# A STRATAL OPTIMALITY THEORETIC ACCOUNT OF STANDARD ODIA

***Dissertation Submitted to Jawaharlal Nehru University***
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***for the award of the degree of***

**MASTER OF PHILOSOPHY**

**(LINGUISTICS)**

**By**

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Dated 20th July 2018

## CERTIFICATE

This thesis titled **"A Stratal Optimality Theoretic Account of Standard Odia"** submitted by **Ms. Anusuya Nayak**, Centre for Linguistics, School of Language, Literature and Culture Studies, Jawaharlal Nehru University, New Delhi, for the award of the degree of Master in Philosophy, is an original work and has not been submitted so far in part or in full, for any other degree or diploma of any University or Institution.

This may be placed before the examiners for evaluation for the award of the degree of Master of Philosophy.

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# DECLARATION

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This thesis titled **"A Stratal Optimality Theoretic Account of Standard Odia"** submitted by me for the award of the degree of Master of Philosophy, is an original work and has not been submitted so far in part or in full, for any other degree or diploma of any University or Institute.

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# ABBREVIATIONS AND SYMBOLS

| | |
|---|---|
| LPM | Lexical Phonology and Morphology |
| OT | Optimality Theory |
| H | Heavy Syllable |
| L | Light Syllable |
| ´ | Primary Stress |
| ` | Secondary Stress |
| < > | Extrametricality of a Prosodic Constituent |
| σ | Syllable |
| Σ | Foot |
| / / | An Underlying Representation |
| [ ] | Surface Form |
| ☞ | Optimal Output |
| ♣ | Correct Surface Form (Non-Optimal Candidate) |
| * | Violation Marks |
| ! | Fatal Violation |

# INDEX OF CONSTRAINTS

Due to the variation in the practice of different researchers in Optimality Theory, constraints having different names may have the same definition. Therefore, I shall indicate them below. The constraints mentioned in boldface type are innovations by the present work.

**Faithfulness Constraints**

IDENT (Acc)

IDENT-STRESS

IDENT-IO (stress)

MAX –IO

DEP –IO

**Prosodic Markedness Constraints**

*μμ́.μ]

FTBIN

PARSE- σ

GrWd= PrWd

*CLASH

**α]σ-EX(σσσ)**

NOHIATUS

***V(back)**

**Alignment Constraints**

ALIGN

ALIGN-L

LEFTMOST

ALIGN (Stem,R; PrWd, R)

ALIGN (Hd-σ; Ft, L)

# *Chapter 1*

# INTRODUCTION

## 1.1 Research Problem

In this study, I explore the phenomenon of opacity in phonological stress in Odia, an Indo-Aryan language spoken in the state of Odisha. The variety I am investigating is the Standard Odia, spoken in eastern parts of Odisha. Opacity refers to the "counterintuitive quirk of phonological grammars" (Bermúdez-Otero, 1999; 56). The purpose of this thesis is to draw upon insights from the morphosyntactic conditioning of phonological rules so that the same can be applied to study opacity with respect to stress preservation in Odia complex words. I employ empirical investigations to study the nature of opaque phonological rules caused due to stress preservation in Odia and use the results to argue for a particular version of Optimality Theory: Stratal Optimality Theory (Bermúdez-Otero, 1999, 2003; Kiparsky, 2000, 2003a). The theoretical aim of the present work is to resolve the problems of opacity due to the apparent contradiction between the phonological processes and the morphosyntactic units by proposing a Stratal Theoretic approach in which different morphological constituents are evaluated at distinct strata.

"Stress preservation is an indicator of the relationship between words" (Collie, 2007). It is a phenomenon whereby a complex word preserves the stress pattern of the word embedded within it: for example the words, *phenòmenólogy (phenómenon)* and *orìginálity (original)* showcase the stress preservation in English.

Stress Preservation has garnered a lot of attention in various generative theories since Chomsky and Halle's *Sound Patterns of English*, where they analysed English stress preservation to showcase one of their major theoretical innovations-the cycles. The study of stress preservation provides us insights into two key areas of generative phonology: the nature of the interface between phonology and morphology and the phenomenon of phonological opacity. This thesis aims to explore the areas of stress preservation, the interfacing of phonology and morphology and the opaque phonological rules in Standard Odia within the framework of Stratal OT.

(1) Odia Stress Preservation:

| Embedding word | Embedded word |
|---|---|
| a) *pɔ̃́hɔɾabàla* | *pɔ̃́hɔɾa* |

b) *mánɔbìkɔṯa* *mánɔbìkɔ*

c) *suńḏɔɾɔpɔ̀ɳia* *suńḏɔɾɔpɔ̀ɳɔ*

The phenomenon of stress preservation causes the complex words to differ in the stress patterns from the phonotactically similar morphologically simple words such as:

(2) Contrast between complex and simple words:

| Complex word | Simple word |
|---|---|
| a) *pɔ̃́.hɔ.ɾa.bà.la* | *ɔ́.pɔ.ɾà.ḏʰɔ* |
| b) *má.nɔ.bì.kɔ.ṯa* | *tʃín.ṯa.ḏʰà.ɾa* |
| c) *sún.ḏɔ.ɾɔ.pɔ̀.ɳi.a* | *ɔ́n.ḏʰa.ɾɔ* |

Odia does not have more than four syllables in simple words. We can see in (2) that in the simple words the initial syllable always receives the primary stress and then the eurhythmic stress assigns secondary stress to the penultimate syllable. But, in the complex words, this is clearly not the case. If we go back to (1) we will observe that the complex words in the first column preserve the stress pattern of the embedded word given in the second column.

The phenomenon of stress preservation leads to the opacity of stress rules in Standard Odia. "Opacity arises from inter-level constraint masking" (Kiparsky, 2003; 13). In light of the theory of OT which has proved successful in accounting for prosody, we shall prove in this thesis that a phenomenon such as stress preservation is problematic for this theory. The Classic Optimality theory model inherently being a strictly parallel and surface oriented model encounters problem in the analysis of opaque relations. The failure of the parallel model of OT to account for the opaque phonological rules led to the development of the Stratal OT model in which the principle of strong parallelism of the classical OT model is compromised and the notion of level segregation and cyclicity of the Lexical Phonology and Morphology model are incorporated.

There are a long complex and intellectual history behind the development of the model of Stratal OT. The theory was proposed by both Bermudez Otero (1999, 2003) and Kiparsky (2000, 2003a). The theory was developed to encapsulate three powerful ideas: the phonological cycle, phonological stratification and the parallel constraint-based computation in the manner of OT. Stratal OT is a merger of the main tenets of two main theories: Lexical Phonology-Morphology (LPM) and Optimality Theory.

Both the theories LPM and Optimality Theory are intrinsically distinct from one another. LPM is a morphology-phonology interface that accounts for the interactions between morpho-syntactic constituents and the phonological processes implemented in a rule-based framework until the advent of constraint-based theories. But, in no way is LPM an intrinsically rule-based theory. However, Optimality theory is a parallelist approach that deals with constraint interactions by, its principle idea being the ranking of these universal and violable constraints and that violations are minimal. Stratal OT combines both these theories. As Kiparsky surmises “Stratal OT is not LPM dressed up in OT costume.....it is more like a happy marriage”. The theory of Stratal OT is not a hybridization of both the theories, neither is it the implantation of LPM onto OT nor is it the other way around. It is also not a compromise between them. “It combines the mutually compatible aspects of both the theories, which complement each other because they deal with different things” (Kiparsky, 2003).

### 1.2 Scope and Objective of the Thesis

This thesis would have three principal outcomes: Firstly, it will provide an analysis of the metrical stress pattern of Odia words in both derived and non-derived environments. Secondly, it will throw light upon the phenomenon of stress preservation and to what extent it exists in Odia and talk about its precise nature. Thirdly, it will support the theoretical innovation of Bermúdez-Otero, which is a version of OT: the Stratal OT model. The versions of Stratal OT employed in this thesis are the models presented in Kiparsky (2000), Bermúdez-Otero (2003) and Bermúdez-Otero and McMahon (2006).

### 1.3 Methodological Approach

In principle, it requires to work out the entire phonology and morphology to motivate the strata and find out the phonology-morphology interactions of a language. For the proposed research, a collection of words including all monosyllabic, di-syllabic, polysyllabic and compound words formed by affixation and concatenation were collected from a participant pool consisting of 8 SPEAKERS.

Amongst this half were male and half were female. The participants were selected from the age bracket of 30 to 50. This age group was preferred so that the participants were consciously aware of the target language and had required native speaker competence. Since some of the speakers were monolingual, translation method could not be used. I intended to employ the Pictorial Stimulus-Driven Elicitation method where pictorial stimuli (photos, drawn pictures, videos) were displayed on the computer screen and the participant was required to describe it & also the reading method where the words were employed in framed sentences to capture the natural speech.

The recordings were done in a controlled setting in a noise-free space with a premium unidirectional professional microphone (Transcend MP330 Direct Line in Recorder). Each word was recorded three consecutive times to obtain satisfactory results. The data were thereafter transcribed with narrow transcription. The recordings were dissected for checking finer properties like pitch, vowel duration and the fundamental frequency to evaluate the vowel quality using software like PRAAT.

### 1.4 Brief Introduction of Odia Language

Odia is an Indian classical language spoken by approximately 4.2% of nation's population. It is spoken majorly in eastern India, with its speakers mostly belonging to the state of Odisha. Along with Odisha, it’s also spoken in parts of West Bengal, Jharkhand, Chhattisgarh, and Andhra Pradesh

It is the sixth Indian language to be elected as one of the Classical Languages of India owing to its long literary history and its unique vocabulary.

The Odia of Mughalbandi, also known as Kataki. Odia is regarded as Standard Odia because of its literary traditions, mainly spoken in the eastern half of Odisha (Districts: Khurdha, Puri, Cuttack, Jajpur, Jagatsinghpur, Kendrapada, Dhenkanal, Angul and Nayagarh).

#### 1.4.1 Morphology and Syntax

Odia shows many similarities with the cases of Sanskrit. It has both accusative and dative markers although the nominative and vocative are usually merged without a separate marker. The three tenses are present, past and future while others being formed using auxiliaries. In Odia, two grammatical numbers i.e. singular and plural are evident.

Odia distinguishes between first, second, and third person. No morphological consequences have been identified for the gender of the noun, pronoun and the verb. Known for its inflectional richness, Odia carries number and case inflexions.

Odia has (SOV) subject–object–verb three-tier tense system. The moods present are indicative, imperative, subjunctive, and interrogative. In Odia, the finite verb agrees in person and number with its subject. Moreover, it marks the honorific form. There are cases where main clauses and some subordinate clause appear without a subject.

### 1.4.2 Phonology

Odia has thirty consonant phonemes, two semivowel phonemes and six vowel phonemes. Odia language possesses no consonant-ending words.

**CONSONANT INVENTORY OF ODIA**

| | | **Bilabial** | **Labio dental** | **Alveolar/ Dental** | **Retroflex** | **Palatal** | **Velar** | **Glottal** |
|---|---|---|---|---|---|---|---|---|
| **Stop/ Affricate** | **Voiceless** | p | | t̪ | ʈ | tʃ | k | |
| | **Voiceless Aspirated** | p$^h$ | | t̪$^h$ | ʈ$^h$ | tʃ$^h$ | k$^h$ | |
| | **Voiced** | b | | d̪ | ɖ | dʒ | g | |
| | **Voiced Aspirated** | b$^h$ | | d̪$^h$ | ɖ$^h$ | dʒ$^h$ | g$^h$ | |
| **Nasal** | | m | | n | ɳ | ɲ | ŋ | |
| **Fricative** | | | | s | | | | h |
| **Flap** | | | | ɾ | | | | |
| **Lateral Approximant** | | | | l | ɭ | | | |
| **Approximant** | | | ʋ | | | j | | |

| VOWEL INVENTORY | | |
|---|---|---|
| | **Front** | **Back** |
| **High** | i | u |
| **Mid** | e | o |
| **Low** | ɑ | ɔ |

**1.5 Thesis Structure**

The structure of the thesis is as follows:

In Chapter 2, I have outlined the theoretical context of the thesis. In section 2.1, the evolution of stratal phonology is discussed. In section 2.2, a brief introduction to the generative model of stratal phonology- Lexical Phonology and Morphology (LPM), is provided. In section 2.3 a general overview of Optimality theory (OT) is discussed. In section 2.4, the Stratal OT model which is the hybrid of its precursors OT and LPM is introduced. In section 2.5, I review the literature based on Stratal OT.

In Chapter 3, the metrical stress pattern of Odia in both simple and complex words is analysed. In this chapter, the stress rules governing the metrical stress pattern in Odia words is provided. In section 3.1, I review the literature based on stress. In section 3.2, the parameters for analysing stress such as Dominance, Quantity-sensitivity, Boundedness and Directionality and the notions of extrametricality, End Rule and the metrical grid are discussed. In section 3.3, I have discussed the phonetics cues for analysing stress in Odia. In section3.4, the metrical stress pattern in Odia simple words is analysed. Finally, in section 3.5, affixation in Odia words is discussed and then I have analysed the metrical stress pattern in Odia derived words.

In Chapter 4, a brief introduction to the phenomenon of opacity and its treatment in various generative models is provided. Section 4.1 talks about the treatment of opacity in Rule-based phonology. In section 4.2, an overview of the treatment of opacity in the OT model is given and also the major theories of OT such as the Trans-derivational

Correspondence Theory, the Sympathy theory and the Stratal models of OT that came up to solve the problem of OT in dealing with opaque phonological rules are also discussed. In Section 4.3, I take up the process of assignment of accent and intonation in the words of ancient Greek and discuss it within the model of OT. In ancient Greek, the process of accentuation and syllabification are serially ordered further leading to opacity. In Section 4.4, I highlight the failure of a strictly parallel model of OT to account for the phenomenon of opacity in ancient Greek. Finally, in Section 4.5, a brief introduction to the Stratal OT model is provided and how it successfully resolves the problem of treatment of opacity in the OT model is discussed.

In Chapter 5, the major focus of this thesis: stress preservation in Odia words is presented within the model of Stratal OT. In Section 5.1, a brief introduction to the phenomenon of stress preservation is provided. In Section 5.2, I have shown the failure of the classical OT model in treating stress preservation leading to opaque phonological rules in Odia. In Section 5.3, I illustrate how the opaque phonological rules caused due to stress preservation in Odia complex words can be accounted for successfully in the Stratal OT model. In Section 5.4, the emergence of morphology is introduced where I discuss the morphosyntactic conditioning of the phonological rules and introduce certain co-phonologies into the grammar of Stratal OT model. In Section 5.5, the version of Stratal OT (Bermudez-Otero & McMahon, 2006) with the fake cyclicity condition is employed and the Odia data depicting stress preservation is re-analysed within this model of Stratal OT. The model is thus supported as it resolves the problem of the strictly parallel model and provides a restrictive analysis to account for opacity successfully.

Finally, the thesis is concluded in Chapter 6.

# *Chapter 2*

# THEORETICAL CONTEXT OF THE THESIS

## 2.1 Introduction

This thesis draws upon works in diverse branches of phonology ranging from Metrical Phonology, Lexical Phonology and Morphology (LPM), Optimality Theory (OT) and Stratal Optimality Theory. This Chapter discusses these theories in relevant details but is not an exhaustive review in its entirety. However, a vast amount of literature is reviewed throughout the thesis wherever appropriate. The purpose of this thesis is to draw upon insights from the morphosyntactic conditioning of phonological rules so that the same can be applied to stress preservation in Odia words. Stress preservation as discussed in the literature of LPM is a result of cyclic phonological rules applying in distinct morpho-syntactic domains. The complex derived words preserve the stress pattern of their immediate subdomain and are therefore opaque to the phonological rules of stress assignment. The Classic Optimality Theory model inherently being a surface oriented theory encounters problems in the analysis of these opaque relations. The theoretical aim of the present work is to resolve the problems of opacity due to the apparent contradiction between the phonological processes and the morpho-syntactic units by proposing a Stratal Theoretic approach in which different morphological constituents are evaluated at distinct strata. Although OT is favoured by many linguists in disparate areas of linguistics, one of its major drawbacks has been to account for the phenomenon of opacity and cyclicity due to its adherence to strict parallelism for evaluation. Numerous theories were proposed to fulfil this drawback of OT such as the Cophonology Theory (Inkelas et al), OO Correspondence theory (McCarthy and Prince, 1995) that introduced various new constraints set to account for the problem of cyclicity and opacity in OT. In this thesis, I shall show how Stratal OT which basically is an incorporation of certain features of Lexical Phonology and Morphology and Optimality Theory, successfully resolves this problem of classical OT.

## 2.2 The Cycle

Chomsky and Halle in their founding work of Generative Phonology, *Sound Patterns of English* (1968) introduced the principle of the cycle for the application of phonological rules. It refers to the application of a sequence of phonological rules to the innermost phonological string without any morphosyntactic boundaries, in a morphologically or syntactically complex form. The rules go on applying recursively till all the internal morphosyntactic bracketing is deleted and the outermost complex form is achieved.

One of the principal motivations for the cycle has been the application of stress rules. The principle of cyclicity has been highlighted in many works of English stress preservation. “Stress preservation is an indicator of the relationship between a word and another word embedded within it” (Collie, 2007). The cycle is sensitive to the morphosyntactic structure of words could account for the difference in their stress patterns. Bermudez Otero (2003) showcases the different patterns of stress between English monomorphemic and morphologically complex words such as *orìginálity* vs *àbracadábra.* The morphologically complex word *orìginálity* retains the stress pattern assigned to its internal cycle *oríginal* whereas the monomorphemic word *àbracadábra* has no such internal cycle to adhere to thus accounting for the difference in stress pattern.  Chomsky and Halle in SPE also proposed for the presence of the cycle in compounds and phrases but this proposal was rejected by Liberman and Prince (1977) in their work on Metrical Phonology. Liberman and Prince argued that there was no requirement of the cycle to determine the stress pattern of compounds and phrases as the prosodic structure of these constituents could be directly projected from their syntactic trees.

Although the cycle had so many advantages yet, it has been rejected by many phonologists. One of the controversial characteristics of the cycle was suggested by Pater (2000): he suggested that if a word’s morphological structure predicts stress preservation to occur then the cycle ensures that stress preservation must occur. This is because the cycle ensures that a word’s morphological structure, whether complex or not, is reflected by its stress pattern. Stress preservation is sometimes prohibited in certain phonological contexts. For instance, in the word *oríginal* derived from the word *órigin*, stress preservation is permitted *(*òríginal)* as it would create a degenerate foot preserving stress on a light syllable preceding an immediately following stressed syllable. The cycle suggests that in cases where the phonological environment permits stress preservation and the morphological structure predicts so, stress preservation must occur without any fail. This poses a serious threat to the principle of the cycle as there are numerous evidences of the failure of stress preservation in contexts where it is totally permitted.

Stratal OT although similar to its predecessor Lexical Phonology and Morphology (LPM) in many aspects, discards one of its main principles which is the Strict Cyclicity condition (Kiparsky, 1982). Classical OT (Prince and Smolensky, 1993) was also against the concept of the cycle in any form and relied on strict parallelism. Bermudez Otero and McMahon (2006) in their Stratal OT model proposed the 'fake cyclicity' condition which suggested that the intra-stratum cyclicity of the Stratum 1 proposed in LPM model, doesn't really exist and can be done away with. This is derived from one of Selkirk's (1980) proposal, which I believe is relevant to the mechanism of fake cyclicity proposed by Otero: he argues that the morphologically complex words were stored in the speaker's memory along with their metrical stress pattern. As the complex words' stress patterns are already stored in the speaker's mental lexicon, the cycle that generated this metrical structure of these words is formally redundant. Therefore, under the principle of Occam's razor, Selkirk rejected the cycle. It wasn't the case that Selkirk rejected the phenomena of stress preservation but rather rejected the proclaimed mechanism of stress preservation which was the cycle as he believed that the mechanism behind stress preservation was historical. In line with this, the principle of fake cyclicity proposed by Otero almost resembles Selkirk's proposal. Fake cyclicity proposes that redundant morpho-phonological relationship between complex words and their bases does exist but as the stress patterns of these words are already stored in the mental lexicon, cyclicity is not the best way to account for these redundant relationships. I shall exemplify the theory of Stratal OT and the fake cyclicity condition in detail in Chapter 5 of the thesis. Before proceeding any further let us have a brief overview of the two important models on which Stratal OT is based.

## 2.3 Lexical Phonology and Morphology

### 2.3.1 Overview:

Lexical Phonology and Morphology (LPM) divulged from its generative predecessor in a very significant manner. Chomsky and Halle proposed in SPE that all the words and phrases of a language were generated by the syntax and phonology viewed all these morpho-syntactic structures at once in the form of boundary symbols such as, =, +, # and ##. Following Siegel's seminal work "Topics in English Morphology" (1974), LPM proposed that there is a separate morphological component called as the lexicon with its distinct set of phonological rules. The morphological and phonological rules are divided into different ordered levels or strata within this lexicon. Mohanan (1986) proposed the 'Bracket Erasure Convention' which suggested that the phonological rules were stratum-specific such that the phonological rule of a stratum could apply on a morphological domain if only that morphological constituent was derived by the morphological rules of that current stratum.

Thus the internal morphological structures of words of a higher stratum are opaque to the phonological rules of a lower stratum.

Kiparsky (1982, 1985), one of the main proponents of the theory of LPM, proposed two key concepts of the model of LPM: Strict Cyclicity and Structure Preservation. Strict Cyclicity is a principle of rule application that makes reference to the application of phonological rules across morpheme boundaries thereby referring to the morpho-syntactic structure of a word. Structure Preservation is another principle that constrains the application of a lexical rule such that no lexical phonological rule may correspond to or produce a segment that is not present underlyingly in the language. Therefore, LPM under the principle of Structure Preservation proposes that all allophonic rules of a language must occur post-lexically.

The number of strata to be proposed has been a matter of great discussion. Earlier models of LPM proposed number of lexical strata which were later discarded. Kiparsky in his (1982) model of LPM proposed the need of lexical strata whereas Halle & Mohanan (1985) and Mohanan (1986) proposed the need of four strata. However, the later models of LPM: Kiparsky (1985), Booij & Rubach (1987), McMahon (1990), Borowsky (1993), Giegerich (1994, 1999) have proposed the need for just two levels of lexical strata.

The major theoretical idea behind most of the models of LPM in the morphological component of the stratal organization of the lexicon has been affix-driven. Following Siegel's (1974) 'Level Ordering Hypothesis' the model of LPM is organized into serially ordered morphological levels. In Tandem, Selkirk (1982) proposed the 'Affix Ordering Generalisation' (AOG) which suggested the presence of an ordering among the attachment of affixes to a string such that an affix marked to attach to a morphological constituent at later stratum cannot attach inside an affix that is stated to attach to the morphological constituent at an earlier stratum. Therefore, the affixes present in the lower stratum are farther from the root whereas affixes present in a higher stratum are closer to the root. LPM has suffered a major setback due to the systematic violations of the AOG. For instance, Hurell (2001) discussed the violation of AOG in the word *ungrammaticality* where the stratum 2 prefix *un-* necessarily attaches before the stratum 1 suffix *–ity*.

To resolve the issues of affix ordering, Giegerich (1988) proposed a solution that rejected the affix driven organisation of morphology in the model of LPM. He retained the level ordering hypothesis of LPM and put forward the idea of a base-driven organization of the lexicon in LPM. He suggested that the morphological strata are defined by morphological base categories and not affixes. He argued for the presence of two morphological strata: Root and Word stratum. The root here does not refer to the conventional irreducible, morphologically simpler base form of a word but rather to a more complex form of a word. Giegerich argued that the morphological constituents undergoing stratum 1 affixation are the roots and since they are recursive in nature, they comprise of morphologically complex forms of words. On the other hand, words are the morphological elements that undergo stratum 2 affixations. They are also recursive in nature.

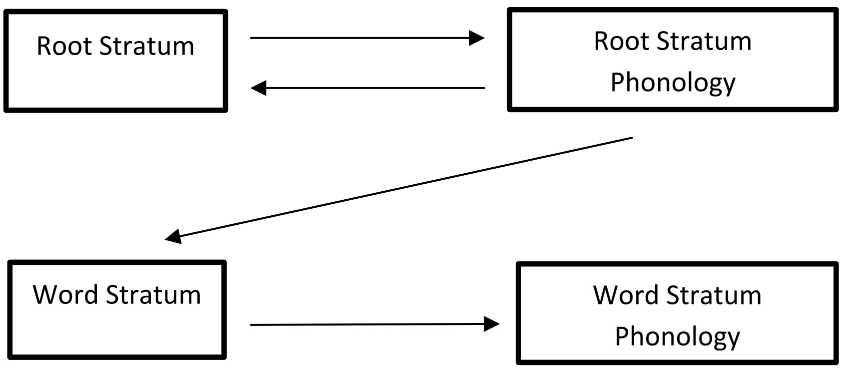



**Fig 2.1:** Giegerich's Lexical Model

Giegerich does not maintain the traditional notion of a 'root' that is an irreducible base of a word but refers to it as a recursive and a morphologically complex category. Giegerich's model enriched the previous model of LPM in a positive way as it improved two main issues faced by its affix-driven predecessors. Firstly, it resolved the problem of AOG violations such as affixes could belong to both the strata at the same time or can have a dual membership of both the strata. Secondly, his model inherently constrains the operation of cyclic phonological rules and not just stipulatively. This latter topic shall be discussed in the next section.

### 2.3.2 Stratum-Internal Cyclicity

It was proposed in the vast amount of literature on LPM that the highest stratum of the LPM model was internally cyclic. This internal cyclic nature of stratum 1 of the LPM model could account for the opaque phonological rules. The schematic representation of this would be as follows:

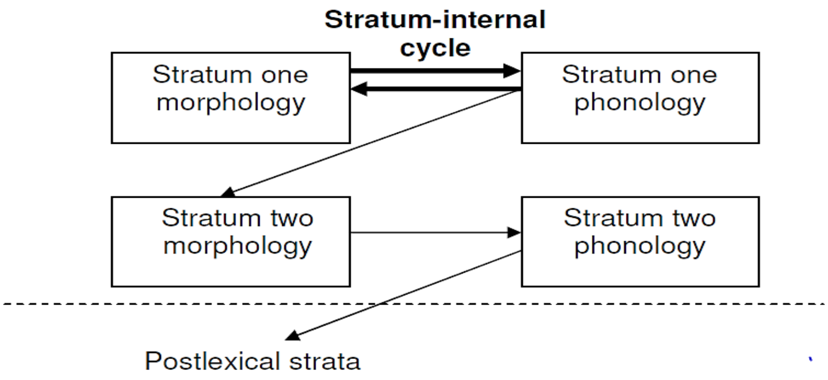



**Fig 2.2:** LPM model

The Stratum-Internal Cyclicity could be witnessed in the phonological rule of Trisyllabic Shortening (Kiparsky, 1982). In Trisyllabic Shortening, vowels are shortened if they belong to the stressed head of a derived word of the trisyllabic sequence. For example, *n/éː/tion* → *n/ǽ/.tio.nal*. The cyclicity of TSS could be seen in *n/ǽ/tionality* as in *nationality*, the initial syllable is not the stressed head and the word is not a trisyllabic sequence, yet we find that the vowel is shortened. This is because the initial syllable of *nætionality* has inherited its short vowel from the embedded word within it that is *nætional*. But, consider the word *nightingale.* Although the word satisfies the phonological requirements needed for the application of the phonological rule of TSS, yet, TSS seems not to have applied. This brings us to the principle of Strict Cyclic Condtion (SCC) proposed by Kiparsky (1982). The SCC was proposed in order to keep a check on the cyclic application of rules thus leading to derivational abstractness. Under the SCC, a phonological structure changing rule can apply only in derived environments. Thus, TSS is a structure changing the rule and is prohibited from applying in *nightingale* as it is a non-derived environment.

However, Stratal OT does away with the stratum internal cyclity and the principle of Strict Cyclic Condition. Stratal OT adopts Giegerich‘s base-driven model of stratification and rejects the stratum-internal cyclicity. It also rejects the principle of Structure Preservation of LPM on the grounds of Richness of the Base in OT which we shall see in the next section. As we know that Stratal OT is a particular form of Optimality Theory, it draws quite a bit of its theoretical framework from OT. Therefore, in the next section, I shall give a brief overview of OT and introduce some of its basic concepts.

## 2.4 Optimality Theory

Optimality Theory, a generativist theory was proposed by Prince and Smolensky in 1993 in *"Optimality Theory: Constraint Interaction in Generative Grammar"*. OT differs from the early rule-based generative theories in the way that it replaces the rules with universal, violable constraints for capturing the phonological generalisations. OT is all about constraint interaction. OT quite efficiently handles typological differences among languages. It proposes that all languages have their own language-specific constraint ranking and differ from each other in terms of their ranking of output constraints.

OT has two types of constraints: Markedness and Faithfulness constraints. Markedness constraints are well-formedness constraints that put emphasis over an unmarked structure over a marked structure as the former is cross-linguistically preferred whereas the latter is avoided mostly. Faithfulness constraints, on the other hand, are identity constraints that ensure to maintain the lexical contrast present in the underlying form or the input to reflect in the output. There are also another type of constraints, known as alignment constraints, which account for the stress pattern of a language. These constraints align the edge of a grammatical word with the prosodic categories.

One of the central assumptions around which OT revolves is that the constraints are universal and violable. The constraints are in constant interaction with each other. When two or more constraints have conflicting interests in a grammar, it is the ranking of the constraints that come into play. In order to find a resolution to this, the demands of a higher ranked constraint are always met even if that leads to the violation of a lower ranked constraint. This interaction of the violable constraints leads us to the optimal candidate. Fig 2 below shows the schematic representation of the OT model:

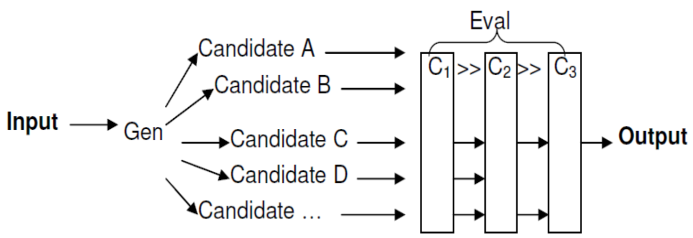



**Fig 2.3:** OT Model (Kager, 1999)

We can see from the above figure, the working of the OT grammar. OT has three main components: Gen, Eval and Con (constraints set). In the OT grammar, the input can be any linguistic form. The Gen (generator) takes the input and generates a bunch of potential output candidates. As we can see these candidates (A, B, C…) are fed into the Eval (evaluator) that contains the language's constraint set ranked hierarchically. The Eval evaluates the most harmonic candidates based on the ranking of the constraints and their interaction and finally provides the optimal candidate which is the output.

As we saw from the working of the OT grammar that anything can be posited in the input and that the language-specific ranking of the constraints and their interaction leads to the optimal out. The principle that ensures that the constraints only apply at the level of Output in OT is:

> Richness of the Base (Kager, 1999; 19)
> "No constraints hold at the level of underlying forms."

Another principle that is vital to the OT mechanism is the principle for Lexicon Optimization (Prince & Smolensky, 2004; 225). Lexicon Optimization states that in case of more than one inputs, the speaker chooses the input that is closest to the output. In the words of Prince and Smolensky (2004),

> "Suppose that several different inputs I1, I2,..., In when parsed by a grammar G lead to corresponding outputs O1, O2,..., On, all of which are realized as the same phonetic form F - these inputs are all phonetically equivalent with respect to G. Now one of these outputs must be the most harmonic, by virtue of incurring the least significant marks: suppose this optimal one is labelled Ok. Then the learner should choose, as the underlying form for F, the input Ik."

In OT, a tableau is used for depicting the constraint ranking and output evaluation. Following is an example from English:

| Input: /dɔg/ | IDENT-IO (voice) | *VOICED-CODA |
|---|---|---|
| a. [dɔk] | *! | |
| ☞b. [dɔg] | | * |

In the above tableau, we can see there is an input that is the language-specific underlying representation that provided to the Gen, in this case, /dɔg/. The Gen generates potential candidates (a) and (b): [dɔk] and [dɔg]. There are two constraints: the one to the left IDENT-IO (voice) is a higher ranked constraint whereas the one to the right *VOICED-

CODA is a lower ranked constraint. The ranking between the constraints is marked by bold lines. Had the constraints been mutually unranked with respect to each other, it would have been represented with the help of dotted lines. The '*' mark shows the number of violations and the '!' mark represents a fatal violation. The violations that occur after a fatal violation are of not much relevance and hence, are shaded. Finally, the most optimal candidate which is the output [dɔg] is marked with an index symbol (☞). As Stratal OT is a particular form of OT, it also adopts the tableaux and showcases the evaluation of the surface form with respect to the constraint ranking with the help pf the tableaux.

OT is a strictly mono-stratal model. Its strong emphasis for parallel evaluation is what makes it distinct from other rule-based generative theories. But there are certain phonological processes or rules that do require a serial treatment. OT tries to account for these with the help of ranking its constraints rather than ordering of rules. As we discussed, in the earlier example of *órigin* and *orìginálity*, where *orìginálity* retains its stress pattern from its immediate sub-domain that is *oríginal* and not its root word *órigin,* a serial approach for evaluation becomes inevitable. The word *orìginálity* remains opaque to the phonological rules of stress assignment, and this opacity is what OT cannot account for with its strict parallelist approach of evaluation. The stress preservation which is an unavoidable serial phenomenon poses a serious threat to the strongly parallel theory of OT. Bermudez Otero (2003) found no conceptual reason why strata could not be incorporated to the OT model. Since, classical OT was a strictly mono-stratal model, Otero proposed the model of Stratal OT. Stratal OT retains the parallel evaluation of OT but has a serial approach such that the grammar is divided into different strata where each strata has its own constraints and constraint ranking with its own parallel computation and the output of a higher stratum serves as the input to a lower stratum. We shall discuss more about the theory of Stratal OT in the next section.

### 2.5 Stratal Optimality Theory

Stratal Phonology is a theory of phonology that deals with the interaction of phonology with other components of grammar. It has fairly simple principles that different morphosyntactic structures determine different domains on which phonology applies cyclically and that these domains associated with different components of the morphosyntactic structure such as stems, words, and utterances have their own distinct phonological generalization. Stratal OT combines this hypothesis within the constraint-based framework of OT. Cyclicity and

Stratification are very important phenomena in the study of stratal phonology as they provided the common grounds for the rise of various stratal models of phonology.

Stratal OT is a relatively new theory with a complex and intellectual history behind its development. The theory was proposed by Bermudez Otero (1999, 2003) and is later enriched by Kiparsky (2003, 2014), Bermudez Otero and McMahon (2006) and Otero (2018, forthcoming). The theory was developed to encapsulate three powerful ideas: the phonological cycle, phonological stratification and the parallel constraint-based computation in the manner of OT. Stratal OT is a merger of the main tenets of two main theories: Lexical Phonology-Morphology (LPM) and Optimality Theory.

Both the theories LPM and Optimality Theory are intrinsically distinct from one another. LPM is a morphology-phonology interface that accounts for the interactions between morpho-syntactic constituents and the phonological processes implemented in a rule-based framework until the advent of constraint-based theories. But, in no way is LPM an intrinsically rule-based theory. However, Optimality theory is a parallelist approach that deals with constraint interactions by, its principle idea being the ranking of these universal and violable constraints and that violations are minimal. Stratal OT combines both these theories. As Kiparsky (2003) surmises "Stratal OT is not LPM dressed up in OT costume.....it is more like a happy marriage". The theory of Stratal OT is not a hybridization of both the theories, neither is it the implantation of LPM onto OT nor is it the other way around. It is also not a compromise between them. "It combines the mutually compatible aspects of both the theories, which complement each other because they deal with different things" (Kiparsky, 2003). The working of the Stratal OT model could be represented as follows:

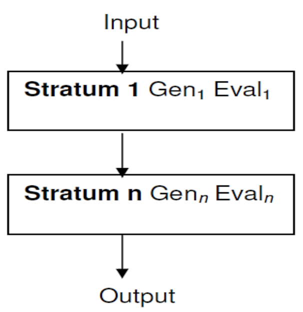



**Fig 2.4:** Stratal OT Model

As we already discussed in the previous section, the model of OT had one single stratum with parallel computation mechanism mapping the input to the output. In contrast to that, the Stratal OT model has several strata that are serially ordered which map the input to the output.

**2.6 Review of Literature**

Bermudez Otero in his work “*The acquisition of phonological opacity*” (2003) first proposed the formal theory of Stratal OT. He borrowed two main concepts from the previous theories of generative phonology: cyclic application and level segregation. Otero’s model although retained many key features of Lexical Phonology Morphology model such as level segregation, cyclicity, but it discarded one of its most important principle which is Structure Preservation. Otero adopted Giegerich’s LPM model which is base-driven. He proposed a three-level model, with two strata prescribed for word formation and the other strata for post-lexical operations. The morphological strata were defined by bases and not affixes. As the model was base-driven it solved the major issue for the treatment of dual level affixes. Griegerich had named his strata: root level and word level where the root level was recursive in nature. Otero divulged from this and called his strata: stem level and word level where the stem level was recursive in nature. This served as more convenient keeping in mind the traditional definition of root and stem where stems are marked for lexical category, unlike roots. Bermudez Otero found no conceptual reason why strata could not be incorporated into the OT model. Therefore, he called his model to be a particular form of OT. His model retains the parallel evaluation of OT but has a serial approach such that the grammar is divided into different strata where each strata has its own constraints and constraint ranking with its own parallel computation and the output of a higher stratum serves as the input to a lower stratum

Later in 2003, Kiparsky in his work “*Accent, Syllable Structure, and Morphology in Ancient Greek*” proposed a model of Stratal OT which he called as LPM-OT to account for the morpho-phonological processes of Ancient Greek. In ancient Greek, the process of assignment of pitch accent is dependent on the syllabification of the underlying representation of words. But, there are certain class of morphologically derived words that do not undergo this process of pre- surface syllabification but receive pitch accents based on their surface structure that has undergone several phonological processes such as deletion, contraction etc. The assignment of pitch accent in ancient Greek is a cyclic phenomenon and a classical model of OT with its strict parallelism approach could not account for this phenomenon of cyclicity. Hence, Kiparsky proposed to resolve this issue of OT by incorporating a stratal approach within it. He combined the two theories of Lexical, Phonology and Morphology and Optimality Theory. He took the characteristic feature of LPM which is the stratification of grammar into different strata or levels and implemented it within the framework of OT and was successful in capturing the problem of cyclicity. Kiparsky not only adopted the serially ordered strata with the inter-stratum cyclicity from the LPM model but also retained the intra-stratum cyclicity of the highest stratum. This inter-stratum cyclicity of stratum 1 attracted much debate later on especially from Otero & McMahon (2006) who proposed the 'fake cyclicity' condition.

Bermudez Otero and McMahon (2006) made a radical departure from the Stratal OT model proposed by Kiparsky (2003) that adopted LPM's principle of intra-stratum cyclicity which suggests that the highest stratum is cyclic in nature. They propose the "fake-cyclic" condition that suggests the internal noncyclic nature of the first stratum. The fake cyclicity condition arose in line with Selkirk's (1980) proposal, which suggested that the morphologically complex words were stored in the speaker's memory along with their metrical stress pattern. As the complex words' stress patterns are already stored in the speaker's mental lexicon, the cycle that generated the metrical structure of these words is formally redundant and should be avoided. Otero and McMahon suggested that all outputs of stratum 1 are stored in the lexicon along with their metrical stress pattern and are referred to as 'lexical entries'. For example in intra-stratum cyclicity a word such as *phenomenology* would be derived as follows: in the first cycle /*phenomenon*/ would be assigned stress and [*phenómenon*] would be derived and in the second cycle *phenómenon* would further undergo suffixation and the stress rules shall apply and [*phenòmenólogy*] would be derived. In Otero & McMahon's Stratal model [*phenòmenólogy*] would be derived in just one cycle as such:

| Input: /phe(nóme)non-ology/ | MAX-FOOTHead | ALIGN (ω, L; Σ, L) |
|---|---|---|
| a. (phè.no)me(nó.lo)gy | *! | |
| ☞b. phe(nò.me)(nó.lo)gy | | * |

The 'fake cyclicity' condition allows us to account for stress preservation in just one cycle. The input *phenómenon* is stored as a lexical entry in the lexicon. Whenever the speaker has to produce phenomenology, the lexical entry is called upon *phenómenon* and suffixation applies. Hence, the cycle giving us *phenómenon* is rendered redundant and is therefore avoided.

This claim of Otero & McMahon on fake cyclicity was supported by Sarah Collie in her work "*English stress preservation*" (2007) that provided psycholinguistic evidence to support the same. Collie gives evidence of weak stress preservation in English and provides psycholinguistic evidence of word frequency. He claims that stress preservation showcases the relationship between words and word frequency affects this strength of the relationship between words. The concept of 'fake cyclicity' of stratum 1 captured "the weak stress preservation's probabilistic dependence on word frequency" (Collie, 2007). As lexical entries are already stored in one's lexicon, fake cyclicity suggests that there is no need of cycle as it only leads to redundancy. Instead, weak stress preservation occurs due to blocking among stored lexical items. As blocking is established as a "psycholinguistic phenomenon that is probabilistically dependent upon word frequency", in his study he provides a psycholinguistic perspective by studying word frequency in English that further support the principle of "fake cyclicity".

Another mentionable work in this area: "*Parallel Evaluation in Stratal OT*" (2009) by Adam Baker, tries to modify the model of Stratal OT developed by Kiparsky and Otero. The alternative model of Baker does away with Stratal OT's serial evaluation and maintains classical OT's parallel evaluation by evaluating one constraint hierarchy that chooses three optimal candidates belonging to the three domains given by Stratal OT namely stem, word and phrase and defines certain limited and principled correspondences between these candidates. Baker in this model breaks down phrase into strings of words and further divides words into stems and affixes. Where Stratal OT has different constraint hierarchies for different strata, Baker's model consists of a single constraint hierarchy that gives three different outputs for the three domains. He predicted that "*all variations between levels is the result of variations between the ranking of faithfulness and markedness constraints, but never between markedness constraints"*.

Kiparsky tried to showcase Stratal OT's efficiency in handling the derivational residue of cyclicity and opacity in his work "*Reduplication in Stratal OT*" (2010) where he dealt with the morpho-phonological process of reduplication. Kiparsky chooses prosodic morphology as it is a massive source of opacity for two reasons: it can involve operations that mask phonological conditioning and in prosodic morphology phonology masks morphology. In the classical OT approach, a special correspondence is drawn between the reduplicant and the two representations of the base: input and output. In the Stratal OT model, Kiparsky proposes that there are no reduplication-specific constraints. The shape of a reduplicant is predicted by the interaction of normal faithfulness and markedness constraints in a language-specific constraint ranking system. He argues that there is nothing morphologically special about reduplicated forms and phonologically their outputs behave like normal affixed forms and compounds. Kiparsky claims that Stratal OT is superior to classical OT in handling opacity with respect to its expressive power and theoretical simplicity. OT can predict linguistically impossible generalizations that are correctly excluded by Stratal OT. Additionally, OT requires extra machinery to deal with opacity whereas nothing needs to be added to Stratal OT to account for opacity or cyclicity.

Kiparsky finally formalized the theory and model of Stratal OT in his paper *"Stratal OT: Synopsis and FAQs"* (2014) where he meticulously draws the outline of the framework of Stratal OT. He explains the advantages of Stratal OT over other theories in dealing with opaque phonological processes. He approves of Otero's adoption of Giegerich model of Lexical Phonology and Morphology which had three hierarchically ordered strata: stems, words and phrases. He describes the failure of rule-based phonology and transderivational OT to deal with opacity where the former does not "reveal any theoretically significant distinction between opaque and transparent rule ordering" (Kiparsky, 2015) and the latter ties up opacity to a particular morpheme or lexeme. On the other hand, drawing insights from Catalan, Kiparsky proposes that Stratal OT retains the descriptive and explanatory gains of classical OT while accommodating issues of cyclicity and opacity. Stratal OT derives opacity in a "principled way from the organization of the grammar, specifically from the interaction of morphology and phonology in a stratified grammar and lexicon" (Kiparsky, 2000).

A Study by Darya Kavitskaya and Peter Staroverov titled "*Stratal OT and underspecification: Evidence from Tundra Nenets*" (2016) provided a detailed analysis of opacity in Tundra Nenets, a Uralic language spoken in Arctic Russia and Northern Siberia. They study the metrical vowel deletion which is a case of self-counterfeeding opacity and its interaction with vowel deletion in final syllables. They show the failure of other OT theories such as OT-CC, Targeted constraints etc. to account for the opacity in Tundra Nenets and the swift ease with which Stratal OT accounts for all the variabilities.

Bermudez Otero in his paper *"Stratal Phonology"* (2018) demarcated the framework of Stratal OT. The paper argued the explanatory superiority of Stratal OT in dealing with phonological opacity as compared to other alternative OT treatments. He laid out the two important claims of Stratal OT: Structure of a Cyclic Domain is Sparse i.e. few morphosyntactic constituents can trigger phonological cycles and that there are different phonological processes for cyclic nodes of different domains or ranks. These domains refer to the concept of root, stem and word. Roots do not define cyclic domains and stems and words define cyclic domains for the stem level and word level. In the post-lexical phonology, utterances define cyclic domains for the phrase level. The affixes are grouped into these strata or domains depending on their morpho-syntactic features. Each stratum has its own phonological functions that are specified by the ranking of different constraints. The derivatives adhere to the strict cyclicity phenomenon: the output of a lower ordered stratum becomes the input of a higher ordered stratum. Otero then goes on to explain the non-recursive nature of the word level and phrase level phonology as compared to stem level phonology by drawing generalizations from a Stratal OT account of German derivatives. For instance, phrase level phonology applies just once over the entire utterance. Likewise, a word level domain is rarely found to be embedded within another word level domain. On the contrary, stem level domains are usually found embedded within domains of the same type. He further gives a Stratal OT account of English dual level affixes. For example, in English, the adjectival suffix –able behaves as a stress neutral suffix in the adjective *pa̍rodiable*, derived from the verb *pa̍rody* whereas in the adjective *reme̍diable* derived from the verb *re̍medy*, it behaves as a stress affecting suffix causing the primary stress to shift to the right. Steriade (1999) proposed that *reme̍diable* is faithful to the metrical contour of a pre-existent adjective *reme̍dial* whereas *pa̍rodiable* doesn't have any such precedent. He referred to this as Lexical Conservatism. Otero provides an alternative analysis to this in Stratal Phonology. He claims that the suffix –able is a dual level suffix that can occupy two structural positions and its stratal affiliation depends upon the morpho-syntactic feature of its base. It can attach to both inflectional and derivational stems. When it attaches high to an inflectional stem, it behaves as a word level suffix and hence is stress neutral and when it attaches low to a derivational stem it behaves as a stem level suffix and hence is stress affecting. Lastly, Otero discards the Affix Ordering Generalization that prevents the word level phonology to apply before the stem level phonology as the Stratification generalization of Stratal OT suffices to do the job.

In this thesis, I shall be showing the stress preservation in Odia derived words and would talk about the opaque phonological rules. As I have already discussed the failure of the classical OT model to capture the stress preservation and the opaque phonological rules due to its inherent mono-stratal and strict parallelism nature, I shall propose to solve the issue and account for Odia weak stress preservation and opaque phonological rules using the Stratal OT model. I shall, in particular, adopt the model proposed by Bermudez Otero (2003) and Bermudez Otero & McMahon (2006) that talked about the phenomenon of fake cyclicity. To proceed further with our discussion on stress preservation in Odia complex words and to account them within the framework of Stratal OT, I need to first establish the metrical stress pattern of Odia. In the next chapter of this thesis, I shall discuss the Metrical Stress Theory of Odia.

## *Chapter 3*

# METRICAL-BASED ANALYSIS OF WORD STRESS PATTERN IN ODIA

### 3.1 Introduction

Metrical Stress Theory, proposed by Hayes (1981) provides a non-linear account of stress in natural languages. His theory posited a hierarchical structure that is capable of representing stress patterns in the minds of speakers. Hayes' primary content of the universal theory of metrical structure lies in the area of tree geometry. He proposed a simple rule schema in which a number of independent parameters are set; the possible combinations of these can predict and account for the various stress patterns occurring in different languages. In line with Hayes's theory, in the current chapter, I shall analyse and outline word stress pattern of Odia in both derived and non-derived environments in the light of the principles and parameters of syllable quantity, foot inventory, directionality and extrametricality.

### 3.2 Review of Literature on Stress

Trager and Smith's "An Outline of English structure" (1957) was one of the first works where the phenomenon of stress was given a formal account. Trager and Smith found that in English utterances consisting of more than one vowel, there was a marked difference in loudness among the vowels. After a systematic analysis, they observed that this difference in loudness was not random but consistent with relative strengths and the location of these vowels was constant within systematic possibilities of variation. The utterances with single vowels had the loudness equal to the greatest loudness found in larger utterances under similar style, emphasis etc. They presumed that this indicated towards the presence of some phonemic entity. They proposed this feature of loudness as the presence of a stress phoneme, called as PRIMARY stress and was marked on the vowel bearing it with the help of an accent mark /'/. As Trager and Smith only examined the feature loudness within a word, they did not discard the vowels with softer loudness as merely being the absence of /'/, but considered them as allophones of the phoneme of loudness, and called them as WEAK stress. They introduced four levels of phonemic prominence in English in descending order such as ´, ˆ, ` and ˘.

Later in 1968, Chomsky and Halle's *Sound Patterns of English*, which was one of the foremost formal models of phonological analysis, represented stress as having a featurevalue [± stress], consisting of linear strings of segments and boundaries. Chomsky and Halle in their analysis of stress in English used integers in place of Trager and Smith's symbols. They encoded the relative degree of prominence among vowels numerically like [1stress], [2stress] and so on. This was in contrast to their basic claim of phonological features having binary values. The next assumption made by Chomsky and Halle was that they derived word stress via rules in which long stretches of vowels and consonants were included in the context of the rule. This further led to the proposal of the Stress Subordination Convention that emphasized that if a rule affects a segment locally, it may affect all the other segments in the string that undergo the same rule. In order to account for stress in compounds and phrases in English, Chomsky and Halle proposed the Compound Stress Rule (CSR) wherein the penultimate word in a compound bears the stress and the Nuclear Stress Rule (NSR) wherein the final word in a phrase bears the stress as in:

| | | | |
|---|---|---|---|
| (1) | Compounds: | bóttle brùsh | 1 2 |
| | Phrases: | Jòhn rúns | 2 1 |

They further stated the cyclicity of the stress rules: "it is natural to suppose that in general the phonetic shape of a complex unit (a phrase) will be determined by the inherent properties of its parts and the manner in which these parts are combined and that similar rules will apply to units of different levels of complexity". Therefore, both these stress rules apply cyclically along with the Strict Subordination Convention in more complex phases. For instance, in a compound like *bottle brush handle*, there occurs a three-step derivation process. In the first step, all the words in the compound receive stress. In the second step, the compound *bottle brush* undergoes CSR and hence, the penultimate *bottle* receives the primary stress further invoking the SSC and reducing the stress on the *brush* from primary to secondary. In the final step, CSR is called upon again for the entire compound thereby assigning primary stress to the penultimate *bottle* and further demoting *brush* and *handle*.

| | | | | |
|---|---|---|---|---|
| (2) | b o t t l e | b r u s h | h a n d l e | |
| | 1 | 1 | 1 | step 1 |
| | 1 | 2 | | step 2 |
| | 1 | 3 | 2 | step 3 |

Similarly, in the phrase *John sees Mary*, all the individual words receive primary stress in the first step. In the second step, NSR acts upon the embedded phrase *sees Mary* where *Mary* receives the primary stress. Finally, in the third step, NSR acts upon the entire phrase by assigning primary stress to *Mary* and demoting *John* and *sees*.

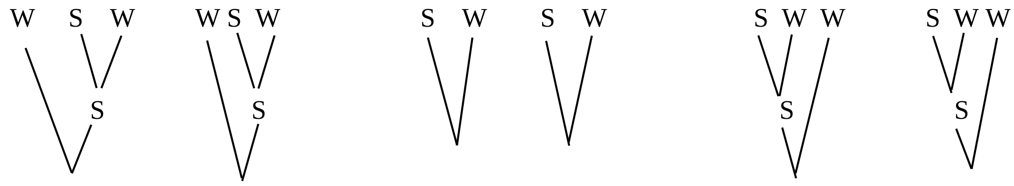
(3) J o h n s e e s M a r y

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | step 1 |
| 2 | 1 | | step 2 |
| 2 | 3 | 1 | step 3 |

Chomsky and Halle treated conceived of stress no differently from other features like [nasal], [corona] etc. "Although their theory had a desirable property of uniformity, however, this theorized uniformity led to many problems" (Hammond, 1995). The numerical encoding of the relative degree of prominence and the Stress Subordination Convention in accounting for stress was in stark contrast to all other features. There were also many empirical problems in Chomsky and Halle's analysis of stress which were brought to light by Liberman in Prince in 1977 that led to the failure of this theory to account for stress patterns.

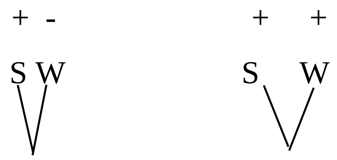
Later in 1975, Liberman laid the foundation for the metrical stress theory in his dissertation titled "*The Intonational Patterns of English*". He proposed the use of metrical patterns (binary branching trees with relational node labels: s and w which were previously used to represent stress patterns of text to achieve the tune-text association in a more natural manner) to represent stress and patterns of stress in English. He rejected the idea of stress being simply a phonetic feature and suggested that stress is a phonetic means with the help of which various linguistic elements are grouped together. He represented the stress pattern of English as a hierarchical organization of s and w positions. Liberman's theory was similar to Chomsky and Halle's formalism as it laid a lot of emphasis on the 'structure' for stress assignment but it also varied from it as his theory did not require the principle of stress subordination, the cyclicity principle or any non-binary feature. The metrical theory operates with the single binary opposition of s/w and requires no variables in the formal statement of the rules. The s and w nodes are relational in nature such that there cannot be a node s without its complementary node w and vice versa. However, with all the simplicity and naturalness the theory had to offer for accounting stress, the theory was initially incapable of accounting for certain distinctions in the degree of prominence in English. For example:

(4) i) bandanna banana ii) rabbi happy iii) Panama Pamela




Although the ranking of the prominence of the syllables is the same in all the above examples, the variation arises in the differentiation of the degree of stress. To account for this stress differentiation, Liberman suggested retaining the segmental feature [+stress] as proposed by Chomsky and Halle in the Sound Patterns of English (1968) but, only with its binary values and by reducing its role to a great extent. For instance, in the English words *hélix* and *nárthèx* we can find that although both of them have the similar metrical structure of 's w' the latter differs from the former on the basis of having a final secondary stress. This problem could be resolved with the help of the binary stress feature [± stress] as in:

(5) hélix nárthèx




The theory tries to account for a pure relative meaning. Relative prominence can be judged only if there is more than one syllable as we cannot have s and w marked in isolation over a single syllable. The theory correctly predicts stress in cases where there are two or more syllables by specifying relative strength of both non-terminal elements and syllables. The theory also takes into account words that have more than one stress, where syllables dominated by only s's get the primary stress whereas the rest metrically strong syllables get secondary stress.

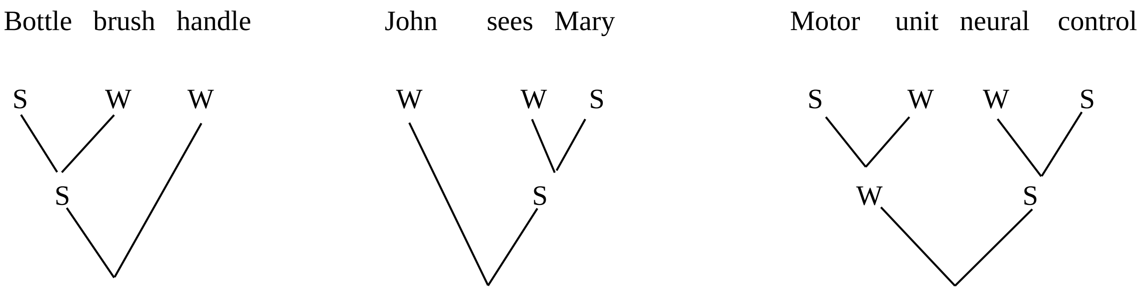
Liberman and Prince's seminal work on metrical theory "On Stress and Linguistic Rhythm" (1977) presented an extensive development of ideas presented earlier in Liberman (1975). They revised the earlier theory of representation of stress by employing two basic ideas: the notion of relative prominence with respect to constituent structure and the notion of linguistic rhythm for the alignment of linguistic elements for the representation of stress with a "metrical grid". Stress is perceived to be the combination of the influence of both the constituent structure and its rid alignment. They claimed that stress was a relative phenomenon and should not be treated as other absolute phonetic variables.

Liberman and Prince found out a major loophole in this exemplification provided by Chomsky and Halle. They figured out that the design provided by Chomsky and Halle works fine with compounds embedded in phrases, it doesn’t work for phrases embedded in compounds. For instance:

| (6) | motor | unit | neural | control |
|---|---|---|---|---|
| | 1 | 1 | 1 | 1 |
| | 1 | 2 | 2 | 1 |
| | *1 | 3 | 3 | 2 |

In the above example, the phrase *neural control* is embedded in a compound. All the words are assigned primary stress in the first step. In the second step, there is an interaction between CSR and NSR. The CSR applies to the compound *motor unit* thereby assigning primary stress to the penultimate (in this case *motor*) and the NSR applies to the phrase *neural control,* thereby assigning primary stress to the final (in this case-*control*). In the final step, CSR applies to the entire compound thereby placing the primary stress on the *motor* and demoting the rest. This is an incorrect prediction as it is found that the attested pronunciation has the primary stress on *control*. Where Chomsky and Halle’s theory failed to account for the stress in certain compounds, Liberman and Prince’s binary branching tree structures could correctly predict them as in:

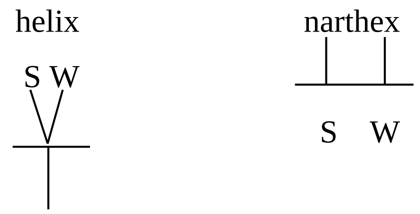
(7)




Their theory not only solved the problem of predicting the stress in compounds with phrasal embedding correctly but also gave us many fruitful insights in the study and analysis of stress. In addition to successfully accounting for the stress pattern in English, laid certain general arguments with the help of which various systems of other world languages could be accounted for. The metrical structure not only gave us a model to rationally represent stress but also provided us with the explanation for the different behaviour of stress rules with respect to other rules. As stress is not an absolute feature, but a relative feature that specifies the degree of prominence in between at least two syllables, metrical trees are the best tool to account for such a natural phenomenon that is not represented locally. It is naturally predicted by the theory of Metrical phonology which considers stress to be a non-local feature that checks the relative prominence among syllables, unlike other theories that equate stress to other locally realized features such as [+back] or [+coronal]. The various perceptual stress values are represented in this theory with the help of binary values such as: s w, w s and '+' and '-'.

Bruce Hayes in his thesis "*A Metrical Theory of Stress Rules*" (1981) proposed the metrical stress theory and gave us a clear understanding of a natural stress rule. At first, he discarded the feature [+stress] and developed a new artifice to determine tree construction by proposing levels in the metrical tree i.e. the foot. For instance, the difference in prominence in the previously mentioned example was shown by Hayes by introducing another level in the tree i.e. the foot level such as:

(8)




In the above example, the horizontal line separates the foot level and the word level where stress is stronger in a foot.

Hayes put restrictions on the syllable structure as well to the rules which shall apply. Syllable plays an important role in Hayes' representation of stress. He proposed a simple, restrictive rule schema with certain independent parameters through which different stress rules found in various languages could be derived. He argued that the most important aspect of metrical theory which is considered to be universal is the tree geometry. He gave us a system to account for the linguistic typology. He proposed that with the help of a small inventory of metrical structures, various stress patterns of different languages could be attested. He defined the maximal size of this inventory and stated certain constraints on what each node in a metrical tree shall dominate. His theory was capable of accounting for all the natural stress systems found across languages rather than a possible one. This system was widely used thereby suggesting that it is the principal factor of the universal metrical theory and further elaborating on the concept of an unmarked stress rule. The principle behind the assignment of metrical stress may vary from language to language depending upon the degree to which the features are constrained by the Universal Grammar. Although there are differences such as directionality of stress assignment or the iterative nature of the stress rules, yet there are a few discernible factors also such as certain absolute constraints and unmarked norms. Hayes proposed a restrictive theory of tree geometry that could make systematic predictions of the stress patterns of different languages. He claimed that "the foot inventory is the optimal notation for natural stress rules."(Hayes, 1980)

As mentioned earlier, stress is a relative prominence observed among syllables. Therefore, there are plenty of stress rules that are sensitive to the syllable structure. This led to an issue for many phonologists to distinguish prominence types among syllables with respect to rules that are sensitive to such differences in syllable structures. The most common and basic type of distinction is to divide the syllables into the light and heavy syllables where the former has a non-branching rime and the latter has a branching rime. Hayes defined that the closed syllables are considered heavy whereas the open syllables are considered light, regardless of vowel length. So, metrical structures may be prominently based upon the syllable prominence such as heavy syllables, long vowels,  ranching rimes etc. There are many languages which do not prescribe to such prominence distinctions among syllables at all. Hayes suggested that in such languages, all syllables must be considered light and hence there is no branching within these syllables. He adopted the terminology of dominant and recessive nodes for the analysis of stress, whereby A dominant node was labelled "strong" and a recessive node was labelled "weak". He further elaborated that "recessive nodes may not branch" whereas dominant nodes are the branching nodes and "any pair of sister nodes contains one dominant node and one recessive node."

### 3.3 Parameters for Analysing Stress

Hayes adopted a terminology to formulate the rules of metrical phonology. The terms relate to the parameters of Dominance, Quantity-sensitivity, Boundedness and Directionality. Thus stress systems are left dominant or right dominant, quantity-sensitive or quantity-insensitive, binary or unbounded and right-to-left or left-to-right. A left dominant or right dominant tree mostly refers to the older concepts of left branching or right branching. A quantity sensitive tree is one in which the dominant nodes are terminal or branching whereas a quantity insensitive tree is one in which the terminal nodes must be counted as non-branching. Lastly, a binary tree is one that is constructed by invoking restrictions on the size of the tree whereas unbounded tree has no restriction on its size, it would be called as unbounded. All the combinations of these parameters seem to be attested in mostly all spoken languages. The most common type of structure is the binary, quantity insensitive tree and hence it is said to be the unmarked structure.

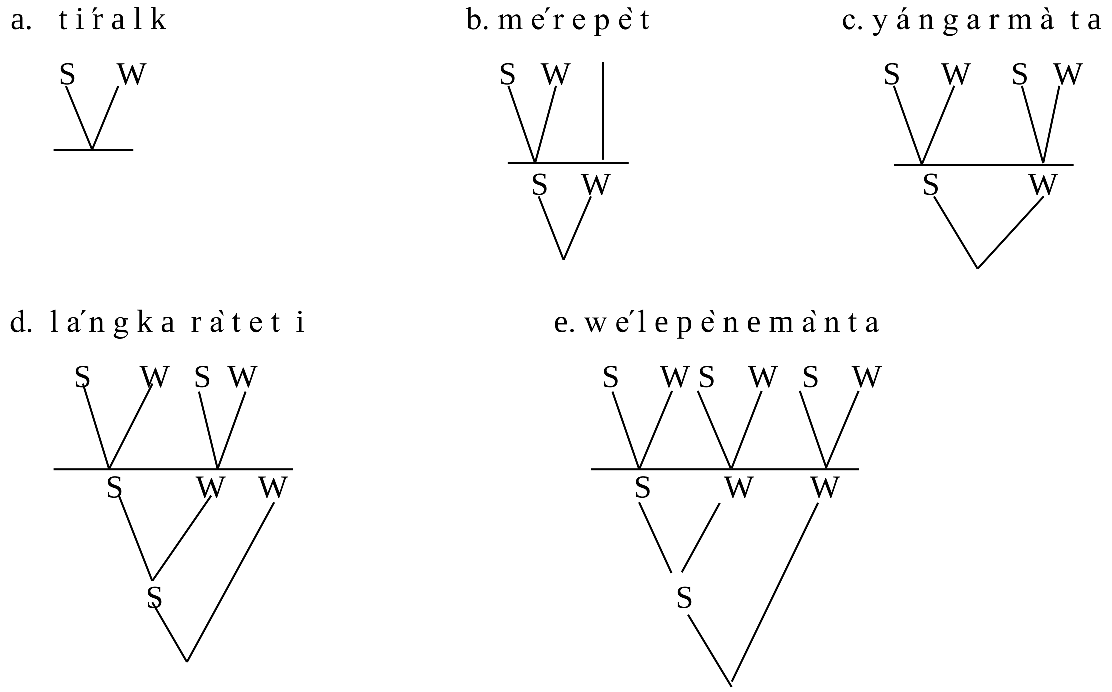
### 3.3.1 Binary, Quantity Insensitive Trees:

This kind of system is the most common. Hayes (1980) discussed the stress system of Maranungku based on Tryon "An Introduction to Maranungku" (1970). In Maranungku, the initial syllables bear the primary stress while every other syllable thereafter bears the secondary stress. For instance:

| | | |
|---|---|---|
| (9) | a. *tíralk* | "saliva" |
| | b. *mérepèt* | "beard" |
| | c. *yángarmàta* | "the Pleiades" |
| | d. *lángkaràtetì* | "prawn" |
| | e. *wélepènemànta* | "kind of duck" |

He explained that to account for the stress pattern of Maranungku with the help of metrical tree structure, we need to construct a binary, quantity insensitive and left dominant feet from left to right and finally group the feet into a left dominant tree structure as follows.

(10)



In the diagram above, we can see that all the feet are constructed going from left to right and are binary, left dominant feet irrespective of the syllable weight and hence, are quantity insensitive. Such structures are termed as binary, quantity insensitive trees.

**3.3.2 Unbounded Systems:**

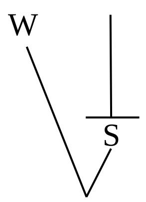
Unbounded Quantity Insensitive Trees

This kind of structure is commonly found in languages that have initial or final stress as there is no parameter to restrict an unbounded foot that is insensitive to syllable weight from encompassing the whole word. Unbounded quantity insensitive trees are found in languages that have word trees wherein any of the feet or syllables of a word can be assigned prominence. Languages such as “Tubatulabal, Nirgil, West Greenlandic Eskimo, Angula and Auca” (Hayes 1994) have a number of word stresses that are equally prominent further suggesting the optionality of word-tree in Universal grammar but its absence is marked.

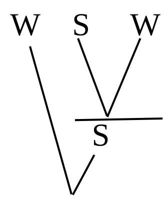
Unbounded, Quantity Sensitive Trees

Such kind of stress pattern is often found in the literature of Eastern Cheremis given in Sebeok and Ingemann (1961). It is also discussed in Hayes (1994). In Eastern Cheremis, the rightmost heavy syllable is stressed else the initial syllable.

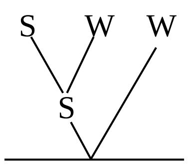
(11) a. š i i n č á a m “I sit”



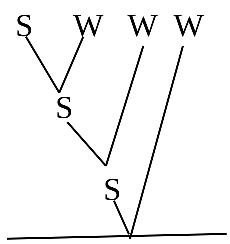

b. s l a a p a a z ə m “his hat (acc.)”




c. p u u g ə l m ə “cone“




d. k i i d ə s t ə z ə “in his hand“



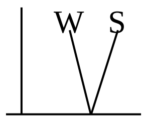
As Eastern Cheremis is a quantity sensitive language with stress being affected by syllable weight, the vowels fall into two categories: full and reduced. Stress falls on the last full vowel whereas if all the vowels are reduced as in ‘e’, then the initial syllable gets the stress. To account for this stress pattern, a left dominant unbounded foot must be drawn at the right edge of the word and a right dominant word tree must be formed.

### 3.3.3 Binary, Quantity Sensitive Trees:

Hayes takes examples from languages such as Aklan and Tubatulabal to describe such stress patterns. In these languages, certain short vowels receive stress regardless of their positions. Hayes makes use of the diacritic feature [+H] to exemplify these stress patterns wherein the diacritic feature [+H] ensures that the rimes attached to it receive the stress irrespectively. He explains it with an example from Tubatulabal, as in:

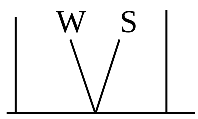
(12) a. t u g u w a- n → t u′g u w a′n his meet

[+H]




a. t u g u w a-yi-n → t u′g u w a′y i′n his meat-obj

[+H]




We can see that the rules of feet construction treat the rime marked with [+H] as a dominant node. As all the stresses are of equal prominence, there is no word tree present.

The central tenet of metrical phonology is the metrical foot. There are two types of feet: trochees and iambs. A syllabic trochee dominates two syllables and assigns stress to the first syllable whereas an iamb dominates two syllables and assigns stress to the second syllable. Hayes asserts that though syllabic trochee is not dependent on syllable weight but iambs are exclusively dependant on syllable weight. Although languages assign stress based upon these two systems, they may differ depending upon the directionality of arranging the feet in a string i.e. left-to-right or right-to-left. There are also languages that make use of bi-directional systems i.e. they build foot at one edge and iterate from the other edge.

### 3.3.4 Extrametricality:

One of the most crucial aspects of the theory developed by Hayes was the notion of extrametricality. “The mechanism of extrametricality allows a syllable at the edge of the footed span to be skipped” (Hammond, 1995). In some cases, when a constituent such as a syllable, mora, vowel or consonant occurs at the edges of a word such as the beginning or the end, it is ignored in the construction of the metrical tree. Such a constituent is called as being ‘extrametrical’. This concept has been of great benefits to the theory of metrical phonology and is attested in many languages. It helps us to account for the irregularities in stress systems at word boundaries. For instance, in Quantity Sensitive systems, heavy syllables at word edges do not receive the stress. These heavy syllables occurring at word edges are completely ignored from the metrical tree and are not treated as heavy. This is only possible if we consider these heavy syllables at word edges to be ‘extrametrical’ and swiftly ignore them while building up the metrical tree and assigning stress. For further exemplification, let us consider an example from Malayalam given in Pandey (Module: Metrical Theory- Word-stress-II):

| | | |
|---|---|---|
| (13) | a. *nɪ́ǰəməm* | “rule” |
| | b. *pú.ɹaːɳəm* | “Purana (Sanskrit texts) |
| | c. *mələ́ǰaːliː* | “a Malayali speaking person” |
| | d. *vaːsùdeːvən* | “a name” |

In Malayalam, a heavy non-final syllable gets stressed starting from the right else the initial syllable receives the stress. This leads us on to a question as to why a non-final heavy syllable receives the stress whereas a final heavy syllable doesn’t. The notion of extrametricality would provide us with the apt answer. In Malayalam, the final vowel or consonant is extrametrical and is ignored in the metrical tree and therefore, the final syllable is always considered light and hence, is never assigned stress. This can be illustrated as follows:

(14) a. b. c. d.


| a. | b. | c. | d. |
|---|---|---|---|
| L L L | L H L | L L H L | H L H L |
| ni jə mə<m> | pu ɹaː ɳə<m> | mə lə jaː li<ː> | ʋaː su deː ʋə<n> |

The final C or V is shown to be extrametrical by putting it in angled <> brackets. It is not the case that final syllables never receive stress in Malayalam. If the final syllable is of the structure V:C, it does receive stress because even if the final consonant becomes extrametrical, the vowel is a long vowel and therefore, is treated as a heavy syllable, thereby, receiving stress.

### 3.3.5 End Rule

In a number of languages, there are varying degrees of prominences. For example, Lenakel is one such language that has two degrees of stress: primary and secondary. In languages as these, where there is more than one stress, the End Rule is deployed to differentiate between the degrees of stress. The End Rule selects a peripheral foot for primary stress and all other feet have secondary stress.

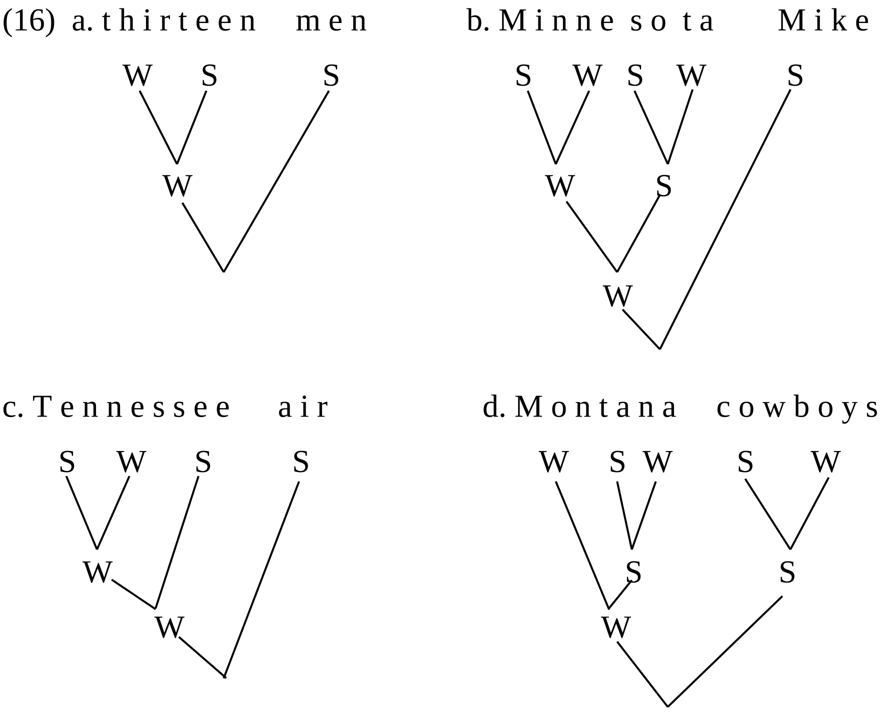
### 3.3.6 Metrical Grid

Liberman and Prince (1977) realised the incapability of the metrical tree to account for the stress shift occurring in English when a modifier is added to a string. They, therefore, came up with another method of representation of stress which they believed would overcome this issue rhythm rule in English that is responsible for the stress shift in a modifier towards the left when it is immediately followed by a stressed syllable in the next word. They called this new method of representation as the metrical grid. To have a further look at the rhythm rule of English let us take an example from Hammond, 1995:

(15) a. *thìrtéen* *thìrtéen men* → *thírtèen mén*
*b. Mìnnesóta* *Mìnnesóta Míke* → *Mínnesòta Míke*
*c. Tènnessée* *Tènnessée air* → *Ténnessèe áir*
*d. Mòntána* *Mòntána cówbòy* → **Móntàna cówbòy*

To illustrate these examples with the help of tree structures would be as follows:

(16)




As we can see, it is difficult to capture the stress clash in a tree structure and therefore the tree structure is unable to account for the stress shifts and is incapable of predicting the correct results. Therefore, Liberman and Prince suggested enhancing the metrical tree with a metrical grid that can correctly account for such stress clashes leading to stress shifts. The metrical grid is constructed by arranging columns that have marks for the syllables, and stress is marked on the syllable with the highest column height. A metrical grid can successfully account for the rhythm rule in English as in:

(17) a.

```
                 x
       x - - - - - - x
   x   x             x
thirteen          men
```

b.

```
                      x
            x- - - - - - - x
x           x              x
x     x     x   x          x
Minnesota          Mike
```

c.

```
                 x
          x ------ x
 x        x ------ x
 x    x   x        x
Tennessee       air
```

d.

```
                  x
          x       x
     x    x  x    x     x
     Montana   cowboys
```

The x marks the syllables, the dotted lines mark the stress clash and the height of the columns marks prominence.

In 1987, Halle and Vergnaud in “An Essay on Stress” proposed a different approach to metrical theory. The enhanced the grid structure to a bracketed grid convention. Their theory laid emphasis on the formal properties of the constituency. In Halle and Vergnaud’s bracketed grid notation, stress is represented as a grid, where the stress constituents are indicated through bracketing. There is a hierarchy of layers labelled as line 0, 1, 2 and so on. Adjacent marks on the same line are grouped together into constituents by bracketing and the head of each line is marked with a mark vertically aligned to it in the next line above it:

(18)

```
              *          line 2
(*      *     *  )       line 1
(* *) (* *) (* *)        line 0
 apa  lachi  cola
```

In the above exemplification, the marks on line 0 indicate the stress-bearing units such as syllables or moras. The brackets group these elements into constituents. The brackets on line 0 represent the foot boundaries of the tree theory. The heads of line 0 constituents are marked on lines 1 which represent higher-level prosodic categories of tree theory such as the word tree. Line 2 further marks the head of line 1.

Further, in this chapter, I shall use Halle and Vergnaud’s metrical grid structure for the analysis of stress in Odia. It gives us a clear picture of how the constituents are grouped together, the head of a constituent and the relative degree of prominence among the constituents in the string.

**3.4 Phonetic Cues of Stress in Odia**

The principal cues for identifying stress are pitch, loudness and length. Stressed syllables are generally louder, higher pitched and longer. However, this may not be the case in all languages. In Odia, the vowels are longer when they are the head of a stressed syllable and are shorter if they do not belong to a stressed syllable. In polysyllabic words carrying eurhythmics stresses, the pitch seems to play a role. When a syllable bears secondary stress, we find that there is a slight rise in pitch.

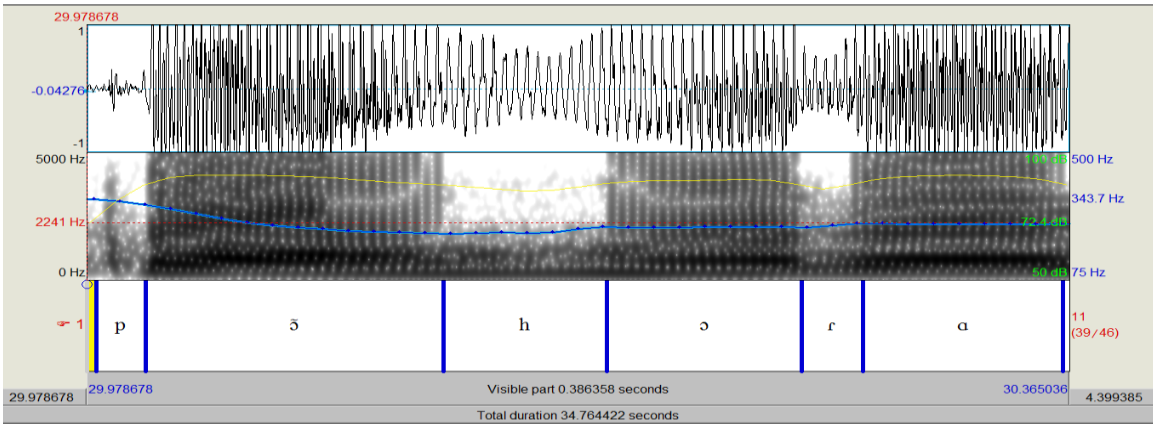



**Fig. 3.1:** Initial Stress in word pɔ̃́hɔɾɑ

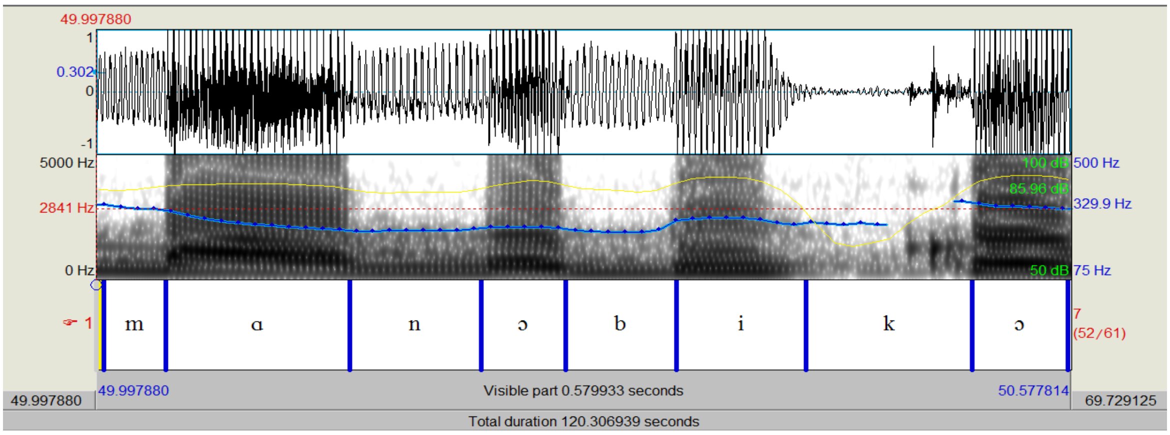



**Fig. 3.2:** Initial and penultimate stress in word mɑńɔbȉkɔ

We can see that in the word *pɔ̃́hɔɾa* (Fig. 1) the initial vowel is longer compared to the other syllables as it stressed. In the word *mańɔbȉkɔ* (Fig .2) the initial vowel is the longest marking initial stress followed by the penultimate syllable that is assigned an eurhythmic stress and also shows a slight rise in pitch.

### 3.5 The Metrical Structure of Odia Non-Derived Words

To pursue the idea of treatment of stress in Odia we need to look at the data of the simple words in Odia in their non-derived environment. We shall deploy the aforementioned parameters to analyse the stress pattern in Odia and identify the metrical rules functioning in the language and check whether the theory of metrical phonology could correctly predict the stress pattern of Odia. Our study shall concern the various monosyllabic, di-syllabic and tri-syllabic lexical words of Odia.

### 3.5.1. *Monosyllabic Lexical Words:*

The monosyllabic lexical words of Odia are of the type:

(19) a. CVː [dʒíː] (live) [gɑ̃ː] (village) [tʃɑ́ː] (tea)

b. CVC [pɔ́ɖʱ] (study) [gól] (round) [lɑ́l] (red)

The prominence in the above words is as follows:

(20)

| | | | | | | |
|---|---|---|---|---|---|---|
| x | x | x | x | x | x | Line 1 |
| (x) | (x) | (x) | (x) | (x) | (x) | Line 0 |
| σ | σ | σ | σ | σ | σ | syllables |
| tʃɑː | dʒiː | gɑ̃ː | pɔɖʰ | gol | lɑl | |

One important point to note here is that the degenerate foot which are the sub-minimal forms a moraic foot are not allowed in Odia. As these degenerate foot are light syllables of the structure CV, they cannot construct a foot on their own. Hence, the monosyllabic word of Odia is made up of a heavy syllable of the type CVC or CVː that consists of two moras and are capable to construct a foot, further receiving stress.

### 3.5.2. *Disyllabic Lexical Words:*

It is found generally in Odia that in disyllabic words the initial syllable receives the stress. The initial syllable could be heavy(H) or light(L). Heavy final syllables are not found in disyllabic words of Odia. Odia constructs a moraic foot from right to left and does not allow a degenerate foot.

To analyse the stress pattern of Odia disyllabic words in detail, we shall look at some of the examples.

(21) a. CV.CV (LL) [d̪áɖʰi] (beard) [mítʃʰɔ] (lie) [níd̪rɑ] (sleep-N)

b. CVC.CV (HL) [gɔ́nʈʰi] (knot) [máʈʈi] (mud) [d̪ánt̪ɔ] (teeth) [múɾkʰɔ] (fool)

The schematic representation of the stress prominence in the above-mentioned words would be as follows:

(22) a.

| | | | |
|---|---|---|---|
| x | x | x | Line 2 |
| (x .) | (x .) | (x .) | Line 1 |
| (x x) | (x x) | (x x) | Line 0 |
| σ σ | σ σ | σ σ | syllables |
| d̪á ɖʰi | mí tʃʰɔ | ní d̪rɑ | |

b.

| | | | | |
|---|---|---|---|---|
| x | x | x | x | Line 2 |
| (x ) | (x ) | (x ) | (x ) | Line 1 |
| (x) | (x) | (x) | (x) | Line 0 |
| H L | H L | H L | H L | weight |
| σ σ | σ σ | σ σ | σ σ | syllables |
| gɔ́n ʈʰi | máʈ ʈi | d̪án t̪ɔ | múɾ kʰɔ | |

From the above analysis, we saw that in disyllabic words of Odia comprising of two light syllables (LL), we first construct a binary foot and then a trochee assigns the primary stress to the initial syllable. In case of a heavy and light syllable in constructions of the type HL, we construct a binary moraic foot with the heavy syllable and as a degenerate foot is not allowed in Odia, the single light syllable remains unparsed to any foot. The moraic trochee thereby assigns stress to the initial syllable. As Odia prefers no coda, disyllabic words with final heavy syllables are not present in the language. Therefore, we concluded that disyllabic words in Odia always bear an initial stress.

### 3.5.3. *Trisyllabic Lexical Words:*

The trisyllabic words in Odia display all three stresses: initial, penultimate and final. To analyse the contexts in which these stress patterns occur, we shall consider some examples. The following syllable types are possible in Odia:

(Light-L, Heavy-H)

(23) i. LLL syllable type with primary penultimate stress:

| | | | | |
|---|---|---|---|---|
| a. | [sɔmɑ́dʒɔ] | (society) | [dʒogɑ́ɖɔ] | (arrangement) |
| b. | [sɔɾíɾɔ] | (body) | [sɑhɑ́sɔ] | (courage) |
| c. | [sɔmúd̪ɾɔ] | (sea) | [kɔʈɔ́k(ɔ)] | (place name) |
| d. | [mɑnɔ́bɔ] | (human) | [hɔdʒɑ́ɾ(ɔ)] | (thousand) |
| e. | [ɔnd̪ʰɑ́ɾɔ] | (darkness) | | |

ii. LLL syllable type with primary initial stress:

f. [pɔ̃́hɔɾɑ] (broom) [tʃɔ́gɔlɑ] (mischievous)

iii. LLH syllable type with primary initial stress and secondary final stress:

g. [hɔ́ɭɔd̪ì:] (turmeric) [ɔ́pɔɾàd̪ʰ] (sin)

iv. HLL syllable type with primary initial stress and secondary penultimate stress:

h. [suńd̪ɔɾɔ] (beautiful) [ɖɑ́kt̪ɔɾɔ] (doctor)

v. LHH syllable with primary penultimate stress and secondary final stress:

i. [ɔhɔ́ŋkɑ̀ɾ(ɔ)] (arrogance)

vi. HHH syllable with primary initial stress and secondary penultimate and final stress:

j. [sɔ́mbɔlpùɾ] (place name)

(The words having final vowel ɔ mentioned in brackets, inherently have a final vowel but in normal speech, most of the speakers delete the vowel and produce the word with a final heavy syllable. Hence, I have shown the optionality of the final vowel by putting it within brackets in these words.)

From the above-mentioned examples, the insight that we draw about the metrical stress pattern of Odia in trisyllabic words is:

- Extrametricality of syllable containing [ɑ] word finally
- Construction of a moraic trochee from right to left.
- In case of more than one foot, End Rule assigns prominence to the head of the leftmost foot.
- Stress clash is avoided: adjacent syllables are not stressed

The schematic representation of the above-mentioned words is as follows:

| | | | | | |
|---|---|---|---|---|---|
| (24) i) | x | x | x | x | line 2 |
| | (x .) | (x .) | (x .) | (x .) | line 1 |
| | (x x) | (x x) | (x x) | (x x) | line 0 |
| | L L L | L L L | L L L | L L L | |
| | sɔ mɑ´ dʒɔ | sɑ hɑ´ sɔ | sɔ mu´ d̪ɾɔ | kɔ ʈɔ´ kɔ | |

In trisyllablic words containing three light syllables, we construct a binary foot from right to left. The syllabic trochee assigns stress to the leftmost syllable of the foot. Therefore, the penultimate syllable receives primary stress. The initial light syllable is left unparsed as the degenerate foot is not allowed in Odia.

| | | | |
|---|---|---|---|
| ii) | x | x | line 2 |
| | (x .) | (x .) | line 1 |
| | (x x) | (x x) | line 0 |
| | L L | L L | |
| | pɔ̃́ hɔ <ɾɑ> | tʃɔ′gɔ <lɑ> | |

In the above words, we can see that the final syllable consisting of the back vowel ɑ is rendered extrametrical. The two light syllables are grouped together into a binary foot. The syllabic trochee assigns stress to leftmost syllable of the foot. Thus, the initial syllable is stressed.

| | | | |
|---|---|---|---|
| iii) | x | x | line 3 |
| | (x ) | (x ) | line 2 |
| | (x .) (x) | (x .) (x) | line 1 |
| | (x x) (x) | (x x) (x) | line 0 |
| | L L H | L L H | |
| | hɔ́ ɭɔ d̪ì: | ɔ́ pɔ ɾàd̪ʰ | |

In trisyllabic words as these consiting of two light syllables and one heavy syllable, the first two light syllables make up a binary foot and the final heavy syllable comprising of two moras makes a feet of its own. The moraic trochee is constructed that assigns stress to the initial and the final syllable. Further, the degree of prominence among these two stresses is established by the End Rule that assigns the primary stress to the leftmost syllable.

| | | | |
|---|---|---|---|
| iv) | x | x | line 3 |
| | (x)-(x .) | (x)-(x .) | line 2 |
| | (x) (x x) | (x) (x x) | line 1 |
| | H L L | H L L | line 0 |
| | suń d̪ɔ ɾɔ | ɖák t̪ɔ ɾɔ | |

In words such as these, where there are one heavy syllable followed by two light syllables, we construct two binary feet from right to left (the two light syllables construct one foot and the heavy syllable consisting of two moras constructs another foot). The trochee assigns stress to the leftmost syllable of both these foot, in this case the initial and the penultimate syllable. As there is a stress clash, to avoid it, the stress on the penultimate syllable is deleted thereby assigning stress only to the initial syllable.

| | | |
|---|---|---|
| v) | x | line 2 |
| | ( x ) | line 1 |
| | (x)---(x) | line 0 |
| | L H H | |
| | ɔ həŋ kɑ́ɾ | |

In trisyllabic lexical words consisting of one light syllable followed by two heavy syllables, two moraic feet are constructed. The initial light syllable is left unparsed as the degenerate foot is not allowed in Odia. A moraic trochee assigns stress to both the heavy syllables. There is a stress clash as two adjacent syllables are stressed. Therefore, the stress on the penultimate syllable is deleted and the final syllable receives the stress. This word seems to be in contradiction to the phonology of Odia and hence remains opaque to the phonological rules. This opacity could have diachronic relevance as the word must have been borrowed from another language and retains its stress pattern.

| | | |
|---|---|---|
| vi) | x | line 3 |
| | (x ) | line 2 |
| | (x)---(x)---(x) | line 1 |
| | H H H | line 0 |
| | sɔ́m bɔl pùr | |

In words such as these where there are three heavy syllables, three moraic feet are constructed. The stress on the second syllable is deleted to avoid a stress clash. Finally, the End Rule assigns primary stress to the head of the leftmost foot, in this case, the initial syllable and the final syllable receives secondary stress.

### 3.5.4 Stress in Complex Words

Affixes are categorized into two types: Primary and Secondary, based on their positional properties and the phonological rules associated with them. Kiparsky in his paper “Word formation and the lexicon" gave us a clear understanding of the functioning of both kinds of affixes in English. "*Primary affixes form a unit with their stem for purposes of such rules as word stress and trisyllable shortening, while secondary affixes do not either trigger or undergo these rules".* (Kiparsky, 1982) Primary affixes are attached before any other affixes and hence are closer to the root. They are of major importance as they affect the stress pattern whereas the secondary affixes, on the contrary, are stress neutral and remain unaffected by these rules.

In this section we shall look at some of the primary affixes in Odia:

(25)

i. N + i → Adj
kɔʈɔ́k(ɔ) + i → [kɔ́ʈki] (of or belonging to Cuttack, a place)
sɔ́mbɔlpùr + i → [sɔ́mbəlpùri] (of or belonging to Sambalpur, a place)

ii. V + uɳi → N
nɑ´tʃɔ + uɳi → [nɑtʃúɳi] (female dancer)

iii. V + uɳijɑ → N
nɑ´tʃɔ + uɳijɑ → [nɑ́tʃuɳi̍jɑ] (male dancer)

iv. V + ɔn̪t̪ɑ → Adj
dʒɔ´ɭə + ɔn̪t̪ɑ → [dʒɔɭə́n̪t̪ɑ] (burning-adj)

v. V + uɑɭɔ → N
dʒɔ´gə + uɑɭɔ → [dʒɔ́guɑ̍ɭɔ] (watchman)

vi. V + ɑɭi → N
kʰe´ɭə + ɑɭi → [kʰeɭɑ́ɭi] (player)

vii. N + ɑɭu → Adj
ni´d̪rɑ + ɑɭu → [nid̪rɑ́ɭu] (sleepy)

viii. N + ʈiɑ → Adj

tom´bʰɑ + t̪iɑ → [t̪ɔ́mbʰɑt̪ìɑ] (metallic)

ix. N + tʃiɑ → Adj

pɑ́ɳi + tʃiɑ → [pɑ́ɳitʃìɑ] (watery)

x. N + ɑɭɔ → N

gɑiː´ + ɑɭɔ → [gɑ́iːɑ̀ɭɔ] (byre)

xi. N + bɑlɑ → N

pɔ̃́hɔɾɑ + bɑla → [pɔ̃́hɾɑbɑ̀lɑ] (person who sells brooms)

xii. N + ɑɾi → N

sɔŋ´kʰɔ + ɑɾi → [sɔ́ŋkʰɑɾi] (person who makes glass bangles)

xiii. Adj + ɑmi → N

tʃɔ́gɔla + ɑmi → [tʃɔ́gɔlɑ̀mi] (naughtiness)

t̪ʰɔ´kɔ + ɑmi → [t̪ʰɔkɑ̀mi] (con)

xiv. N + ikɔ → Adj

mɑnɔbɔ + ikɔ → [mɑ́nɔbìkɔ] (humane)

xv. Adj + pɔɳɔ → N

súnd̪ɔɾɔ + pɔɳɔ → [súnd̪ɔɾɔpɔ̀ɳɔ] (the state of being beautiful)

ɔmiɾɔ + pɔɳɔ → [ɔ́miɾəpɔ̀ɳɔ] (the state of being rich)

xvi. d̪uɾ + N → N

d̪uɾ + sɑhɑ́sɔ → [d̪úɾsɑhɑ̀sɔ] (courage-negative sense)

From the above data, we find that:

- A moraic trochee assigns stress from right to left
- In case of more than one stress, the End rule assigns primary stress to the head of the leftmost foot.
- Stress clash is avoided

The schematic representation of the above-mentioned words is as follows:

(26)

| | | | | |
|---|---|---|---|---|
| i. | x | | x | line 2 |
| | (x .) | | (x) | line 1 |
| | (x x) | → | (x) | line 0 |
| | L L L | | H L | |
| | kɔ ʈɔ́ kɔ | | kɔʈ́ ki | |

| | | | | |
|---|---|---|---|---|
| ii. | x | | x | line 2 |
| | (x .) | | (x .) | line 1 |
| | (x x) | → | (x x) | line 0 |
| | L L | | L L L | |
| | nɑ́ tʃɔ | | nɑ tʃu′ ɳi | |

| | | | | |
|---|---|---|---|---|
| iii. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x .) | | (x .) (x .) | line 1 |
| | (x x) | → | (x x)(x x) | line 0 |
| | L L | | L L L L | |
| | nɑ́ tʃɔ | | nɑ́ tʃu ɳì jɑ | |

| | | | | |
|---|---|---|---|---|
| iv. | x | | x | line 2 |
| | (x .) | | (x) | line 1 |
| | (x x) | → | (x) | line 0 |
| | L L | | L H | |
| | dʒɔ́ ɭə | | dʒɔ ɭə́n <t̪ɑ> | |

| | | | | |
|---|---|---|---|---|
| v. | x | | x | line 2 |
| | (x .) | | (x .) | line 1 |
| | (x x) | → | (x x) | line 0 |
| | L L | | L L L | |
| | kʰé ɭə | | kʰe ɭɑ′ ɭi | |

| | | | | |
|---|---|---|---|---|
| vi. | x | | x | line 2 |
| | (x .) | | (x .) | line 1 |
| | (x x) | → | (x x) | line 0 |
| | L L | | L L L | |
| | ní d̪ra | | ni d̪ra´ɭu | |

| | | | | |
|---|---|---|---|---|
| vii. | x | | x | line 2 |
| | (x) | | (x ) | line 1 |
| | (x) | → | (x) (x) | line 0 |
| | H L | | H L H | |
| | t̪ɔ́m bʰɑ | | t̪ɔ́m bʰɑ t̪ìɑ | |

| | | | | |
|---|---|---|---|---|
| viii. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x .) | → | (x .) (x) | line 1 |
| | (x x) | | (x x) (x) | line 0 |
| | L L | | L L H | |
| | pɑ´ ɳi | | pɑ´ɳi tʃìɑ | |

| | | | | |
|---|---|---|---|---|
| ix. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x) | | (x .)(x .) | line 1 |
| | (x) | → | (x x)(x x) | line 0 |
| | H | | L L L L | |
| | gɑí: | | gɑ́ i à ɭɔ | |

| | | | | |
|---|---|---|---|---|
| x. | x | | x | line 2 |
| | (x .) | | (x .) | line 1 |
| | (x x) | → | (x x) | line 0 |
| | L L | | L L L | |
| | t̪ʰɔ́ kɔ | | t̪ʰɔ kɑ́ mi | |

| | | | | |
|---|---|---|---|---|
| xi. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x .) | | (x .) (x .) | line 1 |
| | (x x) | → | (x x)(x x) | line 0 |
| | L L L | | L L L L | |
| | mɑ nɔ́ bɔ | | mɑ́ nɔ bì kɔ | |

| | | | | |
|---|---|---|---|---|
| xii. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x . ) | | (x .)(x .) | line 1 |
| | (x x) | → | (x x)(x x) | line 0 |
| | L L | | L L L L L | |
| | pɔ̃́ hɔ <ɾɑ> | | pɔ̃́ hɔ ɾɑ bɑ lɑ | |

The metrical structure gives us the stress pattern such as this *pɔ̃hɔ́ɾɑbɑ̀lɑ whereas the actual stress pattern of the word is: pɔ̃̀hɔɾɑbɑ̀lɑ. The stress rule remains opaque in the derivate word as the word retains the stress pattern of its stem. We shall discuss this opacity in detail in the next chapter.

| | | | | |
|---|---|---|---|---|
| xiii. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x)-(x .) | | (x)--(x .)(x .) | line 1 |
| | (x)-(x x) | → | (x) (x x)(x x) | line 0 |
| | H L L | | H L L L L | |
| | sún d̪ɔ ɾɔ | | sún d̪ɔ ɾɔ pɔ̀ ɳɔ | |

| | | | | |
|---|---|---|---|---|
| xiv. | | | x | line 3 |
| | x | | (x ) | line 2 |
| | (x .) | | (x) (x .) | line 1 |
| | (x x) | → | (x) (x x) | line 0 |
| | L L L | | H L L L | |
| | sɑ hɑ̀ sɔ | | d̪úɾ sɑ hɑ̀ sɔ | |

The primary affixes: +i , +uɳi, +uɳijɑ, +ɔn̪t̪ɑ, +uɑ, +uɑɭɔ, +ɑɭi, +ɑɭu, +ʈiɑ, +tʃiɑ, +ɑɭɔ, +bɑlɑ, +ɑɾi, +ɑmi, +ikɔ, +pɔɳɔ, and d̪uɾ+ are stress affecting suffixes. The primary or the stem level affixes establish a moraic trochee from right to left and finally, the End Rule attaches promince to the head of the leftmost foot. The secondary or the word level affixes on the contrary do not affect stress and are situated farther from the root. We shall discuss in detail about the stem level and word level affixation and the phonological processes associated with them in the next chapter.

*Chapter 4*

# OPACITY IN EARLY GENERATIVE THEORIES

## 4.1 Introduction

The misapplication of phonological processes is one of the disconcerting facts about human language: sometimes they apply in certain environments where they are not expected to and sometimes they do not apply in certain environments where they are predicted to. This misapplication of phonological grammar is known as opacity. Although the phenomenon of opacity complies with the principles of Universal Grammar (UG), it is not specifically accounted for by the principles of UG. It is neither functional nor adaptive. Opacity "arises through the way in which the contingencies of acquisition or rather mis-acquisition work upon the interface of phonology with the rest of the grammar" (Bermudez Otero, 1999b). The early generative theories tried to account for opacity in many ways; for example, Chomsky and Halle in SPE (1968) regarded opacity as a by-product of rule ordering and tried to account for it through extrinsic rule ordering. In Optimality Theory (OT) two kinds of approaches have arisen to account for opacity: one holds the strongly parallel nature of OT and accounts for opacity by introducing trans-derivational correspondence and the other introduces the mechanism of stratification and cyclicity (familiar to rule-based LPM) into the framework of OT. In this chapter, I shall show how the phenomenon of opacity was captured in the early generative theories and illustrate the failure of the strictly parallel and mono-stratal model of OT to account for opacity with reference to the opaque accentuation rules in Ancient Greek.

## 4.2 Opacity in Rule-Based Phonology

The concept of opacity came into light post Chomsky and Halle's SPE, when there was a huge debate on the abstractness in phonology posed by the rule-based phonology. Kiparsky in his work "Explanations in Phonology" (1982b: 75) defined opacity within the context of rule-based phonology as: A rule *R* of the form $\alpha \rightarrow \beta$ / $\gamma\_\_\delta$ is opaque to the extent that there are surface representations in the language having either (i) $\alpha$ in the environment $\gamma\_\_\delta$ or (ii) $\beta$ derived by *R* in an environment other than $\gamma\_\_\delta$. In the first case, if we find a word of the form [$\gamma\alpha\delta$], it suggests that the phonological rule has not applied even though the structural description of the rule R has been met; in such a situation the rule R is said to have under-applied. In the second case, if we find a word where $\alpha \rightarrow \beta$ in some other environment, it implies that the rule R has over-applied. Such kinds of misapplication of phonological rules give rise to opacity.

In the Rule-based phonology, opacity is considered to be a by-product of rule ordering. The phonological rule R misapplies if some other rules say for example S changes the structural description of R. In case of under-application, the surface form reveals the structural description of R and R seems to have not applied. This is because another later rule S recreates the structural description of R, but since it is ordered after R, R cannot apply to the output of S. S is said to counter-feed R in such a case. We shall exemplify this with the help of an example from McCarthy (1998: 364) where he distinguished two types of counter-feeding derivations:

(1) a. Counter-Feeding in the focus

| | | |
|---|---|---|
| UR | | αβγ |
| Rule *A* | δ → ε / α_ | ---- |
| Rule *B* | β → δ / _γ | αδγ |
| SR | | αδγ |

b. Counter-Feeding in the environment

| | | |
|---|---|---|
| UR | | αβγ# |
| Rule *C* | β → δ / _ε | ---- |
| Rule *D* | γ → ε / _# | αβε# |
| SR | | αβε# |

From the above exemplification, in (1.a) we can see that Rule A targets δ preceded by α. Although the underlying form has the segment α, but is followed by β, therefore, Rule A fails to apply. The subsequent Rule B targets β preceding γ, thereby introducing the segment δ in the environment i.e. following α. Since Rule A has already applied vacuously, it cannot apply after Rule B, even though its structural description does match with the surface form thereby making A non-surface true. Similarly, in (1.b), rule C targets β preceding ε but fails to apply as its structural description doesn't match with the underlying representation. The subsequent Rule D changes the γ into ε before # and yields the structure αβε#. Although Rule C doesn't permit this structure, it fails to apply as it cannot apply after Rule D. Therefore, in both the examples we saw that Rule A and Rule C under-apply and are non-surface true.

McCarthy (1998: 358) claims that opacity occurring due to over-application, on the other hand, is caused due to counter-bleeding derivations such as:

(2) a. Counter-Bleeding Derivation:

| | | |
|---|---|---|
| UR | | αβγ# |
| Rule *E* | $\beta \rightarrow \delta$ / _ γ | αδγ# |
| Rule *F* | $\gamma \rightarrow \varepsilon$ / _# | αδε# |
| SR | | αδε# |

In (2.a), Rule E changes β into δ before γ. A subsequent rule F changes γ into ε before #. The surface form contains a δ derived from β, whose transformation was not apparent as β changes to δ only before γ and the surface form does not have the segment γ. Therefore, the rule seems to over-apply.

Rule-based phonology follows a simple assumption to account for opacity: a generalization R which fails to apply to a particular surface form namely O, must apply appropriately to some related representation to O, let's say X. This implies, in rule-based phonology every linguistic expression must have a number of intermediate representations other than the input and output to which the generalizations apply appropriately. Opacity is accounted for in rule-based phonology through rule ordering.

**4.3 Opacity in Optimality Theory**

Bermudez Otero (1999 b) defines opacity in OT as:

"Let there be a language L where a set of input representations I= $\{I_1, I_2, I_3 \ldots . I_n\}$ is mapped onto a set of output representations O= $\{O_1, O_2, O_3 \ldots . O_n\}$. The mapping between *I* and *O* is opaque if and only if, there is no constraint hierarchy *H*, where CON is bound by Strict Surface Orientation and the GEN-EVAL function is strongly parallel, such that *O* is the optimal output with respect to *I* under *H*."

In line with this definition, no optimality-theoretic grammar can account for the phenomenon of opacity. Under Strict Surface Orientation, the optimality-theoretic grammar restricts the constraint set to compose of just input-output faithfulness constraints and output Markedness constraints. So an optimal candidate can be unfaithful to the input structure if it is dominated by some Markedness constraint and if an output structure violates a well-formed structure, it is dominated by a faithfulness constraint. The correspondence relations established among different representations other than the input do not play any role in optimality theory. Therefore, under the principle of Strict Surface Orientation, it is very difficult to account for opacity in a single pass through GEN and EVAL. This criterion of the non-recursive nature of GEN and EVAL such that the phonological mapping between input and output is carried out in a single pass comprises the principle of Strong Parallelism. Classical OT with its strict adherence to the principles of Strict Surface Orientation and Strong Parallelism is incapable of accounting for opacity correctly. To account for the opaque phonological rules, either of the principles needs to be relaxed in classical OT. In a later section of this chapter, we shall discuss in detail the failure of classical OT to account for opacity with respect to opaque phonological rules in Odia.

With classical OT's failure to account for opacity, there were two groups formed within the camp of OT researchers. The first group upheld the principle of Strong Parallelism at the cost of Strict Surface Orientation whereas, on the other hand, the other group of scholars retained the principle of Strict Surface Orientation while giving away the principle of Strong Parallelism. The former group of scholars upholding Strong Parallelism came up with Correspondence Theories such as General Alignment Theory (McCarthy and Prince, 1993), Trans-Derivational Correspondence Theory (Benua 1995, 1997) and Sympathy Theory (McCarthy 1998). On the other hand, the latter group of scholars upholding the principle of Strict Surface Orientation came up with theories such as LPM-OT (Kiparsky, 1998) and Stratal OT (Bermudez Otero, 1999).

### 4.3.1 Retaining Strong Parallelism

There is a strong demand for the property of strong parallelism in every phonological theory as serial derivations are considered 'cognitively implausible' and 'computationally intractable' (Bermudez Otero 1999). In OT, strong parallelism is maintained through correspondence relations. Correspondence relations are marked by faithfulness constraints that seek identity between not just the input and output but any pair of related phonological representations. The Correspondence Theory establishes a number of parallel identity relations between the output and other related phonological structures and it also gives away the principle of Strict Surface Orientation by flooding the constraint set with correspondence constraints along with the other Faithfulness and Markedness constraints. These Correspondence constraints seek identity between not just the input and output but any pair of related phonological representations thus deviating from the Strict Surface Orientation. Some of the major correspondence theories are: General Alignment Theory

(McCarthy and Prince, 1993), Trans-derivational Correspondence Theory (Benua 1995, 1997) and Sympathy Theory (McCarthy 1998).

In the General Alignment Theory, McCarthy and Prince implement the Alignment constraints in this model which are given access to the morphological categories, to check whether the edges of these morphological domains coincide with certain prosodic boundary. For example, in English, the word-initial secondary stress interrupts the normal alternation of stress assigned from right to left: *(tàta)ma(góuchee)* as compared to **ta(tàma)(góuchee)*. To capture this phenomenon, McCarthy and Prince introduce the Alignment constraint:
Align (Prwd, L; Ft, L): "Each PrWd begins with a Ft."
This constraint requires the left edge of a foot to coincide with the left edge of the prosodic word, thus, rendering us the correct surface form *(tàta)ma(góuchee).*

In Transderivational Correspondence Theory (TCT), Benua introduces OO-correspondence constraints that ensure correspondence between the output representations of different morphologically related lexical items to capture the opaque phonological rules. For example, in TCT, in English words such as origin, original and originality, where there are multiple affixations, there would be multiple recursions and the OO-correspondence constraints shall seek faithfulness between the outputs of each recursion. Although TCT tries to account for opacity, yet many researchers of classical OT feel that TCT fails to successfully account for the problem of opacity, especially in cases of opaque phonological generalizations that do not correspond to the output representation of the relevant related lexical items. McCarthy (1998) proposed the Sympathy Theory which in response to the difficulties faced by Benua's TCT. The Sympathy Theory is an extension of the Correspondence Theory which introduces a new kind of constraint that ensures correspondence between the optimal candidate and a sympathy candidate which is a sub-optimal candidate chosen by a low ranking IO faithfulness constraint.

### 4.3.2 Retaining Strict Surface Orientation

Although strong parallelism is favoured due to the cognitive implausibility of serial derivations, yet many theoretic models of OT such as LPM-OT (Kiparsky, 1998), Stratal OT (Bermudez Otero, 1999) etc. challenge the strict parallelism of the classical OT model. Although these models accept that constraint ranking is superior to rule ordering in any phonological generalization but, they also consider that interleaving is one of the most important properties dealing with phonology-morphology interface. Interleaving can be described as the interaction of morphology and phonology where the phonological rules apply recursively within the domains of morphosyntactic constituents that are arranged hierarchically. Interleaving is showcased in grammars through level segregation and cyclicity. In such a theory, opacity arises due to the input-output relations holding between different phonological representations that belong to phonological domains associated with different levels of morphosyntactic domains.

The model of Lexical Phonology and Morphology (LPM) first employed interleaving. In the LPM model, the grammar is divided into a levelled hierarchy and all the morphological conditioning effects are reduced to interleaving where the morphological structure influences the phonological structure through this levelled hierarchy of recursive domains. The model of LPM-OT and Stratal OT borrow this notion of interleaving from the LPM model and implement it in the OT model. As interleaving is totally incompatible with Strong Parallelism, these models uphold the principle of Strict Surface Orientation while compromising with the principle of Strong Parallelism of the classical OT model. We shall discuss the model of Stratal OT and how it successfully accounts for the opaque phonological rules in detail in the following chapter. In the following sections, we shall look at the phenomenon of opacity in the classical example of accentuation in ancient Greek and discuss the treatment of it within the strictly parallel model of classical OT.

### 4.4 Intonation and Accentuation in Ancient Greek

In this section, I will discuss the treatment of opacity within the model of classical OT in the paper "*Accent, Syllable Structure and Morphology in Ancient Greek*" (Kiparsky, 2003). Kiparsky has showcased the failure of parallel OT to account for the opaque phonological rules of pitch accent in ancient Greek. In ancient Greek, pitch accent is assigned to lexical words based on the syllabification of their underlying representation while another class of derived words are assigned pitch accent depending on the syllabification of their surface structure that undergoes various deletion and contraction processes. Noyer (1997) also tried to account for the pitch accent in ancient Greek through the model of classical OT and claimed that OT's parallel model is incapable of accounting for the pitch accent in ancient Greek. He put forward a cyclic analysis where he claimed that the assignment of pitch accent in ancient Greek does not occur in the word level or any other level prescribed by UG but at an arbitrary point in the derivation. He thus proposed an extrinsic rule ordering in the OT grammar to account for the pitch accent in ancient Greek. Kiparsky believed that the idea of extrinsic ordering of rules would pose a challenge to any version of OT and hence proposed a stratal version of OT that can successfully account for pitch accent in ancient Greek.

### 4.4.1 Recessive Accent in Ancient Greek

Phonological opacity and cyclicity are two important phenomena for Greek accentuation and syllabification. Greek showcases "recessive accent" which is the unmarked pattern and intonations of the type: acute and circumflex. According to recessive accent given in Kiparsky (2003; 3), the accent falls on the penult if the final syllable is heavy, otherwise on the antepenult. For example, the pitch accent on Greek words would be as follows:

| | | |
|---|---|---|
| (3) | a. *ánth.roo.pos* | 'person' (Nom.Sg) |
| | b. *anth.roó.poon* | 'persons' (Gen.Pl.) |
| | c. *sóo.mat* | 'body' (Nom.Sg) |
| | d. *soó.ma.ta* | 'bodies' (Nom.Pl) |
| | e. *soo.má.toon* | 'bodies' (Gen.Pl) |

Word-final consonants are extrametrical in Greek. Therefore, a VC and V rhymes make light syllables in word-final positions and VV, VVC and VCC rhymes make heavy syllables. From the above data it can be seen that the accented syllable containing a long vowel or diphthong is further differentiated based upon the intonation patterns, where the intonation pattern is either acute (VV́) as in (3.b) and (3.d) or circumflex (V́V) as in (3.c). Accented two-mora syllable depicts acute intonational pattern in the antepenult and circumflex pattern only if the final syllable is bimoraic. Thus, the accent placement of ancient Greek depends upon the syllable weight and the mora count where mora refers to a tone bearing unit (TBU) and not a unit of syllable weight. Thus, the three types of syllabic distinction in Greek would be as follows:

(4) a. V: light syllables
b. VC: heavy syllables with one mora
c. VV: heavy syllables with two moras

Thus, in ancient Greek, the syllable weight determines the place of accent whereas the mora count determines the intonational pattern. The recessive accent discussed earlier determines the position of the pitch accent. The generalization that Kiparsky (2003) drew about the accent and intonation pattern of ancient Greek was:

Recessive accent determined by syllable structure:

(5) a. V(C): *ép+okhos* “mounted”

b. VV(C): *lipó+naus* “deserting the fleet”

c. VC(C): *lipó+thriks* “balding”

Intonation determined by mora count:

(6) a. Acute intonation (VV) occurs only before two syllables or a syllable with two moras.

b. Acute intonation also occurs in word-final syllables in the nominative and accusative forms.

c. Circumflex intonation (VV) occurs elsewhere.

For instance,

(7) a. VCC: *katéelips* ‘terrace’; a circumflex intonation is assigned on the accented syllable as it is followed by a single light syllable.

b. VVC: *kat+eérees* ‘fitted out’; an acute intonation is assigned on the accented syllable as it is followed by a syllable with two moras.

c. VC: *kat+éemar* ‘day by day’; a circumflex intonation is assigned on the accented syllable as it is followed by a single light syllable.

Steriade (1988b) gave an analysis of ancient Greek within the generative model. The rules for the formation of foot in ancient Greek are as follows:

(8) a. Extrametricality of word-final consonant.

b. Extrametricality of word-final light syllable.

c. Syllabic trochee is constructed at the right edge of the word.

Steriade also proposed rules for the construction of intonational patterns in ancient Greek which are as follows:

(9) a. Extrametricality of a word-final monomoraic syllable.

b. Acute intonation is constructed on a bimoraic accented syllable only if it is followed by at least one mora that is not extrametrical.

c. Otherwise, the circumflex intonational pattern is constructed.

In line with Steriade's analysis of ancient Greek, Kiparsky (2003) proposed the OT model for accounting for the pitch accent of ancient Greek. Kiparsky proposed two constraints: a faithfulness constraint IDENT (Acc) and an alignment gradient constraint ALIGN defined as follows:

(10) a. IDENT (Acc): Corresponding segments in a foot have the same pitch

b. ALIGN: The head of a foot must bear a pitch accent.

The faithfulness constraint ensures that the recessive accent does not fall on the final foot while the alignment constraint is a gradient constraint that ensures that the pitch accent falls as close to the foot-head as possible. IDENT (Acc) does not permit the recessive accent to fall on the final syllable, but if there is no mora to the left of the foot, ALIGN assigns the pitch accent to the head.

Based on the rules presented in (8) and (9) and the constraints presented in (10), Kiparsky illustrated an OT model for determining the pitch accent of ancient Greek. Below mentioned are some of the derivations of the examples mentioned in (3) and (7):

(11)

| i. Input: [soomat] | IDENT (Acc) | ALIGN |
|---|---|---|
| ☞ a. (sóo)mat | * | * |
| b. (soó)mat | * | *!* |

| ii. Input: [soomat-a] | IDENT (Acc) | ALIGN |
|---|---|---|
| a. sóo(ma.ta) | | *!* |
| ☞ b. soó(ma.ta) | | * |
| c. soo(má.ta) | *! | |
| d. soo(ma.tá) | *! | * |

| iii. Input: [soomat-oon] | IDENT (Acc) | ALIGN |
|---|---|---|
| a. sóo.ma(too)n | | *!** |
| b. soó.ma(too)n | | *!* |
| ☞ c. soo.má(too)n | | * |
| d. soo.ma(tóo)n | *! | |
| e. soo.ma(toó)n | *! | * |

| iv. Input: [katee-lips] | IDENT (Acc) | ALIGN |
|---|---|---|
| a. ká.tee(lip)s | | *!** |
| ♣ b. ka.tée(lip)s | | *!* |
| ☞ c. ka.teé(lip)s | | * |
| d. ka.tee(líp)s | *! | |

We can see from the above illustrations that the above ranking of constraints render us the correct output forms in (11i, ii, iii) whereas the above system does not work in (11.iv) where it yields an incorrect output **ka.teé(lip)s* as opposed to *ka.tée(lip)s*. To solve this issue, Kiparsky (2003) proposed another constraint that prevents an acute penult accent if the final syllable has one mora or a single tone bearing unit which is stated as follows:

**μμ́.μ]: No acute before a word-final mora.*

The above-mentioned constraint dominates IDENT (Acc) and ALIGN. Let us look at the derivation of the word [katee-lips] with the revised ranking of constraints:

| iv. Input: [katee-lips] | *μμ́.μ] | IDENT (Acc) | ALIGN |
|---|---|---|---|
| a. ká.tee(lip)s | | | *!** |
| ☞ b. ka.tée(lip)s | | | *!* |
| c. ka.teé(lip)s | *! | | * |
| d. ka.tee(líp)s | | *! | |

Therefore, we can see from the above tableaux that the revised ranking of constraints rendered us the correct surface form. The derivation of (11 i, ii, iii) remains unaffected by the addition of the new constraint as it rendered vacuously. In this section, we discussed the general pattern of intonation and recessive accent in ancient Greek and how OT successfully accounts for it. Let us further our discussion to the analysis of accent and intonation in final syllables determined by morphological categories in ancient Greek.

### 4.4.2 Morphologically Determined Accent and Intonation in Final Syllables

We saw in the previous section that a lot of words in ancient Greek depict recessive accent that is majorly phonologically driven. In this section, we shall discuss the group of words of ancient Greek that showcase accent and intonation on the final syllable who have a predictable pattern and are determined by the morphological categories. Kiparsky (2003) noted this as follows:

(12) A two-mora word-final syllable is acute in nominative and accusative case forms.

Let us consider the examples given in Kiparsky (2003) to have a close look at the difference in the intonational pattern of the final syllables in different morphological categories of ancient Greek:

| | | | | | |
|---|---|---|---|---|---|
| (13) | a. *po.d-oús* | 'feet' | (A.Pl.) | *po.d-óon* | (G.Pl.) |
| | *b. phu.g-eé-n* | 'flight' | (A.Sg.) | *phu.g-ée-s* | (A.Sg.) |
| | *c. zeús* | 'Zeus' | (Nom.) | *zéu* | (Voc.) |
| | *d. hipp-eú-s* | 'horseman' | (Nom.) | *hipp-éu* | (Voc.) |

From the above examples, we see that the acute intonation pattern on final syllables is found only in nominative and accusative case forms whereas the circumflex pattern which is ensured by the constraint ALIGN is found elsewhere.

### 4.4.3 Opacity in Ancient Greek

Till now we have discussed the accent and intonation pattern of ancient Greek. In this section, we shall look at the opaque accentuation rules. In ancient Greek, the accent is assigned to underived words before vowel contraction and is thus made opaque by it. To understand this phenomenon clearly we shall look at some examples of finite verbs. In the previous section, we discussed that finite verbs are always assigned recessive accent. The following examples from Kiparsky (2003), presented in (12) show that the recessive accent is assigned before vowel contraction and is therefore opaque in the output form:

| | | | | |
|---|---|---|---|---|
| (14) | a. */poi.é.-oo/* | *poi.óo* | **poí.oo* | 'make' (1.Sg) |
| | *b. /phi.lé.-e.te/* | *phi.léi.te* | **phí.lei.te* | 'love' (2.PL) |
| | *c. /te.the.-ée-te/* | *ti.thée.te* | **tí.thee.te* | 'put' (2.Pl.Subj) |

In the above words, we see that the recessive accent does not apply. Had it applied, we would have got forms in the third column marked with a * symbol. The forms within slashes are the stem level forms and display recessive accent but their output forms are opaque to the recessive accentuation. This implies that recessive accentuation occurs at the stem level before vowel contraction.

Let us consider the opacity in intonation patterns of ancient Greek. As discussed (10), we know that bimoraic final syllable in the forms with nominative and accusative case marking take the acute intonational pattern whereas the circumflex pattern occurs elsewhere in ancient Greek. Have a look at the below-mentioned examples in (13) based on Kiparsky (2003):

| | | | | |
|---|---|---|---|---|
| (15) | a. */pló.-os/* | *plóus* | **ploús* | 'sailing' (Nom.Sg.) |
| | *b. /a.lee.thé.s-a/* | *a.lee.thée* | **a.lee.theé* | 'true' (Acc.Sg) |
| | *c. /her.me.-ee-n/* | *herméen* | **her.meén* | 'Hermes' (Acc.Sg) |
| | *d. /di.-i/* | *dií* | **díi* | 'Zeus' (Dat.Sg) |

The above-mentioned examples display opacity in the intonational pattern. 13 (a, b, c) with the Nominative and Accusative case markings display a circumflex intonational pattern whereas 13 (d) with the dative case marking which should be assigned a circumflex intonational pattern displays acute intonation. The generalization that we conclude from this is that accent is marked to the stem level forms before syllabification and is therefore retained on the original mora or as close to it. From the above examples given in (12) and (13), it is clear that the recessive accent and the intonational patterns are assigned to the stem level forms and are therefore bleed other phonological rules that follow them, thus leading to opacity.

**4.5 Failure of Parallel OT**

There is no way that we can account for the data in (12) and (13) with the strictly parallel approach of OT. For example, let us consider the example in (12b) */phi.lé.-e.te/* which is contracted to *phi.léi.te* 'you love'. We already know that recessive accent is assigned invariably to finite verbs in ancient Greek. Looking at the syllable structure of the surface form, we should get a form as **phí.lei.te.* As the final syllable is light, accent should have been assigned to the antepenultimate syllable. But this is clearly not the case. The surface form *phi.léi.te* is opaque to the rules of recessive accentuation. This can only be achieved by having a faithfulness constraint that dominates the other constraints responsible for recessive accentuation. But the question that arises here is what kind of faithfulness constraint can do so. It cannot be an I/O faithfulness constraint because under the OT's strongly parallel approach, the input can only be an underlying representation and the predictable accent cannot be assigned to the underlying representation as it will violate the principle of Freedom of Analysis where the input representations for the finite verbs can be assigned accent anywhere and there wouldn't be any specific accentuation that the optimal candidate is expected to be faithful to. Kiparsky notes that we cannot also posit any other OO faithfulness constraint as that would lead to over-application of rules to uncontracted verbs that have the correct accentuation. He suggests that the accent marked on contracted verbs can only be related to the fact that they are contracted.

Kiparsky (2003) suggested that the opacity in ancient Greek could be accounted for by the Sympathy theory (McCarthy, 1999). He proposed that the optimal output *phi.léi.te* could be derived by faithfulness to the sympathy candidate which in this case would be the losing uncontracted candidate *phi.lé.-e.te.* In the Sympathy Theory, the sympathy candidate is the optimal candidate that satisfies a selector constraint which is a faithfulness constraint that ensures faithfulness to some property of the input and then the constraint ✿CUMUL and ✿ DIFF select the candidate that is closest to the sympathy candidate.

The question that arises here is to what property of the sympathy candidate the output form should be faithful to. Kiparsky (2003) proposes three possibilities. The first possibility is regarding faithfulness to syllable structure. But, this is in clear contradictoriness to McCarthy's claim that faithfulness to syllable should not be allowed as that would lead to the nullification of the effect of cumulativity. Therefore, this faithfulness constraint is rejected. The second possibility is regarding moraic patterning of segments. Keeping in mind our earlier discussion the mora refers to the tone-bearing unit and not the syllable quantity, the sympathy candidate with the form *lé.-e* is identical to the output form *léi* as both have two moras and the same moraic pattern. Therefore, this faithfulness constraint is also discarded. The third possibility is to propose a faithfulness constraint MAX-C and posit a deleted consonant. This possibility has no synchronic motivation and is therefore discarded. Lastly, it is the alignment constraints ensuring alignment between morphemes and syllables that would choose the sympathy candidate but this is totally against McCarthy's Sympathy model where he argues on principled grounds that a sympathy candidate is chosen only by a selector constraint which are faithfulness constraints but in this case the alignment constraints are in no way faithfulness constraints. Therefore, the phenomenon of opacity in ancient Greek could not be accounted for the Sympathy model as well. Kiparsky after trying all the possibilities thus concludes that opacity in ancient Greek can in no way be accounted by a strictly parallel model of OT as it will assign incorrect recessive accentuation to the antepenult in *phi.léi.te.*

### 4.6 Stratal OT Model

In the previous section, we discussed the failure of a strictly parallel model of OT to capture opacity in ancient Greek. Kiparsky argued that the assignment of accentuation in ancient

Greek is a serial phenomenon and therefore cannot be accounted by a strictly parallel model. Kiparsky (2003) proposed that a stratal model of OT with different morphosyntactic levels accompanied by the level-specific phonology can successfully account for opacity in ancient Greek. The fundamental assumption behind developing this theory was that “opacity arises from inter-level constraint masking” (Kiparsky, 2003; 13). The core ideas of his Stratal theory were:

- Different morpho-syntactic constituents such as stems, words and phrases are characterized by different constraints set and their ranking.
- These constraints systems are parallel but interface serially.
- The only types of correspondence constraints are the I/O faithfulness constraints.

Stratal OT was developed to encapsulate three powerful ideas: the phonological cycle, phonological stratification and the parallel constraint-based computation in the manner of OT. It is a merger of the main tenets of two main theories: Lexical Phonology-Morphology (LPM) and Optimality Theory. But, the theory of Stratal OT is not a hybridization of both the theories, neither is it the implantation of LPM onto OT nor is it the other way around. It is also not a compromise between them. “It combines the mutually compatible aspects of both the theories, which complement each other because they deal with different things” (Kiparsky, 2003). Opacity is achieved by the cyclic application of phonological rules where the phonology corresponding to an inner morphosyntactic domain such as the stem applies before the phonology corresponding to an outer morphosyntactic domain such as the word.
Kiparsky proposed that the Stratal OT model can account for the opaque accentuation rules in ancient Greek due to its inherent serialism. He argued that accentuation in Greek is opaque because the accent is assigned to the stem first at the stem level and then the output of the stem level undergoes vowel contraction at the word level. A highly ranked faithfulness constraint IDENT (Acc) at the word level ensures that the accent is retained on the original mora. Therefore, the input */phi.le.-e.te/* receives recessive accent at the stem level, thus forming the stem level output */phi.lé.-e.te/.* The stem level output further serves as the input to the word level where vowel contraction takes place and the faithfulness constraint IDENT(Acc) present at the word level prevents the accent from retracting back, thus, giving us the optimal output *phi.léi.te.*

## 4.7 Conclusion

In this chapter, we discussed the phenomenon of opacity and how it is dealt with different generative theories. The classical example of accentuation in ancient Greek explained the failure of a parallel model of OT to account for opaque phonological rules. It also gave us an insight into the interactions of morphology and phonology. Accentuation in Greek is a serial phenomenon where the accent is assigned at the stem level and then syllabification occurs at the word level. So, the output of the stem level serves as the input to the word level. This is impossible to be accounted for in a strict parallel OT model which is mono-stratal where evaluations occur in a single pass. Therefore, the classical OT model fails to capture the phenomenon of opacity. On the contrary, such kind of serialism is inherent to the model of Stratal OT due to its level segregation and cyclicity. Therefore, the Stratal OT model offers us a correct and restrictive model to capture the opaque phonological rules in a grammar successfully. In the following chapter, I shall discuss in detail the Stratal OT model and its working and how it successfully accounts for the opaque stress rules of Standard Odia which is our major focus of this thesis.

# *Chapter 5*

# A STRATAL OT ACCOUNT OF ODIA COMPLEX WORDS

## 5.1 Introduction

The previous chapter saw the failure of Optimality Theory to account for the intonational and accentuation pattern in ancient Greek due to its strict adherence to strong parallelism. In this chapter, we shall discuss the stress preservation in Odia complex words that give rise to various opaque phonological rules. I shall illustrate the failure of the model of OT to account for the phenomenon of opacity in Odia. Early generative theories argue that stress preservation arises due to both inter and intra stratum cyclicity. In this chapter, we shall see how the model of Stratal Optimality Theory with its serially ordered morphosyntactic and phonological strata resolves the issue of classical OT in dealing with the phenomenon of cyclicity and opacity. I shall deploy the version of Stratal OT proposed in Kiparsky (2000), Bermudez-Otero (2003) and Bermudez-Otero and McMahon (2006) for my analysis in this chapter. Finally, I shall propose a more restrictive analysis of stress preservation with the newer version of Stratal OT that employs the principle of fake cyclicity condition proposed by Bermudez Otero and McMahon (2006).

## 5.2 Stress Preservation

"Stress Preservation is an indicator of the relationship between a word and another word embedded within it" (Collie, 2007). Stress preservation receives a highly restrictive analysis in OT due to the virtue of constraint interaction. In OT, stress preservation is defined as a violable faithfulness constraint that is in interaction with other Markedness constraint. Words that are candidates of stress preservation have an input with stress already assigned that they need to be faithful to. This offers a restrictive analysis to the theory as all the words of the grammar are subjected to the same Markedness constraints. The faithfulness constraints are those that play a vital role in stress preservation. The candidates of stress preservation are faithful to their input's stress pattern whereas candidates that do not exhibit stress preservation are rendered vacuous. Not only does the theory offer a restrictive analysis but also predicts the environments where stress preservation will occur and those where it won't.

Burzio in his work "*Principles of English Stress*" (1994) offers a constraint-based, non-OT analysis of English stress. He claims that stress preservation does not occur across the board, it only occurs in places where it does not threaten the satisfaction of a higher ranked phonological constraint. He refers to stress preservation in his principle of "Metrical Consistency" which is defined as: "every morpheme must be as metrically consistent as possible" (Burzio, 1994). Burzio's proposal of realizing stress preservation as a ranked violable constraint offers the first stepping stone in the analysis of stress preservation within a constraint-based framework. There are two advantages of defining stress preservation as a violable constraint. Firstly, as it is violable, no repair strategies need to be proposed to modify a foot where stress preservation leads to an ill-formed foot. Secondly, being a violable constraint, it is in constant interaction with other well-formedness constraints that are applicable on both simple and complex words and can, therefore, account for the minimal yet crucial differences in stress patterns of these words.

OT retains Burzio's insight on stress preservation. Burzio's principle of metrical consistency is realized as a violable faithfulness constraint in OT that is in constant interaction with other well-formedness constraints or the Markedness constraints. Both morphologically simple and complex words are subjected to the same ranking of Markedness constraints and the ranking and interaction of these constraints account for the difference in the phonology of these words. This is exemplified by Pater (2000) as follows:

| Input: /*tatamagouchi*/ | FTBIN | PARSE- σ | IDENT-STRESS | ALIGN-L |
|---|---|---|---|---|
| ☞ a. (ta.ta) ma \|gouchi | | * | | |
| b. ta (ta.ma) \|gouchi | | * | | *! |
| c. (ta.ta.ma) \|gouchi | *! | | | |

| Input: /*oríginal-ity*/ | FTBIN | PARSE- σ | IDENT-STRESS | ALIGN-L |
|---|---|---|---|---|
| a. (o. ri) gi \| nality | | * | **! | |
| ☞ b. o (ri.gi) \| nality | | * | * | *! |
| c. (o.ri.gi) \| nality | *! | | ** | |

In the above illustration, we can see that the same ranking of constraints can account for the difference in stress patterns in both mono-morphemic and complex words.

### 5.3 OT and Opacity

Although OT's strict adherence to parallelism offers us a restrictive analysis for stress preservation, yet it also causes problems for OT especially in the case of phonological opacity. Phonological opacity is a phenomenon where a surface form doesn't undergo the phonological generalisation that was expected to apply such that the phonology misapplies. Opacity can take two forms: 'over-application' and under-application. Over-application is when a phonological process applies in a context where it was not supposed to i.e. where its structural description is not met and under-application is when a phonological process doesn't apply in a context where it was supposed to i.e. in spite of its structural description being satisfied, it doesn't apply. We find that in a language this phonological misapplication is not random but, systematic and predictable.

In the English words *órigin, oríginal and orìginálity*, we find that *orìginálity* retains its stress pattern from its immediate sub-domain that is *oríginal* and not its root word *órigin.* In such a case, a serial approach for evaluation becomes inevitable. The word *oríginal* undergoes stress assignment and the word *orìginálity* derived from *oríginal* remains opaque to the phonological rules of stress assignment, and thus retains the stress pattern of its immediate subdomain. This phonological opacity is what OT cannot account for. The stress preservation which is an unavoidable serial phenomenon poses serious threat to the strongly parallel theory of OT. To understand phonological opacity and the failure of OT to account for the phenomenon of opacity, we shall consider a treatment of stress preservation in Odia complex words within the framework of classical OT in the following section.

### 5.3.1 Classical OT's Treatment of Stress Preservation in Odia

In this section, we are going to analyse the stress preservation in Odia complex words amounting to opacity within the framework of classical OT. Let us consider an example:

a. pɔ̃́hɔɾɑ → b. pɔ̃́hɔɾɑbɑ̀lɑ → c. pɔ̃́hɔɾɑbɑ̀lɑmɑ̀ne

The metrical stress pattern of Odia can be observed with respect to the following rules:

- Extrametricality of syllable containing [ɑ] word finally only in trisyllables
- A moraic trochee assigns stress from right to left
- In case of more than one foot, the End rule assigns prominence to the head of the leftmost foot.
- Stress clash is avoided

We can see that in (a) since the final syllable contains the vowel ɑ and it is a trisyllabic word, the final syllable is extrametrical and is excluded from the metrical structure. A moraic trochee is established from right to left that assigns stress to the anti-penultimate syllable. Whereas in (b) and (c), the stress rules of Odia do not seem to apply. Had the stress rules applied, we would have got structures like *pɔ̃(hɔ́.ɾa)(bà.la) and *pɔ̃(hɔ́.ɾa)(bà.la)(mà.ne). On the contrary what we have is structures like *(pɔ̃́.hɔ)ɾa(bàla)* and *(pɔ̃́.hɔ)ɾa(bà.la)(mà.ne)*. This blocking of stress rules in these complex words is what drags our attention to. The opacity arising in these words is due to the phenomenon of stress preservation. The complex derived words *pɔ̃́hɔɾabàla* and *pɔ̃́hɔɾabàlamàne* retain the stress pattern of the root word pɔ̃́hɔɾɑ and are therefore opaque to the stress rules. Let us look at how the model of classical OT treats such kind of opaque phonological rules.

To analyse the stress patterns of these words, the constraint set that we shall posit are:

**GrWd= PrWd**

A grammatical word is a prosodic word.

**FTBIN**

Feet are bimoraic

***CLASH**

Adjacent stressed syllables are avoided.

**LEFTMOST**

The most prominent syllable of a word is the head of the leftmost foot.

**ALIGN (Stem, R; PrWd, R)**

The right edge of the stem must coincide with the right edge of the PrWd.

**ɑ]σ-EX(σσσ)**

Word-final syllable consisting 'ɑ' vowel is extrametrical only in trisyllabic words.

**ALIGN (Hd-σ; Ft, L)**

Align the syllable head with the left edge of the foot.

**IDENT-IO (stress)**

Stress of output corresponds with that of input.

**PARSE-σ**

All the syllables must be parsed into feet.

**MAX -IO**

All input segments must have an output correspondent.

**DEP –IO**

All output segments must have an input correspondent.

**NOHIATUS**

No two vowels must occur adjacently.

The ranking of these constraints would be as follows:

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> ALIGN(Hd-σ; Ft,L) >> LEFTMOST>>ALIGN (Stem,R; PrWd, R) >>IDENT-IO (stress) >>PARSE-σ >> MAX-IO >> DEP-IO

From the above ranking of constraints, the above mentioned words could be derived as:

a. Derivation of pɔ̃́hɔɾɑ :

| **Input:** pɔ̃hɔɾɑ | **GrWd= PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **IDENT-IO (stress)** | **MAX-IO** | **DEP-IO** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. (pɔ̃.hɔ́)ɾɑ | | | | | | *! | | * | * | | | |
| ☞ b. (pɔ̃́.hɔ)ɾɑ | | | | | | | | * | * | | | |
| c. pɔ̃(hɔ́.ɾɑ) | | | *! | | | | | | * | | | |
| d. pɔ̃hɔɾɑ | *! | | | | | | | | *** | | | |
| e. (pɔ̃́.hɔ.ɾɑ) | | *! | * | | | | | | | | | |

With the above ranking of constraints, we can derive the output form [pɔ̃́hɔɾɑ] correctly from the input form /pɔ̃hɔɾɑ/. In the above tableux, the optimal candidate (b) incurs the least serious violations to satisfy the higher ranked constraints.

b. Derivation of pɔ̃́hɔɾɑbὰlɑ

| **Input:** /pɔ̃hɔɾɑ + bɑlɑ/ | **GrWd=PrWd** | **FTBIN** | **ɑ]σ-EX(σσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **IDENT-IO (stress)** | **MAX-IO** | **DEP-IO** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. ɔ̃(hɔ́.ɾɑ)(bɑ́.lɑ) | | | | | | | *! | | * | | | |
| ☞b. ɔ̃(hɔ́.ɾɑ)(bὰ.lɑ) | | | | | | | | | * | | | |
| c. pɔ̃́(hɔ́.ɾɑ)(bὰ.lɑ) | | | | | *! | | * | | * | | | |
| ♣d. pɔ̃́.hɔ.ɾɑ(bὰ.lɑ) | | | | | | | | | **!* | | | |
| e. pɔ̃hɔɾɑbɑlɑ | *! | | | | | | | | ***** | | | |

From the above tableux, it can be seen that OT predicts an incorrect output as the optimal candidate. (b) which is the most harmonic candidate that incurs the least fatal violations is not the correct surface form for the input. The surface form for the input is (d) which is not predicted by the OT grammar. The derived word copies the stress pattern of its immediate subdomain thus forming a structure such as *pɔ̃́(hɔ̀.ɾa)(bὰ.la).* As stress clash is not allowed in OT the stress in the leftmost foot is retained and the penultimate foot undergoes defooting. OT being a strictly parallel model, has no scope for such cyclic application of stress rules. A word is derived in a single pass. The input has no specification for stress and the faithfulness constraint IDENT-IO(stress) is therefore rendered vacuous. But, on the contrary, we find evidences of stress copying which implies the cyclic property of stress assignment i.e stress is first assigned to the stem to which the derived word remains faithful to. To understand this cyclic effect better, we shall consider the next example where the word *pɔ̃́hɔɾabàla* undergoes inflectional affixation.

iii. Derivation of pɔ̃́hɔɾɑbɑ̀lɑmɑ̀ne:

| **Input:** /pɔ̃hɔɾɑ+bɑlɑ+mɑne/ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **IDENT-IO (stress)** | **MAX-IO** | **DEP-IO** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. pɔ̃(hɔ̀.ɾɑ)(bɑ̀.lɑ)(mɑ́.ne) | | | | | | | *! | | * | | | |
| ☞b. ɔ̃(hɔ́.ɾɑ)(bɑ̀.lɑ)(mɑ̀.ne) | | | | | | | | | * | | | |
| c. (pɔ̃́.hɔ)(ɾɑ̀.bɑ)(lɑ̀.mɑ)ne | | | | | | | | *! | * | | | |
| ♣d pɔ̃́.hɔ.ɾɑ(bɑ̀.lɑ)(mɑ̀.ne) | | | | | | | | | **!* | | | |
| e. pɔ̃.hɔ.ɾɑ.bɑ.lɑ.mɑ.ne | *! | | | | | | | | | | | |

Here we can see that the OT grammar renders (b) as the optimal candidate whereas it is actually (d) which is the correct surface form for the input */pɔ̃́hɔɾa+bala+mane/.* The word *pɔ̃́.hɔ.ɾa(bà.la)(mà.ne)* retains the stress pattern of its immediate subdomain *pɔ̃́.hɔ.ɾa*.This suggests that the embedded word must be assigned stress first and further serve as an input with its full phonological form for the embedding word. As we already know, such serialism is not allowed in OT, therefore, the input does not have a specification for stress and stress is supposed to be assigned parallely in a single pass in all complex words. The faithfulness constraint ranked lowest in the OT grammar, is rendered vacuous as it has no corresponding input to be faithful to. Therefore, due to stress preservation of the stem in the derived words, the words *pɔ̃́.hɔ.ɾa(bà.la)* and *pɔ̃́.hɔ.ɾa(bà.la)(mà.ne)* are opaque to the stress rules. Thus, OT with its strictly parallel model is incapable of accounting for the cyclic nature of stress assignment further leading to opacity.

There are two ways to account for phonological opacity in OT: firstly, by retaining classical OT's parallel approach and not introducing any intermediate level and secondly, by introducing a serial analysis along with OT's parallel approach i.e. by incorporating the phonological cycle in the model of OT. In this thesis, we shall focus on the latter approach. In the following sections of this chapter, we shall discuss the Stratal OT model in detail and how it successfully overcomes the failure of classical OT model in handling opacity.

## 5.4 Stress Preservation in Stratal OT

Stratal OT (Bermudez Otero-1999b, 2003 and Kiparsky-2003 among others) was developed to encapsulate three powerful ideas: the phonological cycle, phonological stratification and the parallel constraint-based computation in the manner of OT. It is a merger of the main tenets of two main theories: Lexical Phonology-Morphology (LPM) and Optimality Theory. In the model of Stratal OT, the grammar consists of serially ordered levels of OT evaluations. There are three levels of evaluations in Stratal OT namely: stem, word and phrase levels. Stratal OT rejects LPM's principle of structure preservation based on the principle of Richness of base of OT, which is no constraints apply at the level of input. The phonological cycle operates in the model of Stratal OT such that the output of the stem level serves as the input to the word level and the output of the word level serves as the input to the phrase level.

Opacity in Stratal OT "is achieved by the output of an earlier constraint hierarchy (e.g. the stem level cophonology) being only partially overwritten in an evaluation by a later constraint hierarchy (e.g. the word or phrase level co-phonology)" (Collie, 2007: 244). Words and phrases are comprised of different morphosyntactic constituents such as root being the innermost constituent, then the Stem, then the word and finally the phrase. Due to this intrinsic arrangement of morphosyntactic constituents, serialism is inherent to the model of Stratal OT. Therefore, the phonology of these morphosyntactic domains applies likewise such that the phonology corresponding to an inner morphosyntactic domain applies before the phonology corresponding to an outer morphosyntactic domain.

For the exemplification of how Stratal OT accounts for stress preservation and phonological opacity, we shall consider an example from English: *óbvious* → *óbviousness*. Due to strong stress preservation, obviousness is opaque to the stress rule as the primary stress application has misapplied. In English, primary stress is assigned within three syllables from the right edge, but in *óbviousness,* the stress rule misapplies and primary stress is assigned to the preantipenult. The embedding word *óbviousness* retains the stress pattern of the embedded word *óbvious.* As we know in the Stratal OT model, the grammar is divided into different strata based on the morphosyntactic category. Therefore, *óbvious* falls into the stem level category whereas *óbviousness* falls into the word level category. They shall be exposed to different types of constraints with the respective stratum-specific ranking. To account for the strong stress preservation, we shall make use of the faithfulness constraint:

**IDENT-IO (Stress)** = stress of output segments must correspond to the input segments.

The other two constraints are a markedness constraint and an alignment constraint:

**NON FINAL** = final syllable is extrametrical.

**ALIGN-R** = main stress is on the right-most syllable of the word.

| STEM LEVEL | | | |
|---|---|---|---|
| Input: /obvious/ | NON FINAL | ALIGN-R | IDENT-IO (Stress) |
| a. ob(vi̋.ous) | *! | * | |
| ☞ b. (ób)vi.ous | | ** | |

| WORD LEVEL | | | |
|---|---|---|---|
| Input from stem level: /ób.vi.ous-ness/ | NON FINAL | IDENT-IO (Stress) | ALIGN-R |
| a. ob(vi̋.ous)ness | | *! | ** |
| ☞ b. (ób)vi.ous.ness | | | *** |

From the above exemplification, we see that there are two co-phonologies present for the two strata: the stem level and the word level. The output of the stem level becomes the input to the word level. As strong stress preservation occurs in the word level, the faithfulness constraint is ranked higher than the alignment constraint. Whereas, in stratum 1 that is the stem level, stress shifting occurs and therefore the Markedness and alignment constraints are ranked higher than the faithfulness constraint. In Stratal OT, stratification of the grammar into morphosyntactic levels along with the stratum-specific ranking of constraints and their interaction allows us to capture phenomena of phonological opacity and stress preservation. In the next section, we shall apply the model of Stratal OT for the analysis of stress in Odia complex words.

### 5.4.1 Stratal OT Account of Stress Preservation in Odia

In the previous section, we saw the failure of the Classical OT model to account for stress preservation and the opaque stress rules of Odia. In this section, we shall illustrate how we can account for the phenomenon of opacity in the model of Stratal OT successfully.

For exemplification, we shall consider the same examples:

i. a. pɔ̰̃́hɔɾɑ → b. pɔ̰̃́hɔɾɑbɑ̀lɑ → c. pɔ̰̃́hɔɾɑbɑ̀lɑmɑ̀ne

What is interesting to note here in the above examples is the misapplication of the stress rule in certain environments. From the above example, we can see that *pɔ̃́hɔɾa* agrees with the stress rules of Odia but in the case of *pɔ̃́hɔɾabàla* and *pɔ̃́hɔɾabàlamàne*, the stress rules remain opaque. Had the stress rules applied, we would have got a forms like **pɔ̃(hɔ́.ɾa)(bà.la)* and **pɔ̃(hɔ́.ɾa)(bà.la)(mà.ne)*. The stress rules underapply in this case hence proving phonological opacity.

### 5.4.1.1 The Stratal OT Model of Odia

As we have already discussed the two main principles of Stratal OT are level segregation and cyclicity. In the present, as we are mainly focussing on the lexical and complex words of Odia, we shall posit two levels in our model: the stem level and the word level. Therefore, we shall have two constraint rankings for both the levels respectively.

The constraint ranking that we posited earlier in this chapter shall remain intact for our stem level as primary stress is assigned at the stem level. Therefore, the constraint ranking for the stem level is:

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> ALIGN(Hd-σ; Ft,L) >> LEFTMOST>>ALIGN (Stem,R; PrWd, R) >>IDENT-IO (stress) >>PARSE-σ >> MAX-IO >> DEP-IO

The constraint ranking for the word level would undergo a minute change. Since strong stress preservation mostly occurs in the word level, we assume that the faithfulness constraint IDENT-IO (stress) plays a vital role at this level. Hence, it must be ranked higher in the constraint ranking.

Therefore, the constraint ranking for the word level is:

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> IDENT-IO (stress) >> ALIGN(Hd-σ; Ft,L) >>LEFTMOST>>ALIGN (Stem,R; PrWd, R) >> PARSE-σ >> MAX-IO>> DEP-IO

The above words would be derived as follows:

a. Derivation of the word pɔ̃́hɔɾɑ

| **Input:** pɔ̃hɔɾɑ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **IDENT-IO (stress)** | **MAX-IO** | **DEP-IO** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. (pɔ̃.hɔ́)ɾɑ | | | | | | *! | | * | * | | | |
| ☞ b. (pɔ̃́.hɔ)ɾɑ | | | | | | | | * | * | | | |
| c. pɔ̃(hɔ́.ɾɑ) | | | *! | | | | | | * | | | |
| d. pɔ̃hɔɾɑ | *! | | | | | | | | *** | | | |
| e. (pɔ̃́.hɔ.ɾɑ) | | *! | * | | | | | | | | | |

b. Derivation of the word pɔ̃́hɔɾɑbɑ̀lɑ

In the derivation of the word pɔ̃́hɔɾɑbɑ̀lɑ, first stress is assigned to the root word *pɔ̃hɔɾɑ* at the stem level and then the suffix +bɑlɑ is added at the word level and the phonology of the word level applies. Therefore, there are two recursions:

Recursion 1:

| **Input:** pɔ̃hɔɾɑ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **IDENT-IO (stress)** | **MAX-IO** | **DEP-IO** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. (pɔ̃.hɔ́)ɾɑ | | | | | | *! | | * | * | | | |
| ☞ b. (pɔ̃́.hɔ)ɾɑ | | | | | | | | * | * | | | |
| c. pɔ̃(hɔ́.ɾɑ) | | | *! | | | | | | * | | | |
| d. pɔ̃hɔɾɑ | *! | | | | | | | | *** | | | |
| e. (pɔ̃́.hɔ.ɾɑ) | | *! | * | | | | | | | | | |

Recursion 2:

| WORD LEVEL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** p᷄ɔ̃hɔɾɑ+bɑlɑ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **IDENT-IO (stress)** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** |
| a. pɔ̃(hɔ́.ɾɑ)(bɑ̀.lɑ) | | | | | | *! | | | | * | | |
| ☞b. pɔ̃́.hɔ.ɾɑ(bɑ̀.lɑ) | | | | | | | | | | *** | | |
| c. (pɔ̃̀.hɔ)ɾɑ(bɑ́.lɑ) | | | | | | | | *! | * | * | | |
| d. (pɔ̃́)(hɔ̀.ɾɑ)(bɑ̀.lɑ) | | *! | | | * | | | | | | | |
| e. pɔ̃.hɔ.ɾɑ.bɑ.lɑ | *! | | | | | | | | | ***** | | |

From the above illustration, we infer that in the derivation of the above word, the first stress is assigned to the root word at the stem level. The output of the stem level becomes the input to the word level in its full phonological form. A moraic trochee is constructed from right to left. The faithfulness constraint ranked higher at the word level retains the stress of the input on the initial syllable and we get a structure as such (pɔ̃́)(hɔ̀.ɾɑ)(bɑ̀.lɑ). As stress clash is not allowed due to the presence of another constraint *CLASH that is ranked higher than IDENT-IO (stress), the penultimate foot gets deleted to avoid the clash and we get the surface form *pɔ̃́.hɔ.ɾɑ(bɑ̀.lɑ)*.

c. Derivation of the word pɔ̃́hɔɾɑbɑ̀lɑmɑ̀ne:

In the derivation of the word pɔ̃́hɔɾɑ+bɑlɑ+mɑne, first stress is assigned to the root word *pɔ̃hɔɾɑ* at the stem level, and then at the word level, both the suffixes bɑlɑ and mɑne are added simultaneously. As the word level suffixes are stress neutral, they do not bring about any change in the stress pattern and hence are added simultaneously thereby making the word level non-cyclic in nature. Hence, at the word level, the stress of the input is retained and a moraich trochee assigns eurhtmic stress from right to left. Stress clash is avoided. Therefore, our derivation will again have 2 recursions: one at the stem level and one at the word level.

Recursion 1:

| **Input:** pɔ̃hɔɾɑ | **GrWd= PrWd** | **FtBin** | **ɑ\|σ-EX(σσ)** | **NoHiatus** | ***Clash** | **Align (Hd-σ; Ft, L)** | **LeftMost** | **Align (Stem,R; PrWd, R)** | **Parse-σ** | **Ident-IO (stress)** | **Max-IO** | **Dep-IO** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. (pɔ̃.hɔ́)ɾɑ | | | | | | *! | | * | * | | | |
| ☞ b. (pɔ̃́.hɔ)ɾɑ | | | | | | | | * | * | | | |
| c. pɔ̃(hɔ́.ɾɑ) | | | *! | | | | | | * | | | |
| d. pɔ̃hɔɾɑ | *! | | | | | | | | *** | | | |
| e. (pɔ̃́.hɔ.ɾɑ) | | *! | * | | | | | | | | | |

Recursion 2:

| **WORD LEVEL** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** pɔ̃́hɔɾɑ+bɑlɑ+ mɑne | **GrWd= PrWd** | **FtBin** | **ɑ\|σ-EX(σσ)** | **NoHiatus** | ***Clash** | **Ident-IO (stress)** | **Align (Hd-σ; Ft, L)** | **LeftMost** | **Align (Stem,R; PrWd, R)** | **Parse-σ** | **Max-IO** | **Dep-IO** |
| a. pɔ̃(hɔ̀.ɾɑ)(bɑ̀.lɑ)(mɑ́ne) | | | | | | *! | | * | | * | | |
| ☞b. pɔ̃́.hɔ.ɾɑ(bɑ̀.lɑ)(mɑ̀.ne) | | | | | | | | | | *** | | |
| c. (pɔ̃́.hɔ.ɾɑ) bɑ.lɑ.mɑ.ne | | *! | | | | | | | * | **** | | |
| d. (pɔ̃́)(hɔ̀.ɾɑ)(bɑ̀.lɑ)(mɑ̀.ne) | | *! | | | * | | | | | | | |
| e. pɔ̃.hɔ.ɾɑ.bɑ.lɑ.mɑ.ne | *! | | | | | | | | | ******* | | |

In contrast to the classical OT model, we can see that the Stratal OT model successfully accounts for the stress preservation of Odia words and also captures the opaque phonological rules. Cyclicity is an important principle responsible for stress preservation as stress must be assigned first to the root word, to which the derivates are faithful to with respect to stress. Stratal OT model‘s mechanism of level segregation, level-specific constraint ranking and the cyclic application of rules make it capable of accounting for stress preservation. The words *pɔ̃́hɔɾabàla* and *pɔ̃́hɔɾabàlamàne* are faithful to the stem *pɔ̃́hɔɾa* by preserving its stress pattern.

This was considerably simple. But, let us consider another example:

ii. a. sɔ**má**dʒɔ → b. **sá**mɑ**dʒì**kɔ → c. **sá**mɑ**dʒì**kɔt̪ɑ → d. ɔ**sá**mɑ**dʒì**kɔt̪ɑ

In the above example, we can see that the words *sámadʒìkɔt̪a* and *ɔsámadʒìkɔt̪a* do not preserve the stress pattern of the root word *sɔmá:dʒɔ* but, they preserve the stress pattern of the stem *sámadʒìkɔ*. The stress in *sámadʒìkɔ* has shifted to the left after *+ìkɔ* suffixation. The suffix *+t̪a* and the prefix *ɔ+* do not bring about any change in the stress pattern brought about by *ìkɔ* suffixation. This implies that *+ìkɔ* being stress affecting is a stem level suffix whereas the affixes suffix *+t̪a* and *ɔ+* being stress neutral are word level affixes. One of the interesting points to note here is the vowel *ɔ* changing to *a* in the initial stressed syllable and is further retained in the words *sámadʒìkɔt̪a* and *ɔsámadʒìkɔt̪a*. This implies that all the phonological operations occur at the level of *+ìkɔ* suffixation which are further preserved in the other derived words. The *ɔ a* alternation is interesting to look at, hence, we shall discuss it in the next section.

### 5.5 Emergence of Morphology

Till now we discussed the morphology-phonology interactions of Odia complex words in the Stratal OT model where we saw that the morphology determines the phonology. The phonology does not have access to any of the morphological information except for the domain structure. But such an approach could face many obstacles. For example, in the above example of the stem level *ìkɔ* suffixation deriving *sámadʒìkɔ* from *sɔmádʒɔ*. Considering our stem level constraint ranking, after *ìkɔ* suffixation to the root word, we must get a surface form as *sɔmádʒìkɔ*. There is no constraint that will ensure to give us an output of the form *sámadʒìkɔ* and prevent the form *sɔmádʒìkɔ* from surfacing. We may posit a constraint that changes *ɔ* to *a* in the initial stressed position. But, such a phonological operation is not consistent in the grammar. We have pollysyllabic forms like *ɔ́pɔɾád̪ʰi , dʒɔ́guaɭɔ, kʰɔ́ɾaʈìa* etc which are derived in the stratum 1 and have the vowel *ɔ* in the initial stressed position. Therefore, we cannot posit any such constraint that changes *ɔ* to *a* in the initial stressed position which is not consistent in the grammar.

The interesting thing that we find is that the phonological process of changing of *ɔ* to *a* in the initial stressed position is just peculiar to *ìkɔ* suffixation. For further exemplification, consider these examples:

a. sɔmɑ́dʒɔ + ikɔ → sɑ́mɑdʒìkɔ
b. sɔmɔ́jɔ + ikɔ → sɑ́mɔjìkɔ
c. bɔ́ɾsɔ + ikɔ → bɑ́ɾsikɔ
d. sɔɾíɾɔ + ikɔ → sɑ́ɾiɾìkɔ
e. sɔmúd̪ɾɔ + ikɔ → sɑ́mud̪ɾìkɔ
f. mɑnɔ́bɔ + ikɔ → mɑ́nɔbìkɔ

We can observe from the above data that in *ìkɔ* suffixation, the vowel *ɔ* is not allowed in the initial stress position. In (a) (b) (c), (d) and (e) we can see changing of *ɔ* to *a* in the initial stressed position. In (f) there is no change, as the stem has no long vowels and already has the vowel *a* in the initial stressed syllable and therefore remains unchanged.

In order to account for such idiosyncratic behaviour of affixes, Bermudez-Otero & McMahon (2006) use the theory of Partially Ordered Grammar (Anttila, 2002) in the model of Stratal OT. They take the basic idea of cophonologies from Anttila‘s model and propose a sub-theory where they introduce stratum-internal cophonologies in stratum 1. They felt the need for such partial ordering as different morphological categories subscribed to different grammars within the stem level such as the adjectival suffixes of English showed variable behaviour to extrametricality. For example, in words such as *orígi<nal>*, *ómi<nous>* and *tóle<rant>*, syllable extrametricality operates whereas in words such as *intrépi<d>* and *atómi<c>*, consonant extrametricality operates. Inkelas et. al (2003) also proposed a similar stratal model of optimality theory in which every affix was specified for a co-phonology of its own. Although their model could correctly make generalisations of the grammar but it made the model too exhaustive. Bermudez-Otero & McMahon (2006), in their model employed Anttilla‘s ‘master hierarchy’ which is a set of partially ordered constraints. In their model the stem level phonology consists of this partially ordered constrains or the ‘master hierarchy’. The master hierarchy consists of the basic phonotactic constraints of the stem level and therefore restrict phonological non-uniformity. The constraints that are responsible for the difference in phonology of the affixes are left mutually unordered. Anttila proposed the concept of ‘emergence of morphology’, according to which "the stem level morphological constructions can exploit the areas of phonological indeterminancy allowed by the master hierarchy'' (Bermudez-Otero & McMahon, 2006).

Bermudez-Otero & McMahon (2006) capture this variable behaviour of affixes regarding extrametricality by stipulating a partially ordered grammar where the constraint NONFINAL that requires final syllables to be extrametrical is mutually unranked with another constraint PARSE-σ that ensures all syllables are parsed. When NONFINAL >> PARSE-σ, we get forms like *orígi<nal>*, *ómi<nous>* and *tóle<rant>*,but, when PARSE-σ >> NONFINAL, we get forms like *intrépi<d>* and *atómi<c>*.

*The emergence of morphology at the stem level (Bermudez-Otero & McMaho, 2006: 25)*

*a. The master hierarchy:*

*FTBIN >> NONFINAL* *(cíty), not *(cí)ty*

*{NONFINAL, PARSE-σ}*

*b. Cophonology A:*

*FTBIN >> NONFINAL>>PARSE-σ* *orígi<nal>*

*c. Cophonology B:*

*FTBIN >> NONFINAL* *atómi<c>*

*PARSE-σ >> NONFINAL*

In line with Bermudez-Otero and McMahon's cophonology model, I shall propose a similar model with two cophonologies that account for the peculiar behaviour of the affix *ìkɔ* as discussed earlier and the rest stratum 1 affixes. We have seen that when a word undergoes *ìkɔ* suffixation, the vowel *ɔ* in the initial stressed syllable changes to *a*. Therefore, I shall propose a new constraint that does not permit the vowel ɔ in the initial stressed position:

***V(back)**: No back vowel in the initial stress position.

The model for Odia with the revised ranking of constraints shall be:

**STEM LEVEL**

Master Hierarchy:

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> ALIGN(Hd-σ; Ft,L) >> LEFTMOST>>ALIGN (Stem,R; PrWd, R) >>IDENT-IO (stress) >>PARSE-σ

{ MAX-I, DEP-IO, *V(back)}

Cophonology A:

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> ALIGN(Hd-σ; Ft,L) >> LEFTMOST>>ALIGN (Stem,R; PrWd, R) >>IDENT-IO (stress) >>PARSE-σ >> MAX-IO >> DEP-IO >> *V(back)

Cophonology B:

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> ALIGN(Hd-σ; Ft,L) >> LEFTMOST>>ALIGN (Stem,R; PrWd, R) >>IDENT-IO (stress) >>PARSE-σ >> *V(back) >> MAX-IO >> DEP-IO

**WORD LEVEL**

GrWd= PrWd >> FTBIN >> ɑ]σ-EX(σσσ) >> NOHIATUS >> *CLASH >> IDENT-IO (stress) >> ALIGN(Hd-σ; Ft,L) >>LEFTMOST>>ALIGN (Stem,R; PrWd, R) >> PARSE-σ >> MAX-IO>> DEP-IO

As we can see the master hierarchy contains the phonotactic constraints of Odia and the constraints that bring about a difference in behaviour of the affixes are mutually unranked. In Cophonology A, the constraint *V(back) is ranked lowest and hence forms which have the vowel *ɔ* in the initial stress position such as *ɔ́pɔrá̪d̪ʰi , dʒɔ́guaɭɔ, kʰɔ́raʈìa* are allowed to surface. On the contrary, Cophonology B which has the constraint *V(back) ranked higher prevents forms with the back vowel *ɔ* in the initial stress position such as *sɔmádʒìkɔ* and thus changes it to *sámadʒìkɔ*. The word level constraint hierarchy remains intact.

Therefore, in the derivation of the words *sɔmádʒɔ* would be derived by Cophonology A in the stem level. The derived word sámɑdʒìkɔ on the other hand would be derived by the Cophonology B due to *+ìkɔ* suffixation in the stem level. The words *sámadʒìkɔt̪a* and ɔsámɑdʒìkɔt̪ɑ carrying word level affixes +t̪ɑ and ɔ+ would be derived in the word level. Let us look at the derivations of these words:

a. Derivation of the word sɔmɑ́dʒɔ

The word sɔmɑ́dʒɔ is derived in the stem level.

| STEM LEVEL: COPHONOLOGY A | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmɑdʒɔ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** | ***V(back)** |
| a. (sɔ́.mɑ)dʒɔ | | | | | | | | *! | | * | | | |
| ☞b.sɔ(mɑ́.dʒɔ) | | | | | | | | | | * | | | |
| c. (sɔ́mɑdʒɔ) | | *! | | | | | | | | | | | |
| d. sɔmɑdʒɔ | *! | | | | | | | | | *** | | | |
| e. (sɔ.mɑ́)dʒɔ | | | | | | *! | | * | | * | | | |

b. Derivation of the word sɑ́mɑdʒìkɔ

The word sɑ́mɑdʒìkɔ will be derived in two recursions. In the first recursion the stem sɔmɑ́dʒɔ will be derived by Cophonology A. In the second recursion, the output of the first recursion will undergo *+ìkɔ* suffixation and thus will be derived by the Cophonology B.

Recursion 1:

| **STEM LEVEL:** COPHONOLOGY A | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmɑdʒɔ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** | ***V(back)** |
| a. (sɔ́.mɑ)dʒɔ | | | | | | | | *! | | * | | | |
| ☞b.sɔ(mɑ́.dʒɔ) | | | | | | | | | | * | | | |
| c. (sɔ́mɑdʒɔ) | | *! | | | | | | | | | | | |
| d. sɔmɑdʒɔ | *! | | | | | | | | | *** | | | |
| e. (sɔ.mɑ́)dʒɔ | | | | | | *! | | * | | * | | | |

Recursion 2:

| **STEM LEVEL:** COPHONOLOGY B | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmɑ́dʒɔ + ìkɔ | **GrWd = PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ;Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | ***V(back)** | **MAX-IO** | **DEP-IO** |
| a.(sɑ.mɑ́)(dʒi.kɔ̀) | | | | | | *!* | | | | | | * | |
| ☞b. (sɑ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | | * | |
| c.(sɑ̀.mɑ̀)(dʒí.kɔ) | | | | | *! | | * | | | | | * | |
| d.(sɔ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | *! | * | |
| e. (sɑmɑ́dʒi)kɔ | | *! | | | | | | * | | * | | * | |

The two recursions occurring at the stem level hints towards a stratum internal cycle where the output of the first cycle serves as the input to the next cycle. From the above illustration, we saw how the Cophonology B prevents the form *sɔ́madʒìkɔ* from surfacing and renders us the optimal output *sámadʒìkɔ.*

c. Derivation of the word *sámadʒìkɔt̪a*

The word sɑ́mɑdʒìkɔt̪ɑ will be derived in three recursions. In the first recursion the stem sɔmɑ́dʒɔ will be derived by Cophonology A. In the second recursion the output of first recursion will undergo *+ìkɔ* suffixation and thus will be derived by the Cophonology B. The word level suffix +t̪ɑ will be added to the output of recursion 2 or the stem level phonology and the operation will occur in the word level with the respect to the word level phonology.

Recursion 1:

| **STEM LEVEL**: COPHONOLOGY A | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmɑdʒɔ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** | ***V(back)** |
| a. (sɔ́.mɑ)dʒɔ | | | | | | | | *! | | * | | | |
| ☞b.sɔ(mɑ́.dʒɔ) | | | | | | | | | | * | | | |
| c. (sɔ́mɑdʒɔ) | | *! | | | | | | | | | | | |
| d. sɔmɑdʒɔ | *! | | | | | | | | | *** | | | |
| e. (sɔ.mɑ́)dʒɔ | | | | | | *! | | * | | * | | | |

Recursion 2:

| **STEM LEVEL**: COPHONOLOGY B | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmɑ́dʒɔ + ìkɔ | **GrWd = PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ;Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | ***V(back)** | **MAX-IO** | **DEP-IO** |
| a.(sɑ.mɑ́)(dʒi.kɔ̀) | | | | | | *!* | | | | | | ** | * |
| ☞ b. (sɑ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | | ** | * |
| c.(sɑ̀.mɑ̀)(dʒí.kɔ) | | | | | *! | | * | | | | | ** | * |
| d. (sɔ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | *! | * | |
| e. (sɑmɑ́dʒi)kɔ | | *! | | | | | | * | | * | | ** | * |

Recursion 3:

| WORD LEVEL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɑ́mɑdʒìkɔ+t̪ɑ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **IDENT-IO (stress)** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** |
| a.(sɑ̀.mɑ)(dʒí.kɔ)t̪ɑ | | | | | | | | *! | * | * | | |
| ☞ b.(sɑ́.mɑ)(dʒì.kɔ) t̪ɑ | | | | | | | | | * | * | | |
| c.(sɑ.mɑ́)(dʒi.kɔ̀) t̪ɑ | | | | | | *!* | ** | | * | * | | |
| d.(sɑ́)(mɑ̀.dʒi)(kɔ̀.t̪ɑ) | | *! | | | | * | | | | | | |

d. Derivation of the word *ɔsɑ́mɑdʒìkɔt̪ɑ:*

The word *ɔsɑ́mɑdʒìkɔt̪ɑ* will be derived in three recursions. In the first recursion the stem sɔmɑ́dʒɔ will be derived by Cophonology A. In the second recursion the output of first recursion will undergo *+ìkɔ* suffixation and thus will be derived by the Cophonology B. In the third recursion, the word level affixes *+t̪ɑ* and *ɔ+* will be added simultaneously to the output of recursion 2 or the stem level phonology and the operation will occur in the word level with the respect to the word level phonology.

Recursion 1:

| **STEM LEVEL** : COPHONOLOGY A | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmɑdʒɔ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** | ***V(back)** |
| a. (sɔ́.mɑ)dʒɔ | | | | | | | | *! | | * | | | |
| ☞b.sɔ(mɑ́.dʒɔ) | | | | | | | | | | * | | | |
| c. (sɔ́mɑdʒɔ) | | *! | | | | | | | | | | | |
| d. sɔmɑdʒɔ | *! | | | | | | | | | *** | | | |
| e. (sɔ.mɑ́)dʒɔ | | | | | | *! | | * | | * | | | |

Recursion 2:

| **STEM LEVEL**: COPHONOLOGY B | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmádʒɔ + ìkɔ | **GrWd = PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ;Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | ***V(back)** | **MAX-IO** | **DEP-IO** |
| a.(sɑ.mɑ́)(dʒi.kɔ̀) | | | | | | *!* | | | | | | ** | * |
| ☞ b. (sɑ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | | ** | * |
| c.(sɑ̀.mɑ̀)(dʒí.kɔ) | | | | | *! | | * | | | | | ** | * |
| d.(sɔ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | *! | * | |
| e. (sɑmɑ́dʒi)kɔ | | *! | | | | | | * | | * | | ** | * |

Recursion 3:

| **WORD LEVEL** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** ɔ+sámadʒìkɔ + t̪ɑ | **GrWd= PrWd** | **FTBIN** | **ɑ\|σ-EX(σσσ)** | **NOHIATUS** | ***CLASH** | **IDENT-IO (stress)** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** |
| a.ɔ(sɑ́.mɑ)dʒì.kɔ. t̪ɑ | | | | | | | | | * | **! ** | | |
| ☞ b.ɔ(sɑ́.mɑ)(dʒì.kɔ)t̪ɑ | | | | | | | | | * | ** | | |
| c. ɔ(sɑ́.mɑ)dʒì(kɔ̀.t̪ɑ) | | | | | *! | | | | | ** | | |
| d.(ɔ.sɑ́)(mɑ.dʒì)(kɔ.t̪ɑ̀) | | | | | | | *! | | | | | |

This derivation was based on the version of Stratal OT in Kiparsky (2000). Kiparsky retained LPM's model stratum-internal cyclicity of the highest stratum in his model of Stratal OT. In the derivation of (c) and (d), we saw that there are two stem level recursions and one-word level recursion. The derivation of *(ɔ((sámadʒ)ìkɔ)t̪a)* was interesting. We find that there are two recursions for deriving the stem in the stem level. On the contrary, although there were two word level affixes ɔ+ and + t̪ɑ, we had just one recursion in the word level. This is because the word level is internally noncyclic. Therefore, both the affixes attach simultaneously to the stem without bringing about any change to the stress pattern of the embedded word or the stem.

The affixation of stress neutral suffixes in the word level in the above-mentioned words showcase strong stress preservation. The complex words mirror the stress patterns of the embedded words, the stem. One more important thing to note here was that the words sάmɑdʒìkɔt̪ɑ and ɔsάmɑdʒìkɔt̪ɑ mirror the stress pattern of their immediate subdomain sάmɑdʒìkɔ and not sɔmάdʒɔ. This indicates towards the cyclic nature of the application of the stress rules.

Stratal OT adopted the intra stratum cyclicity of the highest stratum from the LPM model which was quite controversial and received much debate until 2007 when it was formally rejected. Bermudez Otero and McMahon (2007) proposed the fake-cyclicity condition that discarded the inter-stratum cyclicity in the model of Stratal OT. Stratal OT maintained that the stem level is non-cyclic in nature. We shall discuss the fake cyclicity condition in detail in the next section of this chapter.

### 5.6 Fake Cyclicity

Bermudez Otero and McMahon (2006) made a radical departure from the Stratal OT model proposed by Kiparsky (2003) that adopted LPM's principle of intra-stratum cyclicity which suggests that the highest stratum is cyclic in nature. In their model of Stratal OT, the highest stratum-the stem level is internally noncyclic. In their model, each stratum consists of just one phonological cycle. They propose the "fake-cyclic" condition that suggests the "epiphenomenon of sensitivity to input structure coupled with the storage of stem level outputs in the permanent lexicon" (Collie, 2007). Fake cyclicity proposes that redundant morpho-phonological relationship between complex words and their bases does exist but as the stress patterns of these words are already stored in the mental lexicon, cyclicity is not the best way to account for these redundant relationships.

The fake cyclicity condition arose in line with Selkirk's (1980) proposal, which suggested that the morphologically complex words were stored in the speaker's memory along with their metrical stress pattern. As the complex words' stress patterns are already stored in the speaker's mental lexicon, the cycle that generated the metrical structure of these words is formally redundant and should be avoided. Selkirk rejected the cycle under the principle of Occam's Razor. It wasn't the case that Selkirk rejected the phenomena of stress preservation but rather rejected the proclaimed mechanism of stress preservation which was the cycle as she believed that the mechanism behind stress preservation was historical.

Otero and McMahon suggested that all the outputs of stratum 1 are stored in the permanent lexicon and are referred to as ‘lexical entries’. As these lexical entries are the outputs of stratum 1, they are stored along with all the phonology that is associated with them in stratum 1 which includes stress as well. When a complex word has to be derived in the same stratum, this stem which is the lexical entry is called upon and it serves as the input. Therefore, the previous cycle for the derivation of the stem from an unmetrified input is not required and is considered redundant. For example in intra-stratum cyclicity a word such as *phenomenology* would be derived as follows: in the first cycle /*phenomenon*/ would be assigned stress and [*phenómenon*] would be derived and in the second cycle *phenómenon* would further undergo suffixation and the stress rules shall apply and [*phenòmenólogy*] would be derived. In Otero & McMahon’s Stratal model [*phenòmenólogy*] would be derived in just one cycle as such:

| Input: /phe(nóme)non-ology/ | MAX-FOOTHead | ALIGN (ω, L; Σ, L) |
|---|---|---|
| a. (phè.no)me(nó.lo)gy | *! | |
| ☞b. phe(nò.me)(nó.lo)gy | | * |

The ‘fake cyclicity’ condition allows us to account for stress preservation in just one cycle. The input *phenómenon* is stored as a lexical entry in the lexicon. Whenever the speaker has to produce phenomenology, the lexical entry *phenómenon* is called upon and suffixation applies. Hence, the cycle giving us *phenómenon* is rendered redundant and is therefore avoided.

According to the fake cyclicity condition, the Stratal OT model of the above words *sɔmádʒɔ, sámadʒìkɔ, sámadʒìkɔt̪a, ɔsámadʒìkɔt̪a* would be as follows:

i. sɔmádʒɔ:

| **STEM LEVEL**: COPHONOLOGY A | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmadʒɔ | **GrWd=PrWd** | **FTBIN** | **α\|σ-EX(σσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** | ***V (back)** |
| a. (sɔ́.mɑ)dʒɔ | | | | | | | | *! | | * | | | |
| ☞b.sɔ(mɑ́.dʒɔ) | | | | | | | | | | * | | | |
| c. (sɔ́mɑdʒɔ) | | *! | | | | | | | | | | | |
| d. sɔmɑdʒɔ | *! | | | | | | | | | *** | | | |
| e. (sɔ.mɑ́)dʒɔ | | | | | | *! | | * | | * | | | |

ii. sámadʒìkɔ:

| **STEM LEVEL**: COPHONOLOGY B | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɔmádʒɔ + ìkɔ | **GrWd=PrWd** | **FTBIN** | **α\|σ-EX(σσ)** | **NOHIATUS** | ***CLASH** | **ALIGN (Hd-σ;Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **IDENT-IO (stress)** | **PARSE-σ** | ***V (back)** | **MAX-IO** | **DEP-IO** |
| a.(sɑ.mɑ́)(dʒi.kɔ̀) | | | | | | *!* | | | | | | ** | * |
| ☞ b. (sɑ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | | ** | * |
| c.(sɑ̀.mɑ̀)(dʒí.kɔ) | | | | | *! | | * | | | | | ** | * |
| d.(sɔ́.mɑ)(dʒì.kɔ) | | | | | | | | | * | | *! | * | |
| e. (sɑmɑ́dʒi)kɔ | | *! | | | | | | * | | * | | ** | * |

The noun stem sɔmádʒɔ which we derived earlier, being a stratum 1 output, is thus stored in the speaker‘s permanent lexicon as a lexical entry. When the speaker has to produce sámadʒìkɔ for the first time, he shall call upon the lexical entry sɔmádʒɔ and suffixation takes place on that. The cycle deriving sɔmádʒɔ from an unmetrified input doesn‘t occur as part of our derivation as we already know the stress pattern of the word. Therefore, there is just one cycle in contrast to our earlier discussion of derivation of the word sɑ́mɑdʒìkɔ where there were 2 cycles.

iii. sɑ́mɑdʒìkɔt̪ɑ:

| WORD LEVEL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** sɑ́mɑdʒìkɔ+t̪ɑ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσ)** | **NOHIATUS** | ***CLASH** | **IDENT-IO (stress)** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem, R; PrWd, R)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** |
| a.(sɑ̀.mɑ)(dʒí.kɔ)t̪ɑ | | | | | | | | *! | * | * | | |
| ☞ b. (sɑ́.mɑ)(dʒì.kɔ) t̪ɑ | | | | | | | | | * | * | | |
| c.(sɑ.mɑ́)(dʒi.kɔ̀) t̪ɑ | | | | | | *!* | ** | | * | * | | |
| d.(sɑ́)(mɑ̀.dʒi)(kɔ̀.t̪ɑ) | | *! | | | | * | | | | | | |

iv. ɔsɑ́mɑdʒìkɔt̪ɑ:

| WORD LEVEL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input:** ɔ + sɑ́mɑdʒìkɔ + t̪ɑ | **GrWd=PrWd** | **FTBIN** | **ɑ\|σ-EX(σσ)** | **NOHIATUS** | ***CLASH** | **IDENT-IO (stress)** | **ALIGN (Hd-σ; Ft, L)** | **LEFTMOST** | **ALIGN (Stem,R; PrWd, R)** | **PARSE-σ** | **MAX-IO** | **DEP-IO** |
| a.ɔ(sɑ́.mɑ)dʒì.kɔ.t̪ɑ | | | | | | | | | * | **! ** | | |
| ☞b. ɔ(sɑ́.mɑ)(dʒì.kɔ)t̪ɑ | | | | | | | | | * | ** | | |
| c. ɔ(sɑ́.mɑ)dʒì(kɔ̀.t̪ɑ) | | | | | *! | | | | | ** | | |
| d.(ɔ.sɑ́)(mɑ.dʒì)(kɔ.t̪ɑ̀) | | | | | | | *! | | | | | |

In contrast to the previous derivations which required more than one cycle to derive a complex word, under the fake cyclicity condition, we can derive these words in just a single cycle. In (iii) and (iv) we can see that the derived word sɑ́mɑdʒìkɔ which serves as the input, is the output of a stratum 1 cycle and gets stored in the speaker‘s permanent lexicon as a lexical entry with its complete phonological structure. When the speaker has to produce the words sɑ́mɑdʒìkɔt̪ɑ and ɔsɑ́mɑdʒìkɔt̪ɑ, the stem sɑ́mɑdʒikɔ is directly called and serves as the input for the derivation process. The redundant cycles for the derivation of the embedded words sɔmɑ́dʒɔ and sɑ́mɑdʒìkɔ are avoided as these words are already present in the speakers permanent lexicon in their full phonological forms. Therefore, the words sɑ́mɑdʒìkɔt̪ɑ and ɔsɑ́mɑdʒìkɔt̪ɑ are just derived in a single phonological cycle at the word level.

The fake cyclicity condition suggests that whenever a speaker has to use a stem level output, he doesn't necessarily have to perform every time all the phonological computations from the underlying representation, but extract it from his mental lexicon due to the listing of these stem level outputs. The knowledge of stress preservation is very crucial as it is a part of the speaker‘s linguistic competence. Any model that does not consider stress preservation as a part of the linguistic competence of a speaker would be incorrect and incomplete. Otero & McMahon( 2006) incorporate this idea into their version of Stratal OT.

## 5.7 Conclusion

In this chapter, we discussed the Stratal OT models presented by Kipasky(2000), Bermudez Otero (2003) and Bermudez Otero and McMahon(2006). We looked at the phenomenon of stress preservation leading to opacity in Odia complex words and how Stratal OT with its intrinsic serialism and parallel evaluation at each level can successfully account for such opaque phonological rules. In this chapter, the notion of fake cyclicity (Bermudez-Otero & McMahon, 2006) was introduced. It has been shown that the notion of fake cyclicity in Stratal OT provides a more restrictive model for the analysis of stress preservation, unlike the cycle. The fact that stress preservation is a result of redundant lexical storage, redundancy rules and blocking and not the result of cyclicity has been highlighted in this chapter.

# *Chapter 6*

## CONCLUSION

In this thesis, I have presented the discussion and analysis of the morphology-phonology interactions in Standard Odia. I have majorly focussed on the morphosyntactic conditioning of phonological rules with respect to stress preservation in Odia complex words. While many issues are still unresolved, I have tried to identify the prime characteristics of the system and sought to resolve the complexities of this language and its interactions through the lens of a developing model of the morphology-phonology interface: Stratal Optimality Theory.

In Chapter 1, a brief introduction to the thesis is provided.

In Chapter 2, I discuss the theoretical context of the thesis and review the literature on the model of Stratal OT.

In Chapter 3, I have accounted for the metrical stress pattern of Odia words. The rules for this are stated as follows:

- Extrametricality of syllable containing [ɑ] word finally only in trisyllables.
- Construction of a moraic trochee from right to left.
- In case of more than one foot, End Rule assigns prominence to the head of the leftmost foot.
- Stress clash is avoided: adjacent syllables are not stressed.
- Hiatus is not allowed.

These rules could account for the stress pattern of all the simple words of Odia. But, the problem arises in case of complex words such as *pɔ̃́hɔrabàla, sámadʒìkɔʈ̪a, súnd̪ɔrɔpɔ̀ɳia etc* where the above mentioned stress rules are blocked else we might have got incorrect surface forms as **pɔ̃(hɔ́.ɾa)(bà.la), *sa(má.dʒi)(kɔ̀.ʈ̪a) and *(sún)d̪ɔ(ɾɔ̀.pɔ)(ɳì.a).* These opaque stress rules arise due to the phenomenon of stress preservation where the embedding word preserves the stress pattern of its embedded word such as *pɔ̃́hɔrabàla (pɔ̃́hɔra), sámadʒìkɔʈ̪a (sámadʒìkɔ)* and *súnd̪ɔrɔpɔ̀ɳia (súnd̪ɔrɔpɔ̀ɳɔ).* The complex words miror the stress pattern of the embedded words. Clearly, stress preservation is a cyclic phenomenon where stress must be first assigned to the embedded word which is further retained in the embedding word. Therefore, the phenomenon of stress preservation renders certain stress rules opaque in Odia.

In Chapter 4, we discussed how such kind opacity that arises due to the interactions of morphology and phonology is accounted for in different generative theories. Rule-based phonology accounts for opacity through extrinsic rule ordering or by level segregation that is by dividing the grammar into different morpho-syntactic strata where each stratum served as a domain for the stratum-specific phonology to apply. The latter theory was popularly known as the Lexical Phonology and Morphology model. In this chapter, the failure of classical OT model to account for opacity in ancient Greek was also discussed. We saw that the classical OT for its strict surface orientation and strongly parallel model is incapable of accounting for the phenomenon of opacity that arises due to the serial nature of the application of phonological rules.

In Chapter 5, I demonstrated the failure of classical OT to account for the phenomenon of stress preservation in Odia. In Odia, the primary stress is assigned at the stem level whereas at the word level, the stress of the embedded word is retained and only an eurhythmic stress is assigned to maintain the rhythmic pattern of words. If there is a stress clash, the leftmost foot is retained and the right foot undergoes defooting thereby avoiding stress clash. As classical OT requires the evaluations to occur in a single pass, it is impossible to account for stress preservation in the strictly parallel model of classical OT as the phenomenon of stress preservation is inherently cyclic in nature and is determined by the morphosyntactic domains. To resolve this issue of the classical OT model, we employed the Stratal OT model which has scope for both level segregation and cyclicity within the framework of OT. It was evident from the analysis of Odia stress preservation that Stratal OT could successfully and efficiently account for the phenomenon of opacity and the morphology-phonology interactions in Standard Odia. I also tried to extend the model to capture all the phonological variations with respect to the nature of affixes. In Odia, the suffix *ikɔ* behaves differently from other affixes as it does not allow a back vowel in the initial stress position. In line with Bermudez-Otero and McMahon (2006) "emergence of morphology", I employed the Co-phonology theory into the model of Stratal OT where there were two co-phonologies present: one is the default and the other being for *ikɔ* suffixation. Finally, I support the version of Stratal OT (Bermudez-Otero & McMahon, 2006) for my analysis as it provides a more restrictive model for the analysis of stress preservation, unlike the cycle. Through the fake cyclicity condition, I proposed that stress preservation is a result of redundant lexical storage, redundancy rules and blocking and not the result of cyclicity.

This thesis constitutes a rigorous investigation of stress preservation in Odia till date and has shown to support the version of Stratal OT (Bermudez-Otero, 2003; Mermudez-Otero & McMahon, 2006).

### 6.1 Regarding Future Research

This thesis also brings up some theoretical issues that need future consideration. Firstly, further empirical investigations need to carried out to understand the fake cyclicity condition and its cognitive implications. Secondly, the most interesting future work would be related to stress preservation itself where we can characterize affixes based on strong and weak stress preservation and make generalisations based on that. In this thesis, I concentrated only on the strong stress preservation occurring at the word level. The weak stress preservation occurring at the stem level could also be taken into consideration and future work could be carried out. In line with this, I come with the third proposal where the fake cyclicity condition can be applied to the weak stress preservation in stratum 1. We already know that under the fake cyclicity condition every output of stratum 1 gets stored in the mental lexicon of a speaker, so weak stress preservation in Odia (if any) can be accounted for easily in stratum 1 as the immediate subdomain which is also a stratum 1 output is already present in the mental lexicon of the speaker and the faithfulness constraints at stratum 1 can yield us the correct surface form by retaining the stress pattern. Finally, since the thesis has proved the efficiency of the Stratal OT model, this model can be employed for a comparative analysis of the dialectal variations of Odia concerning the morphology-phonology interactions by showcasing the linguistic typology with dialect-specific constraint ranking.

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# ANNEXURE

**ANNEXURE 1:** Metrical Stress In Odia Words Showcasing Affixation

1. V + ɑ → N
   pɔ´ɖʱə + ɑ → pɔ´ɖʰɑ
   tʃʰɑ´ɳə + ɑ → tʃʰɔ´ɳɑ
   le´kʱ + ɑ → le´kʰkʰɑ
   bɑ´dʒ + ɑ → bɑ´dʒɑ

2. V + ɑ → Adj
   pɔ´ɖʱə + ɑ → pɔ´ɖʰɑ
   tʃʰɑ´ɳə + ɑ → tʃʰɔ´ɳɑ
   pʱɑ´ʈ + ɑ → pʰɔ´ʈɑ
   pʱu´ʈ + ɑ → pʰu´ʈɑ

3. N + ɑ → Adj
   d̪ɑ´ɖʰi + ɑ → d̪ɑ´ɖʰiɑ
   gɔn´ʈʰi + ɑ → gɔ´nʈʰiɑ
   mɑʈ´ʈi + ɑ → mɑ´ʈʈiɑ
   d̪ʰu´ɭi + ɑ → d̪ʰu´ɭiɑ
   pɑ´ɳi + ɑ → pɑ´ɳiɑ
   hɔ´ɭɔd̪ì + ɑ → hɔɭəd̪ìɑ

4. Adj + ɑ → N
   kɔʈ́ki + ɑ → kɔʈ́kiɑ
   sɔ́mbəlpùɾi + ɑ → sɔ́mbəlpùɾiɑ

5. N + uɑ → Adj
   pɑ´ʈʰɔ + uɑ → pɑʈ́ʰuɑ
   mi´tʃʰɔ + uɑ → mitʃ́ʰuɑ
   ɔnd̪ʰɑ́ɾɔ + uɑ → ɔnd̪ʰɑ́ɾuɑ
   hɔ´ɭɔ + uɑ → hɔɭ́uɑ
   bɔ´ɳɔ + uɑ → bɔ́ɳuɑ
   d̪ɑ´ɖʰɔ + uɑ → d̪ɑ́ɖʰuɑ
   sɑ´gɔ + uɑ → sɑ́guɑ
   kɑ´ʈʰɔ + uɑ → kɑʈ́ʰuɑ
   pe´ʈɔ + uɑ → peʈ́uɑ
   mɑɖɔ + uɑ → mɑ́ɖuɑ

6. N + i → N
   ɔ´pɔɾɑ´d̪ʰə + i → ɔ´pɔɾɑ´d̪ʰi
   d̪okɑ́nə + i → d̪okɑni
   bepɑ́ɾɔ + i → bepɑɾi

7. V + ɔɳɑ → Adj
   mɑ́ɾə + ɔɳɑ → mɑ´ɾɔɳɑ
   mɑ́dʒə + ɔɳɑ → mɑ´dʒɔɳɑ

8. V + ɔɳɑ → N
kʰe´ɭə + ɔɳɑ → kʰe´ɭɔnɑ
gʰɔ´ʈə + ɔɳɑ → gʰɔ´ʈɔɳɑ
be´lə + ɔɳɑ → be´lɔɳɑ

9. V + uɳi → N
nɑ´ʈʃə + uɳi → nɑʈʃuɳ́i
ɾɑ´nd̪ʰə+ uɳi → ɾɑ´nd̪ʰuɳi
ʈʃa´kʰə + uɳi → ʈʃakʰ uɳ́i

10. V + uɳija → N
ɾɑn´d̪ʰ + uɳija → ɾɑ́nd̪ʰuɳìɑ
nɑ´ʈʃ + uɳija → nɑ́ʈʃuɳìɑ
ʈʃa´kʰ + uɳija → ʈʃɑ́kʰuɳìɑ

11. V + ɔnt̪ɑ → Adj
dʒɔ´ɭə + ɔnt̪ɑ → dʒɔɭəńt̪ɑ
dʒiː´ + ɔnt̪ɑ → dʒiəńt̪ɑ
bɔ´hə + ɔnt̪ɑ → bɔhəńt̪ɑ
pʰɔ´ɭə + ɔnt̪ɑ → pʰɔɭəńt̪ɑ

12. V + uɑ → Adj
lɔ´ɖʰə + uɑ → lɔ́ɖʰuɑ
pɔ´ɖʰə + uɑ → pɔ́ɖʰuɑ
kʰɑ´ + uɑ → kʰɑ́uɑ

13. Adj + uɑ → Adj
ʈɑ´ɳɔ + uɑ → ʈɑ́ɳuɑ

14. V + ɔ → N
kʰe´ɭə + ɔ → kʰe´ɭɔ
hɔ´sə + ɔ → hɔ´sɔ

15. V + ɔɳɔ → N
mɔ´ɾə + ɔɳɔ → mɔ´ɾɔɳɔ
mɑ´gə + ɔɳɔ → mɑ´gɔɳɔ
bɑ´ʈə + ɔɳɔ → bɑ´ʈɔɳɔ

16. V + ɔɳi → N
ʈʃɑ̃´hə + ɔɳi → ʈʃɑ̃´hɑɳi
kɔ´ɾə + ɔɳi → kɔ´ɾɔɳi
kʰɔʈə + ɔɳi → kʰɔ´ʈɔɳi

17. V + eɳi → N
dʒɑ´ɭə + eɳi → dʒɑ´ɭeɳi
bʰɑ´sə + eɳi → bʰɑ´seɳi
bʰɑ´ɭ + eɳi → bʰɑ´ɭeɳi

18. V + ɑɳɔ → N
dɔ´ɾə + ɑɳɔ → dɔ´ɾɑɳɔ
u´ɖə + ɑɳɔ → u´ɖɑɳɔ
pʰe´ɖə + ɑɳɔ → pʰe´ɖɑɳɔ
bʰɑ´sə + ɑɳɔ → bʰɔ´sɑɳɔ

19. V + uɑɭɔ → N
dʒɔ´gə + uɑɭɔ → dʒɔ́guɑ̀ɭɔ
ɾɔ´kʰə + uɑɭɔ → ɾɔ́kʰuɑ̀ɭɔ

20. V + ɑɭi → N
kʰe´ɭə + ɑɭi → kʰeɭɑɭi
d̪e´kʰə + ɑɭi → d̪ekʰɑɭi
mɑ´ɖə + ɑɭi → mɔɖɑî
kɑ´ʈə + ɑɭi → kɔʈɑɭi

21. V + ɾɑ → N
bɑ´nʈə + ɾɑ → bɑ´nʈəɾɑ / bɔnʈəɾɑ

22. N + uɾɑ → Adj
d̪ɑ´nt̪ɔ + uɾɑ → d̪ɑ´nt̪uɾɑ
kɑnd̪ɔ + uɾɑ → kɑ´nd̪uɾɑ

23. N + ɑɭi → Adj
tʃɔi´t̪ɔ + ɑɭi → tʃɔi´t̪ɑɭi
bʰɑi´ + ɑɭi → bʰɑi´ɑɭi

24. N + ɑɭu → Adj
ni´d̪rɑ + ɑɭu → nid̪rɑɭu
d̪ɔ´jɑ + ɑɭu → d̪ɔjɑɭu

25. N + eli → Adj
ru´pɑ + eli → ru´peli
su´nɑ + eli → su´neli

26. N + ʈiɑ → Adj
t̪ɔm´bʰɑ + ʈiɑ → t̪ɔ́mbʰɑʈìɑ
lu´hɑ + ʈiɑ → luɦɑʈìɑ
kʰɔ´ɾɑ + ʈiɑ → kʰɔ́ɾɑʈìɑ

27. N + tʃiɑ → Adj
pɑɳ́i + tʃiɑ → pɑɳ́itʃìɑ
mɑî + tʃiɑ → mɑí:tʃìɑ
mɔɭ́i + tʃiɑ → mɔɭ́itʃìɑ

28. N + ɑɭɔ → N
gɑi:´ + ɑɭɔ → gɑí:ɑ̀ɭɔ
mɔ̃i´si + ɑɭɔ → mɔ̃íśiɑ̀ɭɔ

29. N + bala → N
ɖa´kə + bála → ɖa´kə ba´la
pɔ̃´hɔɾa+ bála → pɔ̃´hɔɾa ba´la

30. N + aɾi → N
sɔŋ´kʰɔ+ aɾi → sɔŋ´kʰaɾi
kɔ´nsa + aɾi → kɔ´nsaɾi
su´na + aɾi → su´naɾi

31. N + ɾa → N
pa´nɔ + ɾa → pa´nɔɾa
ɖa´kɔ + ɾa → ɖa´kɔɾa
ka´tʃɔ + ɾa → ka´tʃɔɾa

32. N + i → Adj
kɔʈɔ́k + i → kɔ́ʈki
sɔ́mbɔlpur + i → sɔ́mbəlpùri
ɖák̪t̪ɔɾə + i → ɖák̪t̪əɾi
máśʈɔɾə + i → máśʈəɾi
ɔhɔ́ŋkàɾ + i → ɔhɔ́ŋkaɾi
sahás + i → sahasi
d̪ʰɔ´nɔ + i → d̪ʰɔ́ni
gɔɾ´bɔ + i → gɔ́ɾbi
ɾo´gɔ + i → ɾógi

33. N + ikɔ → Adj
sɔmáďʒɔ + ikɔ → sa´madʒi´kɔ
sɔmɔ́ĵɔ + ikɔ → sa´mɔji´kɔ
bɔ́ɾsɔ + ikɔ → báɾsikɔ
sɔɾíɾɔ + ikɔ → sa´ɾiɾi´kɔ
sɔmúd̪ɾɔ + ikɔ → sa´m ud̪ɾìkɔ
mánɔbɔ + ikɔ → ma´nɔbi´kɔ
34. Adj + t̪a → N
ma´nɔbi´kɔ + t̪a → ma´nɔbi´kɔt̪a
sɔ´madʒi´kɔ + t̪a → sa´madʒi´kɔt̪a

35. Adj + ami → N
tʃɔ́gɔla + ami → tʃɔ´gɔlami
ʈʰɔ´kɔ + ami → ʈʰɔ́kami
mu´ɾkʰɔ + ami → múɾkʰami
d̪u´sʈɔ + ami → d̪úsʈami

36. Adj + pɔɳɔ → N
súnd̪ɔɾɔ + pɔɳɔ → súnd̪ɔɾɔpɔ̀ɳɔ
bɔ́ɖɔ + pɔɳɔ → bɔ́ɖɔpɔ̀ɳɔ
sɔ́t̪i + pɔɳɔ → sɔ́t̪ipɔ̀ɳɔ
ɔmíɾɔ + pɔɳɔ → ɔ́miɾəpɔ̀ɳɔ

| | | | | | |
|---|---|---|---|---|---|
| 37. Adj | | + | ia | → | Adj |
| su´nd̪ɔɾɔ | | + | ia | → | su´nd̪ɔɾia |
| bɑ´nd̪ɔɾɔ | | + | ia | → | bɑ´nd̪ɔɾia |
| 38. N | | + | ia | → | Adj |
| pɑũ´sɔ | | + | ia | → | pɑ̃ús̀ia |
| mulɔ | | + | ia | → | mulia |
| koɖ́ʰɔ | | + | ia | → | koɖ́ʰia |
| kiɾ´t̪ɔnɔ | | + | ia | → | kiɾ´t̪ɔnia |
| dʒogɑɖ́ə | | + | ia | → | dʒo´gɑɖia |
| 39. N | | + | ia | → | N |
| suńd̪ɔɾɔpɔ̀ɳɔ | | + | ia | → | suńd̪ɔɾɔpɔ̀ɳia |
| bɔɖ́ɔpɔ̀ɳɔ | | + | ia | → | bɔɖ́ɔpɔ̀ɳia |
| sɔt̪́ipɔ̀ɳɔ | | + | ia | → | sɔt̪́ipɔ̀ɳia |
| 40. N | + N | + | ia | → | Adj |
| bɑǵʰɔ | + peʈ́ɔ | + | ia | → | bɑǵʰɔpeʈ́ia |
| gʰusuɾ́i | + lɑŋ́guɖɔ | + | ia | → | gʰusuɾ́ilɑŋ́guɖia |
| pus̀pɔ | + mɑ́sɔ | + | ia | → | pus̀pɔmɑ̀sia |
| nɔî | + kuʈɔ | + | ia | → | nɔíkùʈia |
| 41. Adj | + N | + | ia | → | Adj |
| mɔʈi | + muńɖɔ | + | ia | → | mɔʈimùnɖia |
| d̪ɔ́sɔ | + kɑʈʰi | + | ia | → | d̪ɔ́səkɑ̀ʈʰia |
| bɑɾ́ɔ | + mɑ́sɔ | + | ia | → | bɑɾ́ɔmɑ̀sia |
| d̪ui | + ʈɔ́ŋkɑ | + | ia | → | d̪uíʈə̀ŋkia |
| kʰɔ́ɾɑ | + d̪ińɔ | + | ia | → | kʰɔ́ɾɑd̪ìnia |
| 42. Adj | + Adj | + | ia | → | Adj |
| d̪ʰo´bɔ | + d̪ʰɔu´ʈɔ | + | ia | → | d̪ʰobɔd̪ʰɔùʈia |
| d̪ɔ´sɔ | + hɔdʒɑɾ́ | + | ia | → | d̪ɔ́shɔdʒɑ̀ɾia |

**ANNEXURE 2:** Praat Images of Odia Words

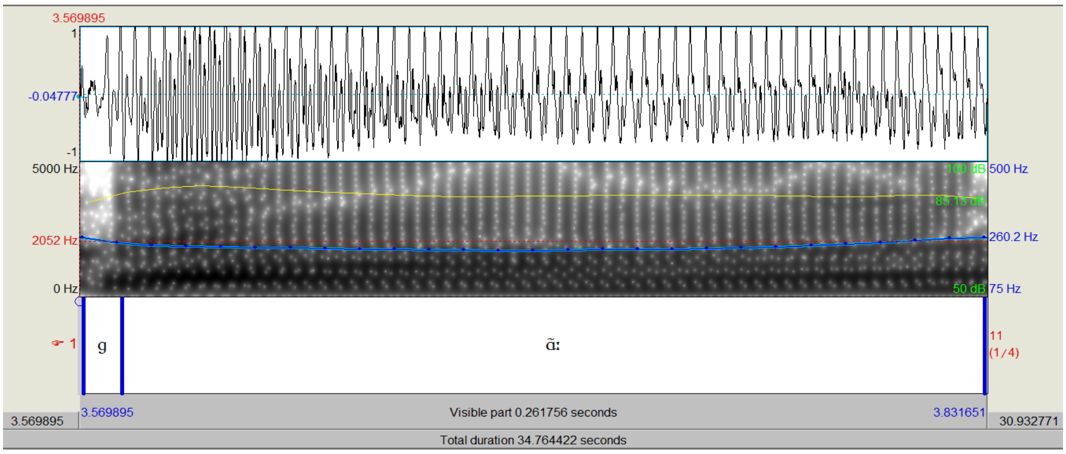


*Fig 1. Stress in word gã́ː*

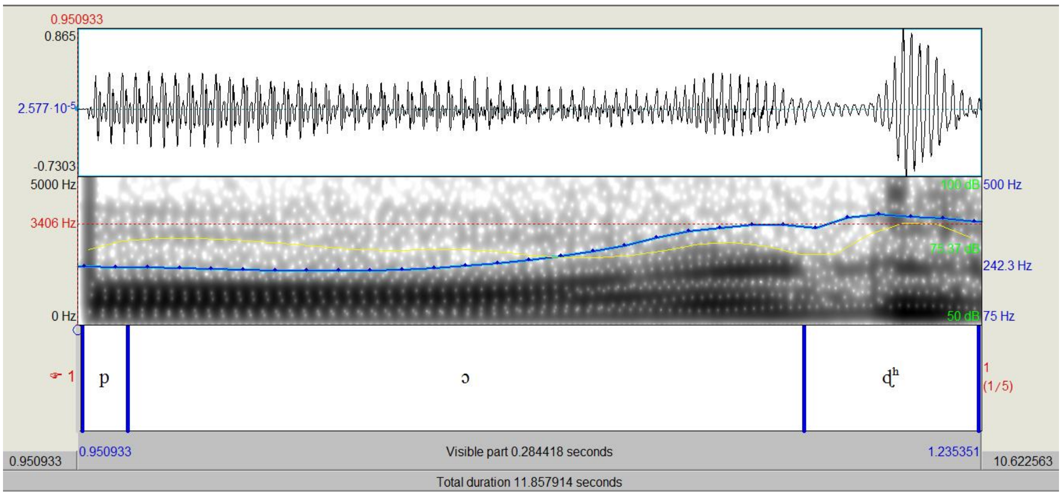


*Fig 2. Stress in word pɔɖʰ*

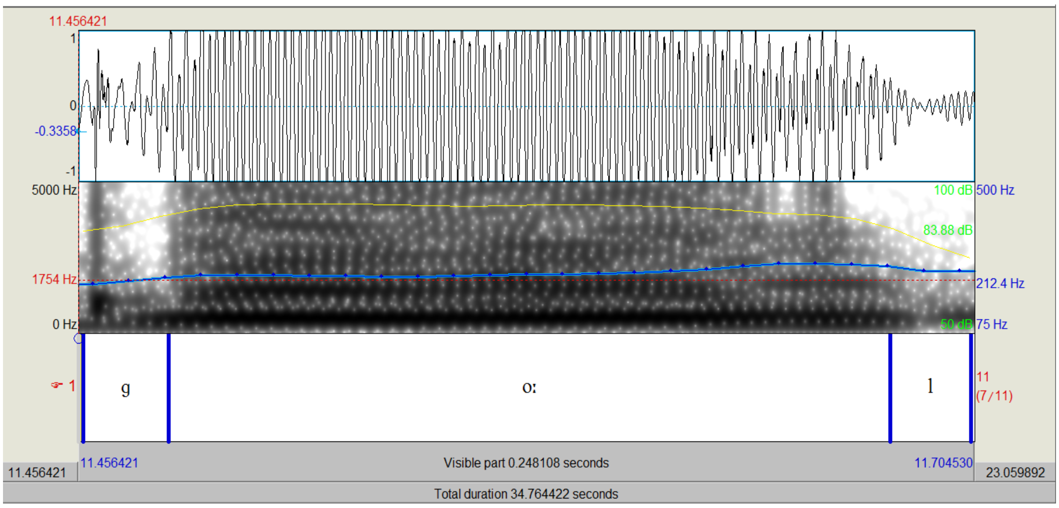


*Fig 3. Stress in word gól*

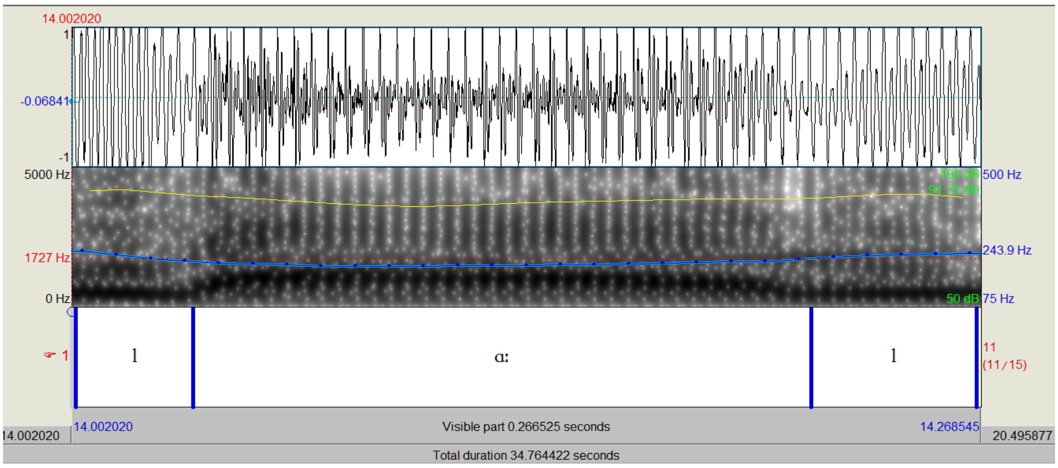


*Fig 4. Stress in word lál*

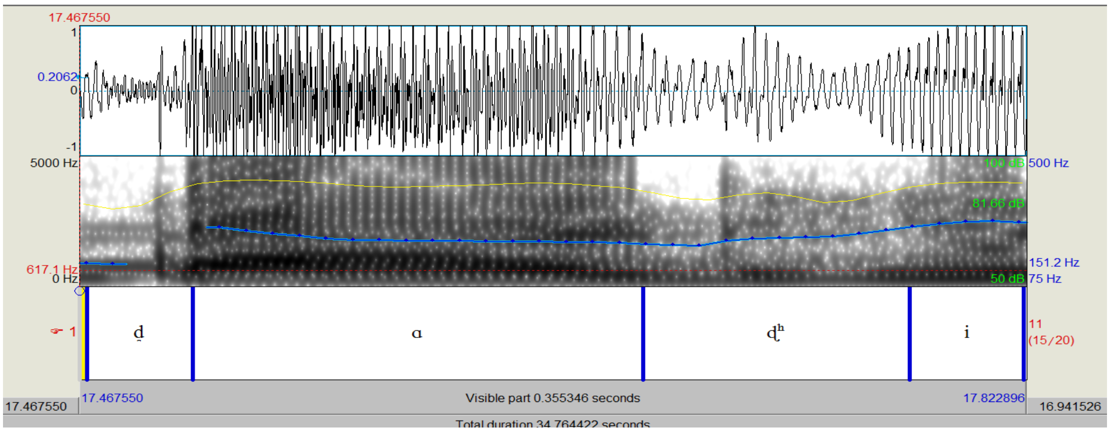


*Fig 5. Stress in word d̪ád̪ʰi*

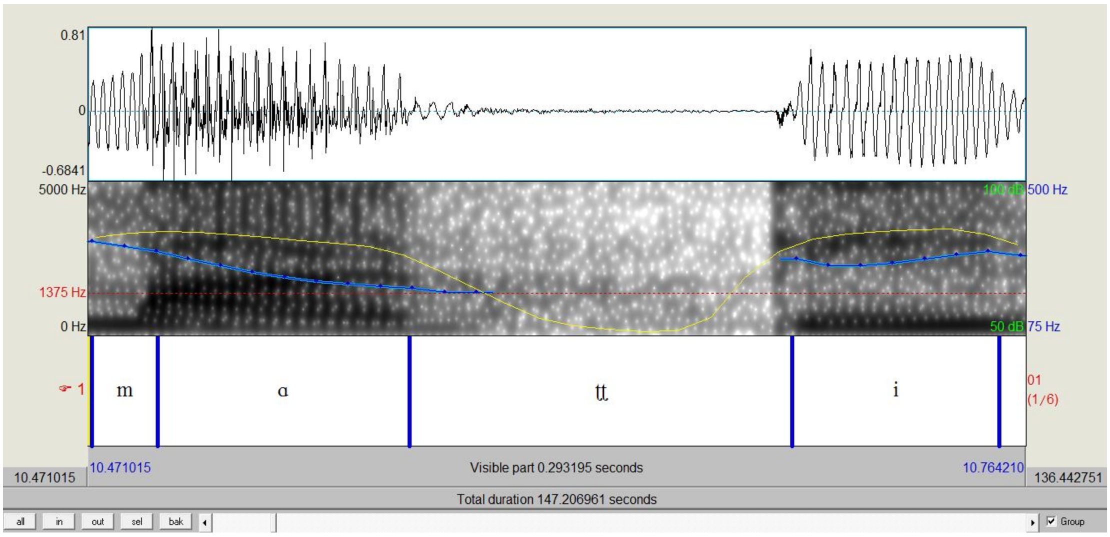


*Fig 6. Stress in word máʈʈi*

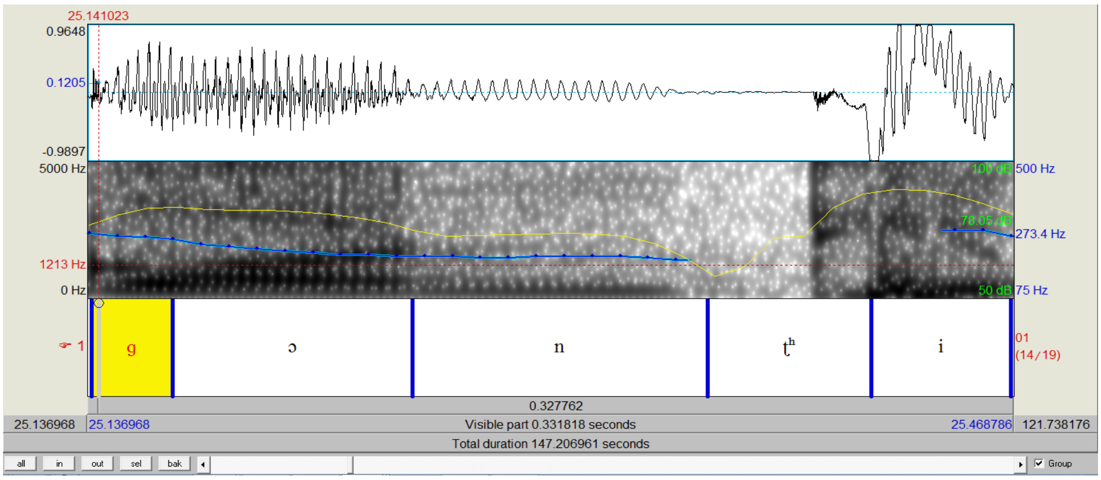


*Fig 7. Stress in word gɔ́nʈʰi*

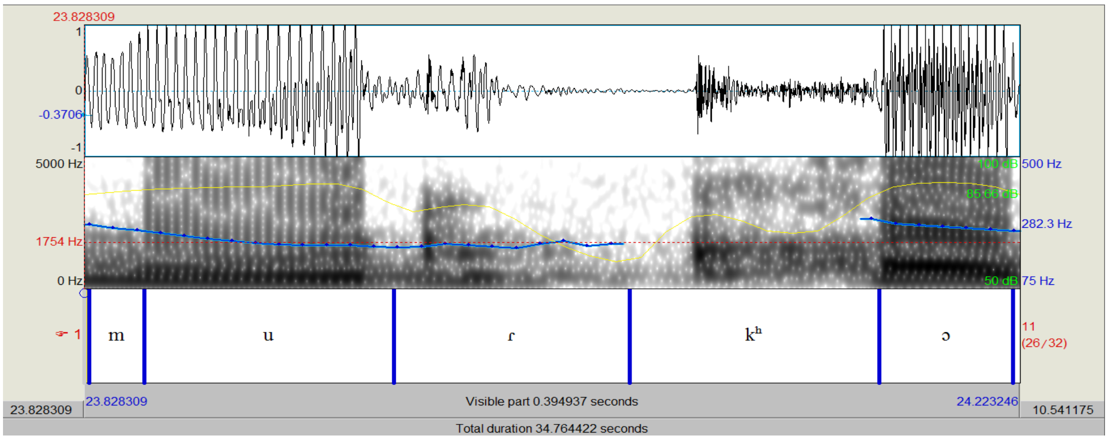


*Fig 8. Stress in word múɾkʰɔ*

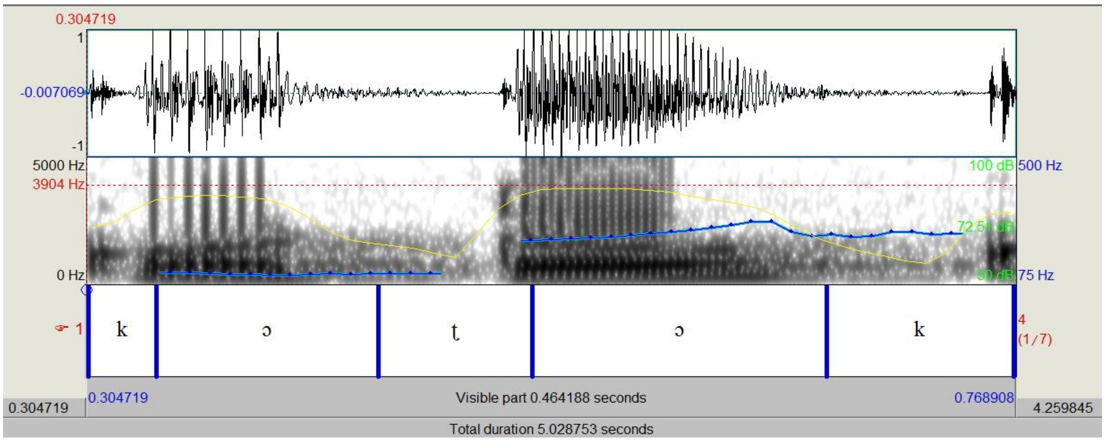


*Fig 9. Final Stress in word kɔʈɔk(ɔ)*

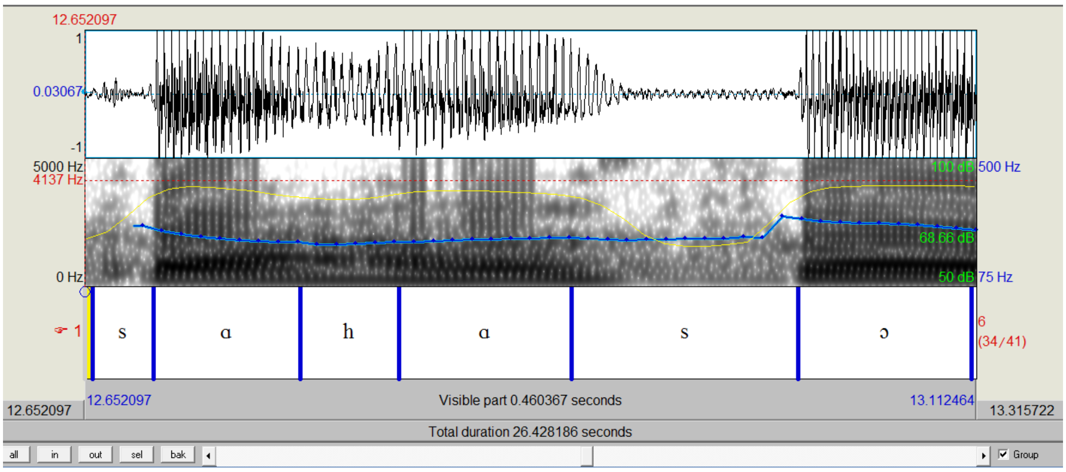


*Fig 10. Penultimate Stress in word sahásɔ*

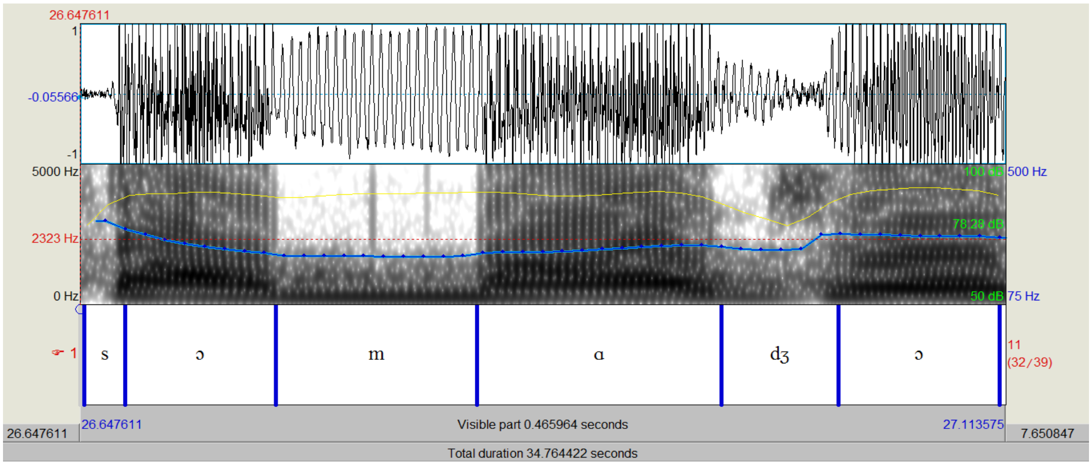


*Fig 11. Penultimate Stress in word sɔmádʒɔ*

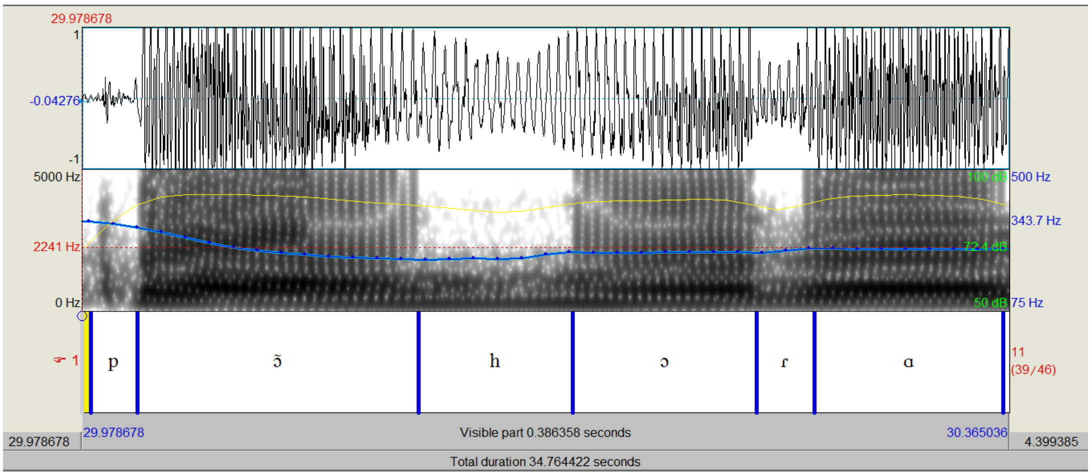


*Fig 12. Initial Stress in word pɔ̃́hɔra*

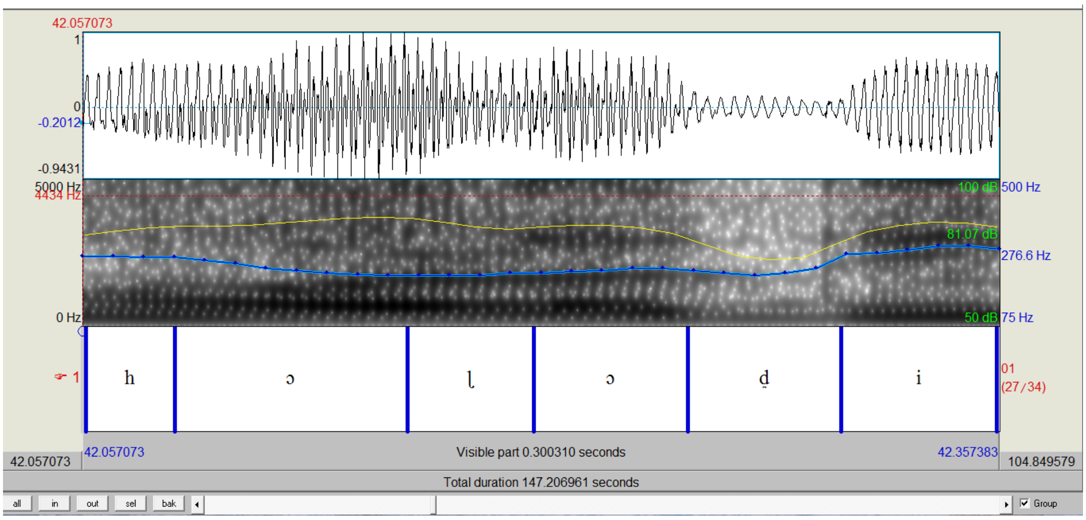


Fig 13.Initial Stress in word hɔ́ɭɔɖìː

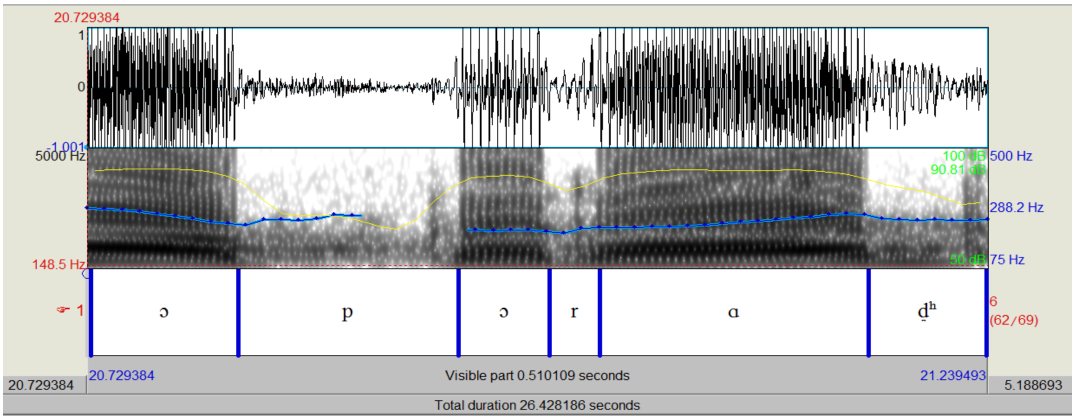


Fig 14. Final Stress in word ɔ́pɔràɖʰ

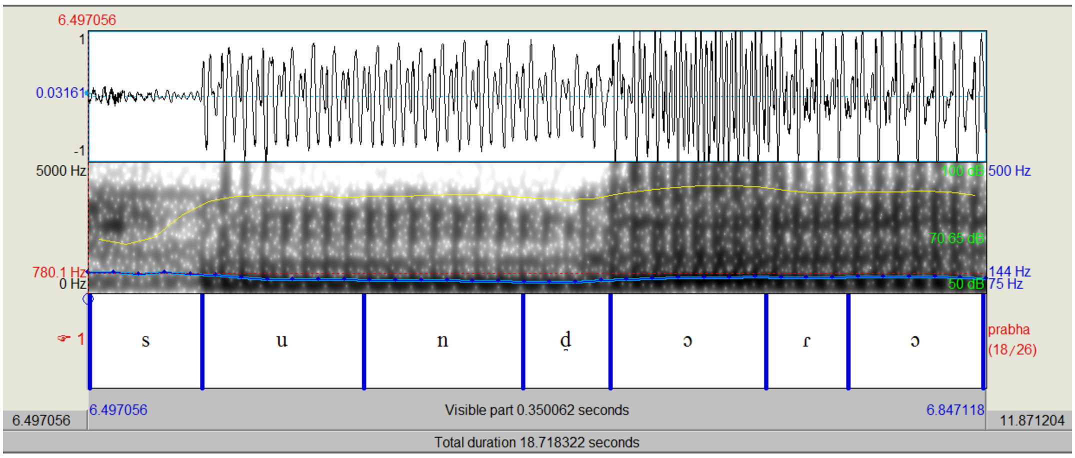


Fig 15. Final Stress in word súnɖɔ̀ɾɔ

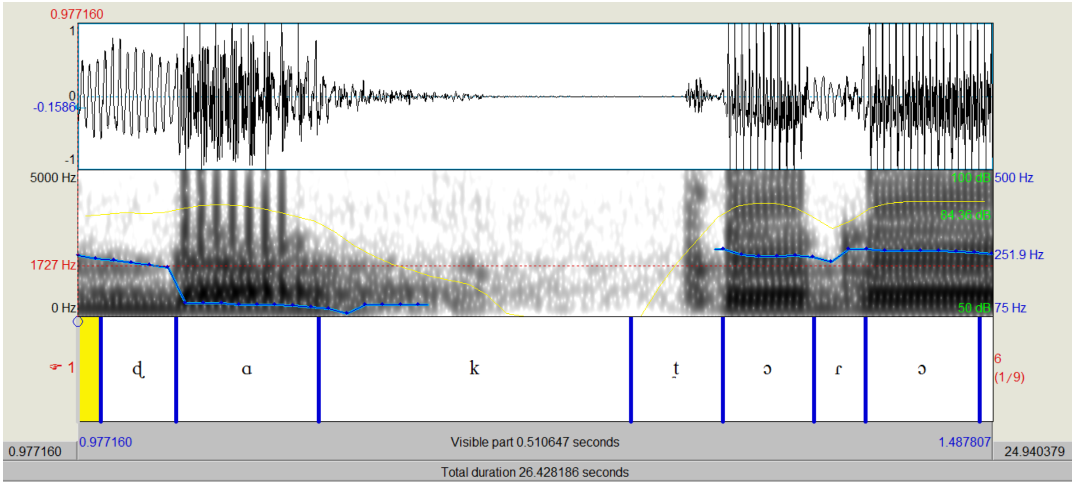


*Fig 16. Initial Stress in word ɖakt̪ɔɾɔ*

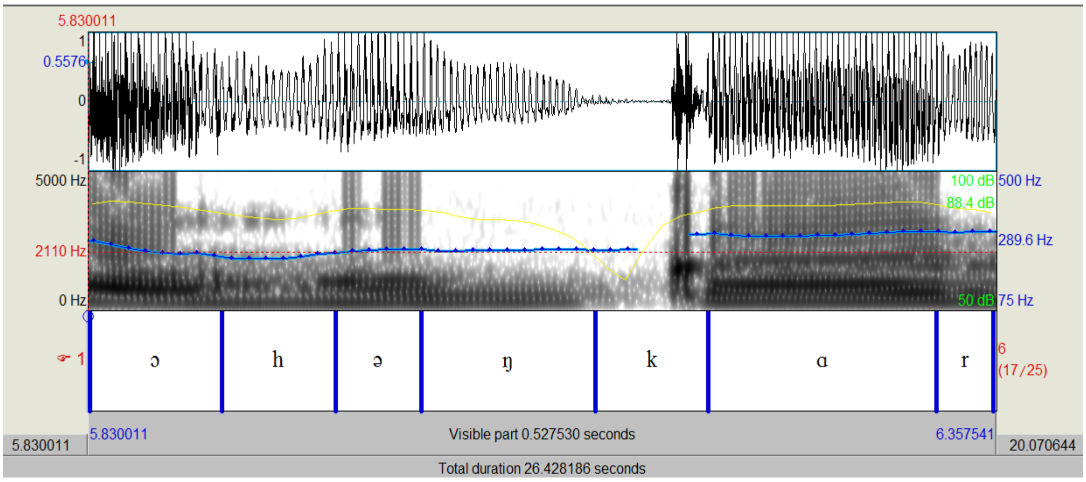


*Fig 17. Final Stress in word ɔhəŋkaɾ(ɔ)*

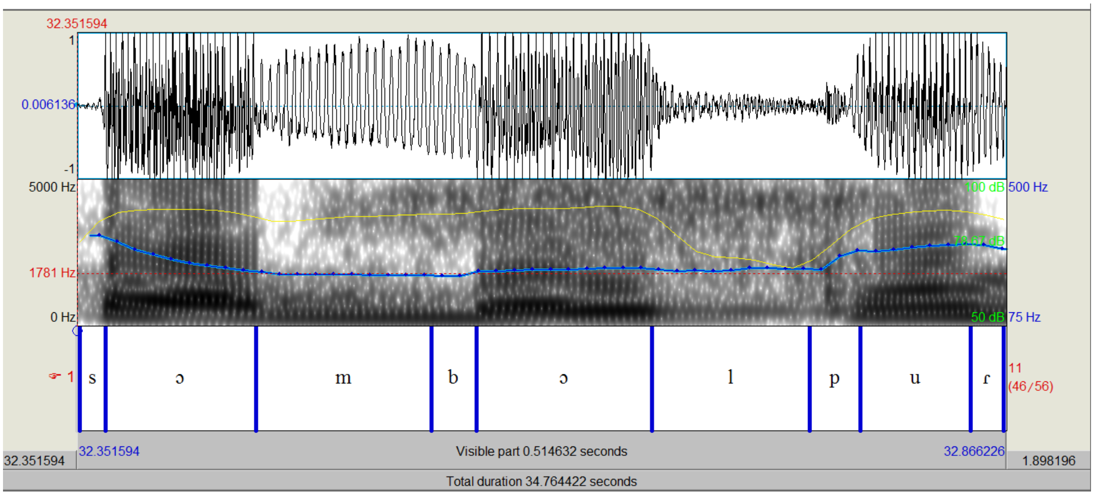


*Fig 18. Stress in word sɔ́mbɔlpuɾ̀*

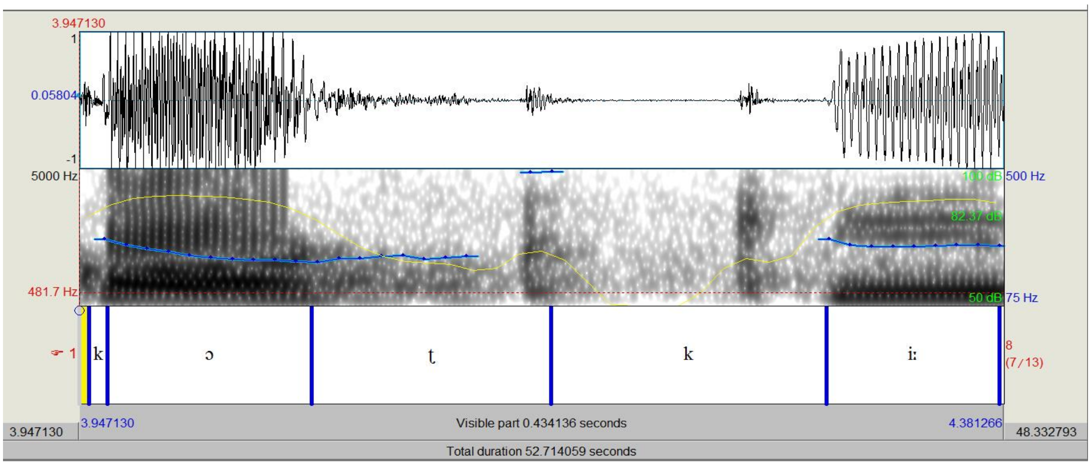


*Fig 19. Stress in word kɔ́ʈki*

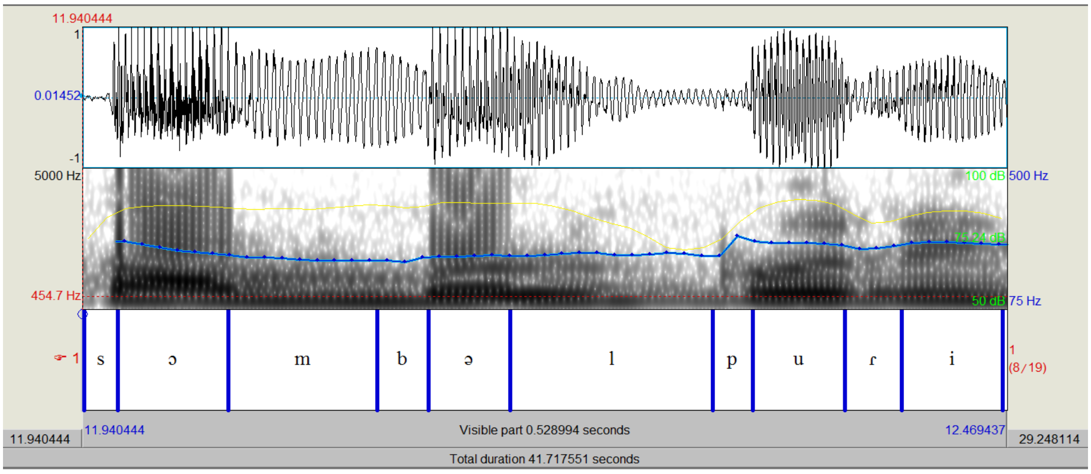


*Fig 20. Stress in word sɔ́mbəlpùri*

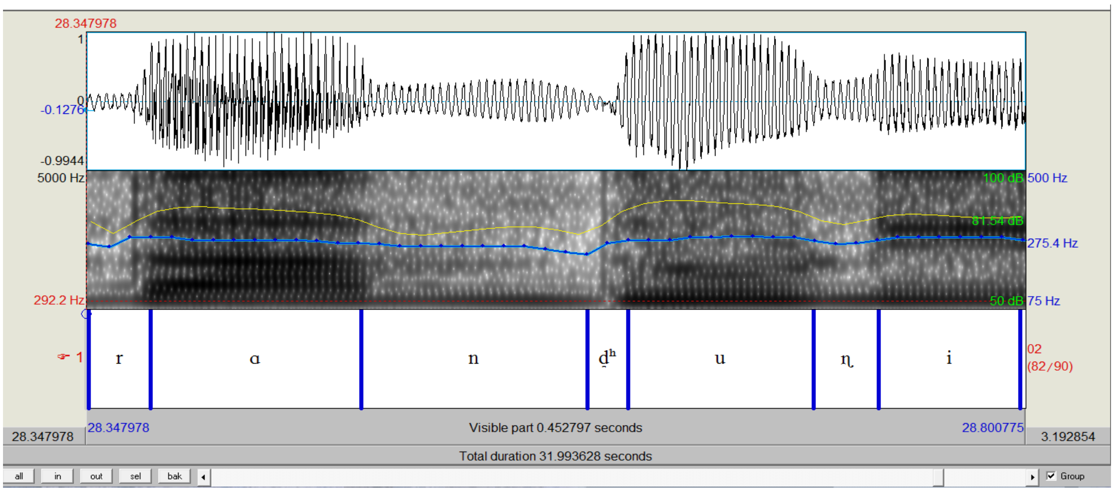


*Fig 21 . Stress in word ɾánɖʰuɳi*

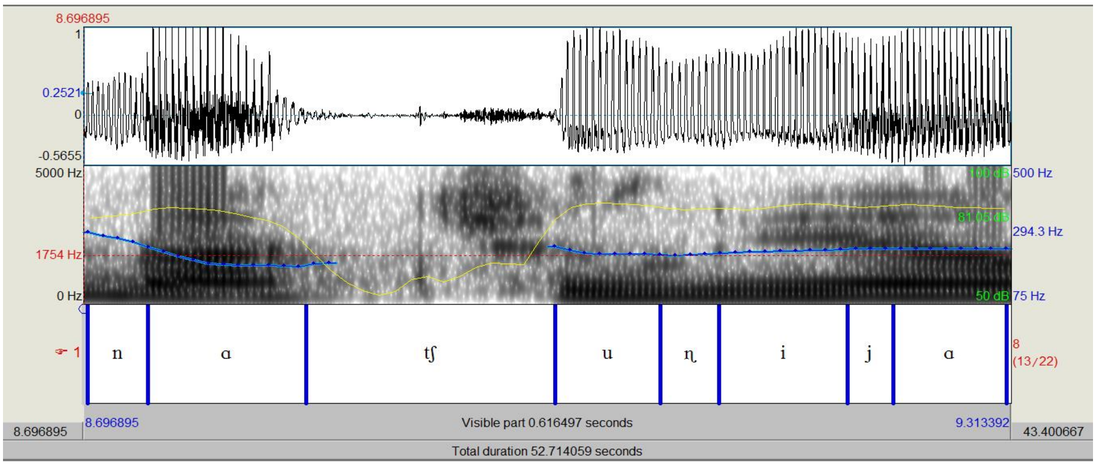


*Fig 22. Stress in word naˊtʃuɳiǰa*

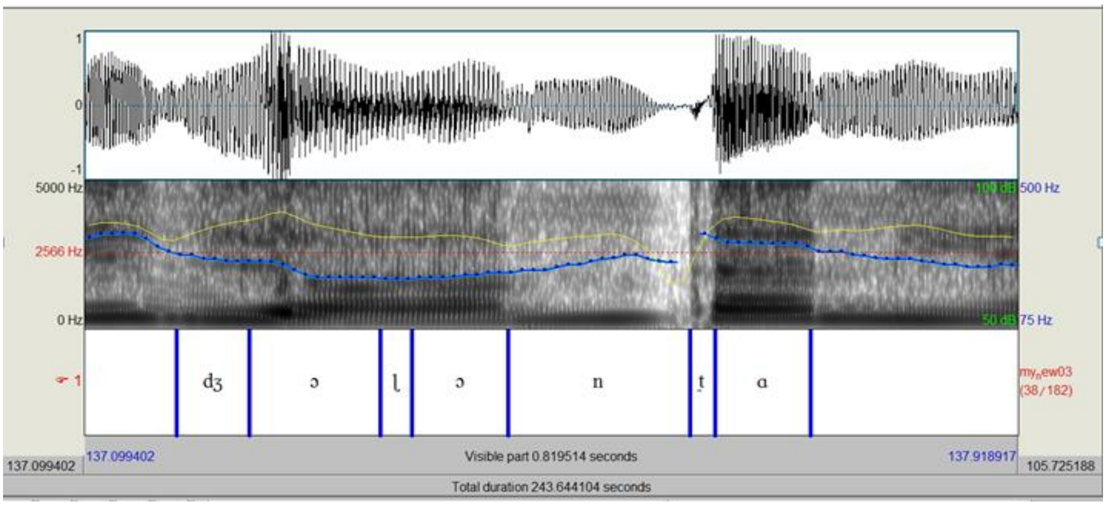


*Fig 23 . Stress in word dʒɔɭəˊn̪t̪a*

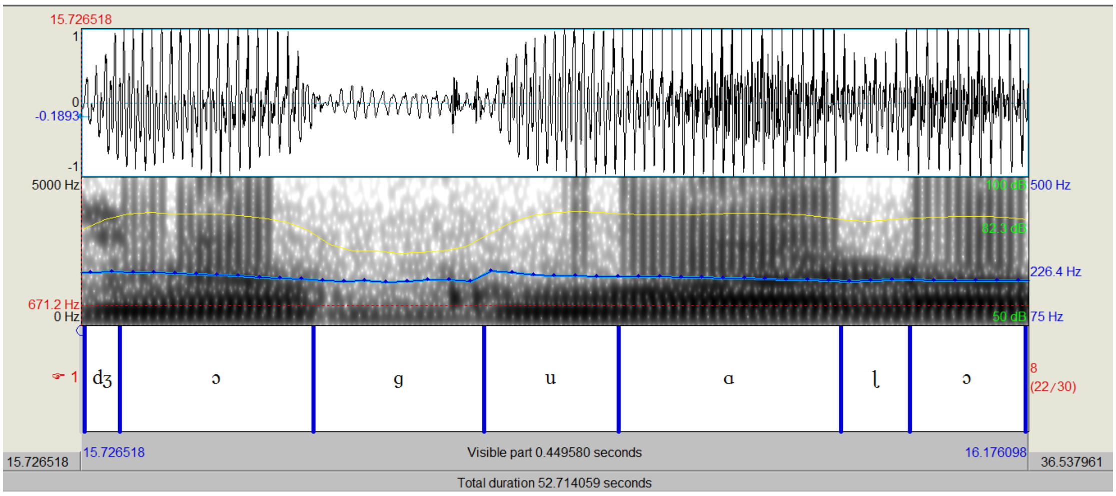


*Fig 24. Stress in word dʒɔˊguaɭɔ*

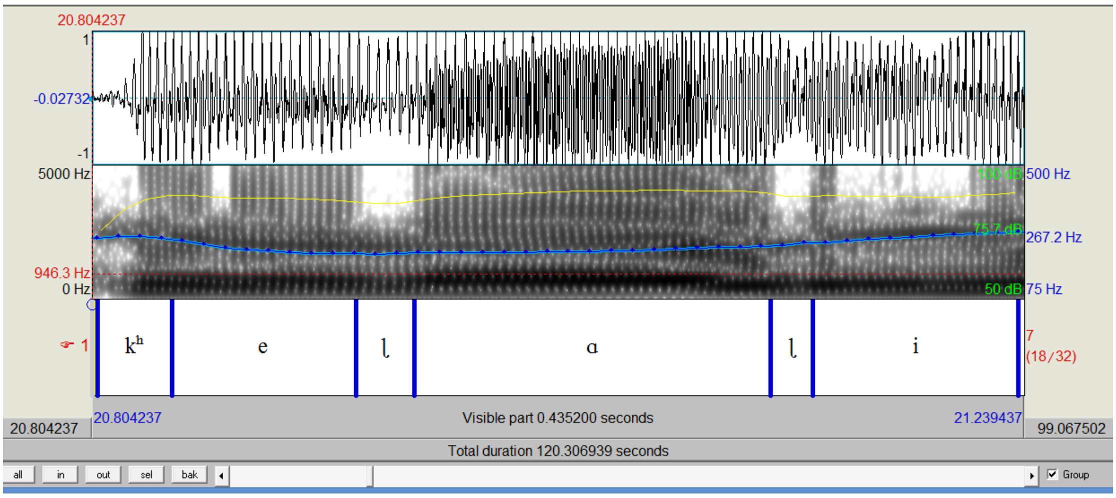


*Fig 25 . Stress in word kʰeɭaɭi*

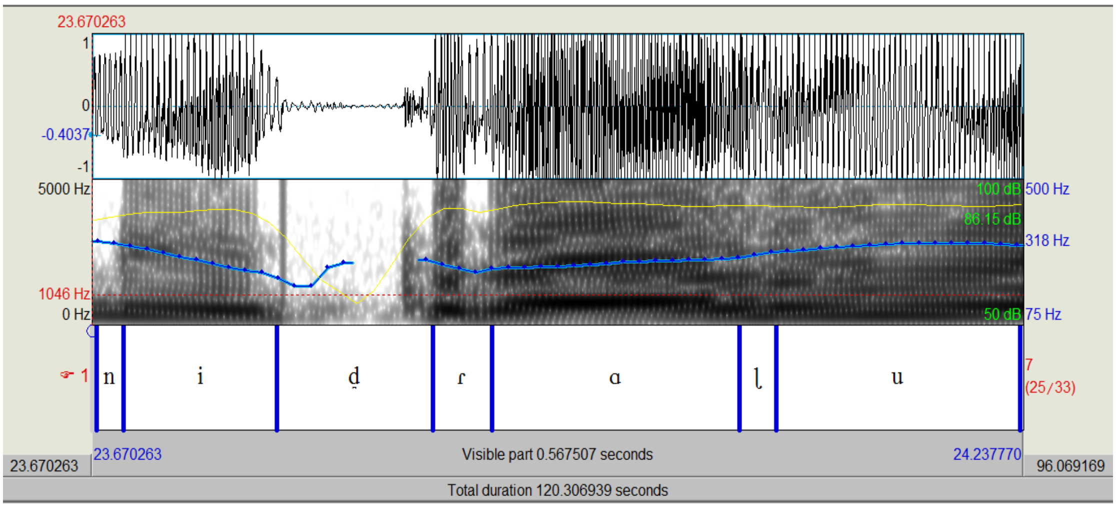


*Fig 26 . Stress in word nid̪raɭu*

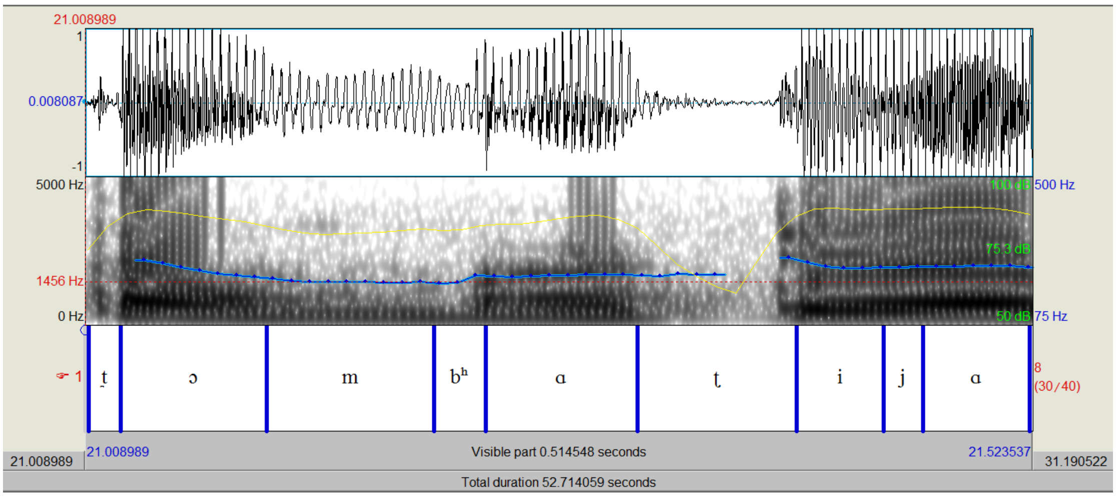


*Fig 27. Stress in word t̪ɔ́mbʰat̪ìa*

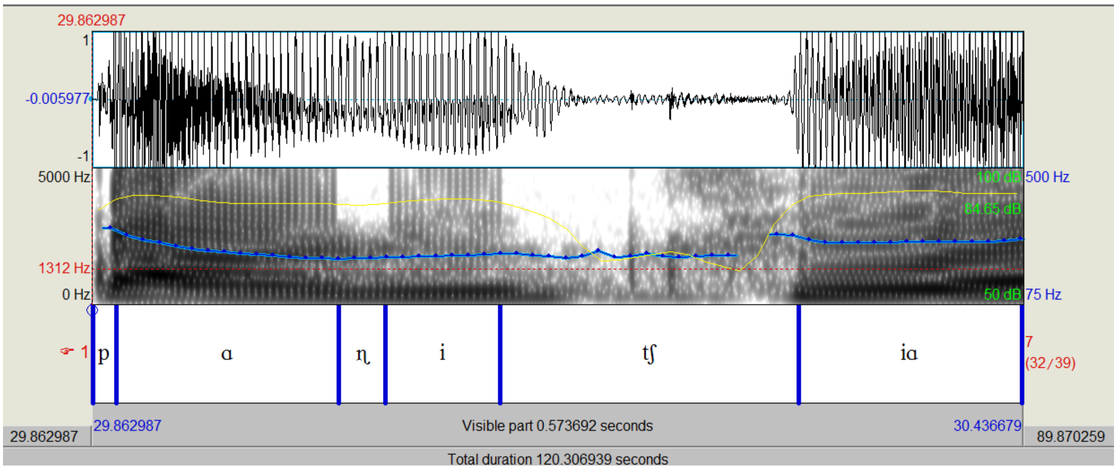


*Fig 28. Stress in word paɳ́itʃìa*

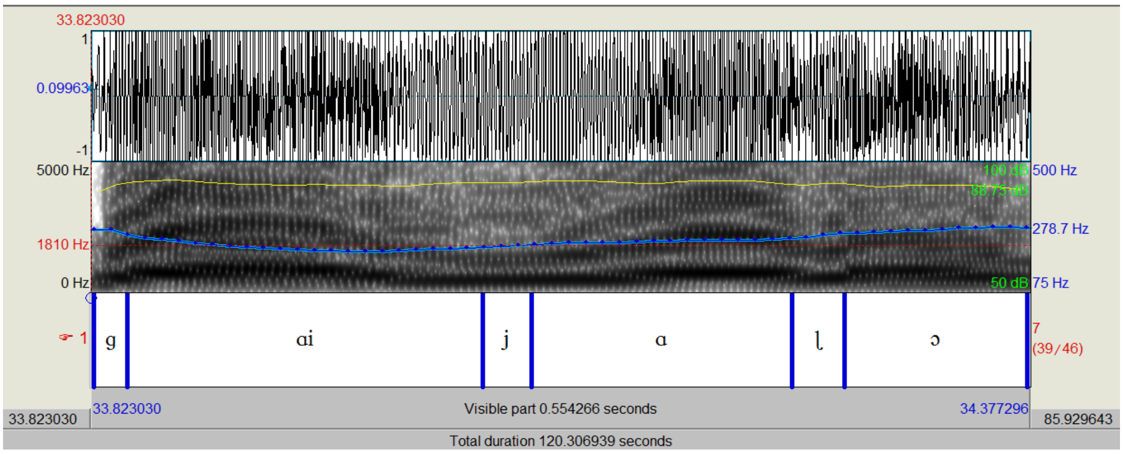


*Fig 29. Stress in word ga′ijàɭɔ*

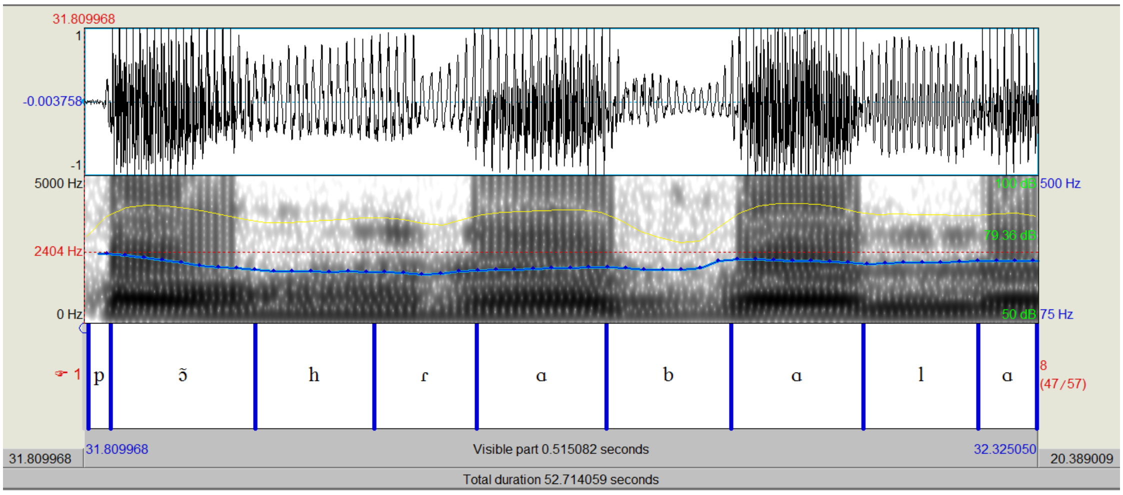


*Fig 30:. Stress in word pɔ̃́hɾabàla*

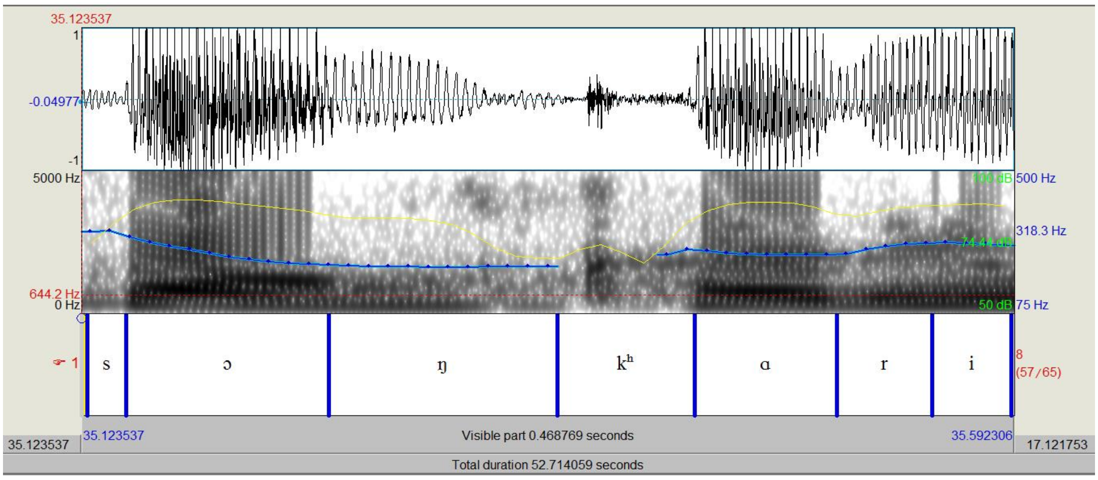


*Fig 31. Stress in word sɔ́ŋkʰaɾi*

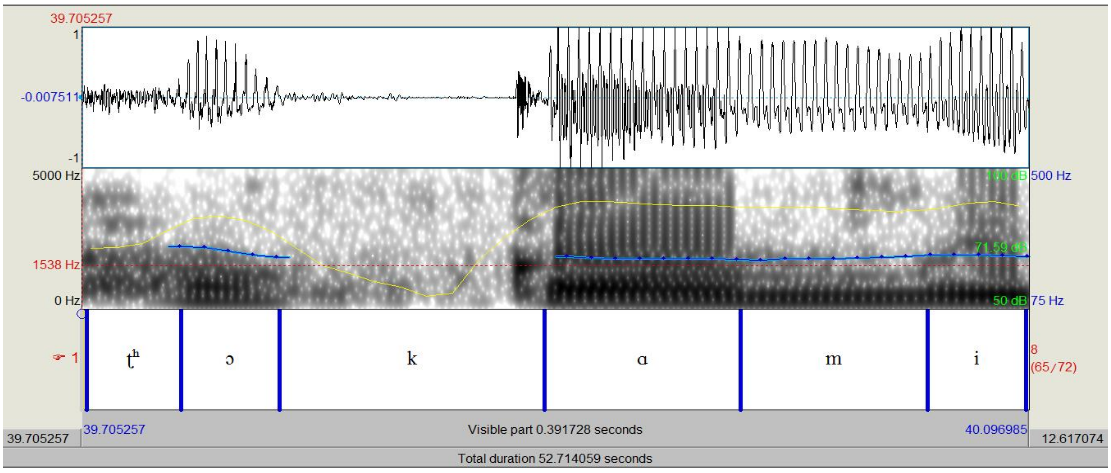


*Fig 32. Stress in word t̪ʰɔkámi*

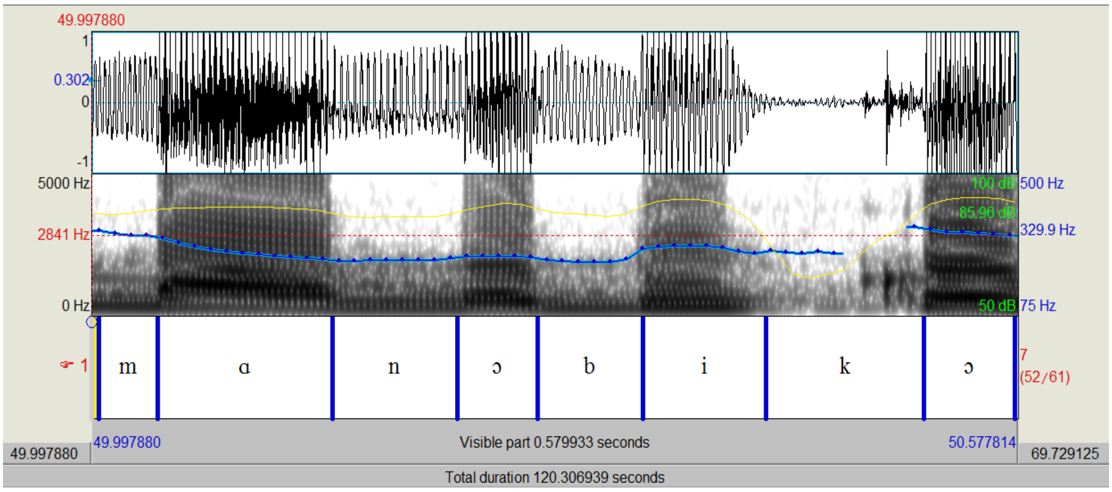


*Fig 33. Stress in word mánɔbìkɔ*

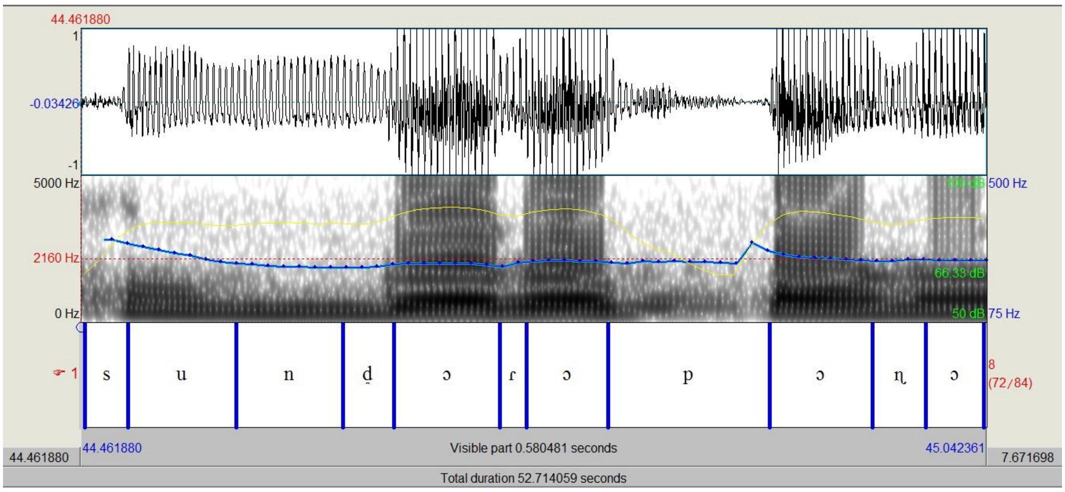


*Fig 34. Stress in word súnd̪ɔɾɔpɔ̀ɳɔ*

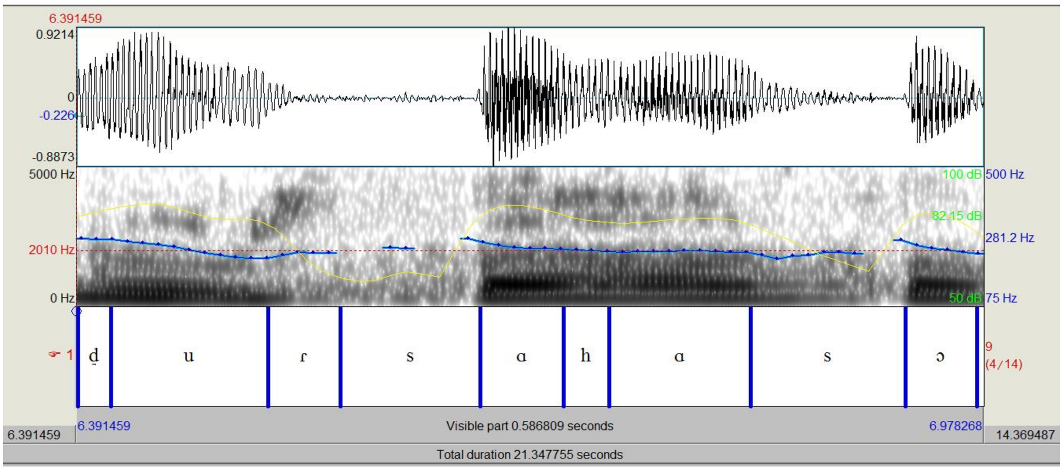


*Fig 35. Stress in word d̪úɾsahàsɔ*

**ANNEXURE 3:** Vowel Duration Chart

<u>DI-SYLLABLES:</u>

| **VOWEL= ɑ** | **DURATION** | |
|---|---|---|
| WORD | INITIAL | FINAL |
| d̪ɑɖʰi | 0.136516 | |
| pɑɳi | 0.121918 | |
| pʰɔʈɑ | | 0.053335 |
| pilɑ | | 0.070805 |
| badʒɑ | 0.094602 | 0.060815 |
| kand̪ɔ | 0.084098 | |

| **VOWEL= i** | **DURATION** | |
|---|---|---|
| WORD | INITIAL | FINAL |
| pilɑ | 0.091152 | |
| tʃiɾɑ | 0.088871 | |
| d̪ɑɖʰi | | 0.071439 |
| ɾogi | | 0.065221 |
| pɑɳi | | 0.078537 |

| **VOWEL= e** | **DURATION** | |
|---|---|---|
| WORD | INITIAL | FINAL |
| lekʰkʰɑ | 0.067064 | |
| belɔ | 0.090583 | |
| kʰeɭɔ | 0.084640 | |
| kile | | 0.072390 |

| **VOWEL= u** | **DURATION** | |
|---|---|---|
| WORD | INITIAL | FINAL |
| pʰuʈɑ | 0.091095 | |
| buɳɑ | 0.082863 | |
| sunɑ | 0.095406 | |
| bohu | | 0.070628 |

| **VOWEL= o** | **DURATION** | |
|---|---|---|
| WORD | INITIAL | FINAL |
| ɾogi | 0.096772 | |
| seo | e= 0.112814 | 0.106145 |

| VOWEL= ɔ | DURATION | |
|---|---|---|
| WORD | INITIAL | FINAL |
| pʰɔʈɑ | 0.083562 | |
| ʈʰɔkɔ | 0.178703 | 0.086387 |
| ɾogɔ | | 0.081334 |
| kɑnd̪ɔ | | 0.060609 |
| belɔ | | 0.078040 |
| kʰeɭɔ | | 0.068685 |

<u>TRI-SYLLABLES:</u>

| VOWEL= ɑ | DURATION | | |
|---|---|---|---|
| WORD | INITIAL | MEDIAL | FINAL |
| pɑɳijɑ | 0.090324 | | 0.069318 |
| ɖɑkt̪ɔɾɔ | 0.101173 | | |
| mɑʈʈijɑ | 0.067065 | | 0.058026 |
| mɑsʈɔɾi | 0.084398 | | |
| kʰeɭɑɭi | | 0.069066 | |
| pʰeɖɑɳɔ | | 0.093034 | |
| ɔnd̪ʰɑɾɔ | | 0.077270 | |
| d̪ɔjɑɭu | | 0.087382 | |
| kʰeɭɔnɑ | | | 0.074363 |
| d̪ʰuɭiɑ | | | 0.068712 |
| pɔɖʰuɑ | | | 0.075847 |
| belɔɳɑ | | | 0.085186 |
| dʒiɔnt̪ɑ | | | 0.068080 |

| VOWEL= ɔ | DURATION | | |
|---|---|---|---|
| WORD | INITIAL | MEDIAL | FINAL |
| pɔɖʰuɑ | 0.095926 | | |
| sɔmbɔlpuɾ | 0.124765 | 0.079496 | |
| hɔɭɔd̪i | 0.088069 | 0.061872 | |
| dʒɔɭɔnt̪ɑ | 0.114648 | 0.074770 | |
| ɖɑkt̪ɔɾɔ | | 0.026981 | |
| dʒiɔnt̪ɑ | | 0.073172 | 0.053961 |
| pʰeɖɑɳɔ | | | |
| ɔnd̪ʰɑɾɔ | 0.099990 | | 0.070899 |
| sɔmud̪ɾɔ | 0.078029 | | 0.069604 |
| kirtɔnɔ | | 0.064897 | |
| d̪ɔjɑɭu | 0.104271 | | 0.084782 |
| | | | 0.091783 |

| VOWEL= i | DURATION | | |
|---|---|---|---|
| WORD | INITIAL | MEDIAL | FINAL |
| dʒiɔnt̪ɑ | 0.110135 | | |
| kiɾt̪ɔnɔ | 0.087148 | | |
| pɑɳija | | 0.078559 | |
| d̪ʰuɭia | | 0.077672 | |
| mɑsʈɔɾi | | | 0.057016 |
| kʰeɭɑɭi | | | 0.069947 |
| kɔʈki | | | 0.050702 |
| hɔɭɔd̪i | | | 0.083559 |
| rupeli | | | 0.050548 |

| **VOWEL= o** | **DURATION** | | |
|---|---|---|---|
| WORD | INITIAL | MEDIAL | FINAL |
| dʒogaɖɔ | 0.801114 | | |
| d̪okanɔ | 0.081147 | | |
| pɔɖosi | | 0.079720 | |

| **VOWEL= e** | **DURATION** | | |
|---|---|---|---|
| WORD | INITIAL | MEDIAL | FINAL |
| kʰeɭaɭi | 0.078800 | | |
| belɔɳa | 0.135454 | | |
| rupeli | | 0.080380 | |
| pʰeɖaɳɔ | 0.830653 | | |

| **VOWEL= u** | **DURATION** | | |
|---|---|---|---|
| WORD | INITIAL | MEDIAL | FINAL |
| d̪ʰuɭia | 0.090683 | | |
| rupeli | 0.102753 | | |
| pɔɖʰua | | 0.072639 | |
| sɔmud̪rɔ | | 0.088356 | |
| sɔmbɔlpuɾ | | | 0.073174 |
| d̪ɔjaɭu | | | 0.093257 |

QUADRA-SYLLABIC WORDS:

| VOWEL | DURATION | | | |
|---|---|---|---|---|
| WORD | INITIAL | ANTI-PENULT | PENULT | FINAL |
| hɔ.ɭɔ.d̪i.jɑ | 0.079962 | 0.065266 | 0.082555 | 0.069156 |
| ɾɑn.d̪ʰu.ɳi.jɑ | 0.123184 | 0.082470 | 0.102827 | 0.091653 |
| pɑ.ɳi.ʧi.jɑ | 0.094368 | 0.066941 | 0.079492 | 0.054854 |
| dʒɔ.gu.ɑ.ɭɔ | 0.134505 | 0.057126 | 0.097114 | 0.074264 |
| bɔ.ɖɔ.pɔ.ɳɔ | 0.110607 | 0.062301 | 0.065010 | 0.055529 |
| mɑ.nɔ.bi.kɔ | 0.098748 | 0.055814 | 0.098748 | 0.053667 |

PENTA-SYLLABIC WORDS:

| VOWEL | DURATION | | | | |
|---|---|---|---|---|---|
| WORD | INITIAL | SECOND | ANTI-PENULT | PENULT | FINAL |
| sɔm.bɔl.pu.ɾi.jɑ | 0.074691 | 0.059876 | 0.069135 | 0.041358 | 0.066890 |
| pɔ̃.hɔ.ɾɑ.bɑ.lɑ | 0.102113 | 0.087634 | 0.082947 | 0.113327 | 0.073781 |
| bɔ.ɖɔ.pɔ.ɳi.jɑ | 0.107730 | 0.049996 | 0.077375 | 0.051782 | 0.049874 |
| mɑ.nɔ.bi.kɔ.t̪ɑ | 0.097758 | 0.064765 | 0.114255 | 0.065987 | 0.054541 |
| sɔ.t̪i.pɔ.ɳi.jɑ | 0.107588 | 0.056159 | 0.087489 | 0.059114 | 0.058080 |

HECTA-SYLLABIC WORDS:

| VOWEL | DURATION | | | | | |
|---|---|---|---|---|---|---|
| WORD | INITIAL | SECOND | THIRD | ANTI-PENULT | PENULT | FINAL |
| dɔ.sɔ.hɔ.dʒɑ.ɾi.jɑ | 0.092219 | 0.060323 | 0.086672 | 0.071417 | 0.073497 | 0.056930 |
| sun.d̪ɔ.ɾɔ.pɔ.ɳi.jɑ | 0.075726 | 0.061240 | 0.061898 | 0.079719 | 0.075726 | 0.059264 |