Father	14. meza	[me.za]	Table
3. mtoto	[m̩.to.to]	Baby	15. vaa	[va:]	Dress up
4. sahani	[sa.ha.ni]	Plate	16. ng'ombe	[ŋo.ᵐbe]	Cow
5. nyumba	[ɲu.ᵐba]	House	17. ghali	[ɣa.li]	Expensive
6. chakula	[ca.ku.la]	Food	18. nne	[n̩.ne]	Four
7. matiti	[ma.ti.ti]	Breasts	19. mwana	[mwa.na]	Child
8. lala	[la.la]	Sleep	20. salimia	[sa.li.mi.a]	Greet
9. gari	[ɡa.ri]	Vehicle	21. kalamu	[ka.la.mu]	Fountain pen
10. dhambi	[ða.ᵐbi]	Sin	22. huyu	[hu.ju]	This (person)
11. acha	[a.ca]	Leave(let go)	23. embe	[e.ᵐbe]	Mango
12. funza	[fu.ⁿza]	Teach	24. jana	[ɟa.na]	yesterday