Language in India www.languageinindia.com ISSN 1930-2940 Vol. 21:10 October 2021

Svara Sandhi in Odia – An Optimality Theoretic Study

Suhasini Dash, Ph.D. Research Scholar
The English and Foreign Languages University, Hyderabad, 500007.
suhasini.dash24@gmail.com

Abstract

This study attempts to present an Optimality Theoretic (Prince and Smolensky,1993) analysis of the *svara* sandhi changes occurring in Odia (An Indo-Aryan language spoken in the eastern state of Odisha, India). Odia, like other major Indian languages such as Bengali, Telugu, Malayalam, etc., has been influenced by Sanskrit and has hence subsumed the phenomenon of sandhi occurring in Sanskrit.

The phenomena of two sounds combining to form a new sound (/ɔ/ + /ɔ/ = /a/) e.g. sɔsɔ + ɔŋkɔ = sɔsaŋkɔ 'moon' or the insertion of glides in certain other constructions (/ɪ/ + */ɪ/ = /j/) e.g. ɪʊ̈ + adʊ̈ɪ= ɪʊ̈jadɪ 'etcetera', (/u/ + */u/ = /w/) e.g. /su/ + /agɔʊ̈ɔ/ = swagɔʊ̈ɔ 'welcome' or how two vowels of differing heights combine to result in a sort of Vowel Harmony where instead of one vowel influencing the other, both vowels influence each other and result in a sound which has qualities of both vowels (/ɔ/, /a/ + /ɪ/ = /e/) e.g. /gɔɳɔ/ + /ɪsɔ/ = /gɔɳesɔ/ 'Lord Ganesha'; these are some of the processes that will be looked into.

This paper uses the Optimality Theoretic framework to explain these processes. Newly developed constraints such as COALESCENE, *Diphthongs, (low, back V + low, back V = /a/) are proposed in this study along with certain other common and well-established faithfulness constraints such as MAX-V and DEP-V. The study analyses the svara sandhi process in Odia which has evolved from Sanskrit and shares the same features in most constructions while simultaneously showing the applicability of Optimality Theory in such a study.

Keywords: sandhi; svara sandhi; Odia; Optimality theory; vowel harmony; epenthesis

1. Introduction

The aim of this paper is to exhaustively discuss the svara sandhi rules in Odia and to analyse them using the optimality theory (OT) framework given by Prince and Smolensky (1993). Sandhi is a cover term for changes that occur between word or morpheme boundaries. Two words or morphemes combine to form a new word and these result in certain sound changes at the boundaries of the words. The main aim of sandhi is to provide an ease in pronunciation.

This paper endeavours to break down the complex processes that occur in svara sandhi using the OT framework for a step-by-step clarification.

Sandhi is a term that originates from the Sanskrit Grammatical tradition and was adopted by modern western linguistics. Freidrich Max Müller was the first scholar to coin the terms internal and external sandhi in 1866. According to the *Concise Oxford Dictionary of Linguistics* (Matthews, 2007) internal and external sandhi can be defined as:

> "external sandhi: Process of phonological modification that takes place at or across word boundaries. Thus, by one common process of external sandhi in English, an initial /s/ in words like steak is assimilated to a /ʃ/ in e.g. fish steak." (Matthews, 2007)

> "internal sandhi: Process of phonological modification found within words, at or across boundaries of roots and affixes." (Matthews, 2007)

Sandhi in Odia has not been discussed by researchers till now in terms of phonology and hence no previous work is available on it. There are a few existing works on Sandhi but in these works, sandhi has been analyzed through syntax. For example, *External Sandhi and its Relevance to Syntactic Treebanking* (Kochina; Sharma; Gadde; Vijay; Sangal; Bharati, 2011). They discuss the implications of sandhi on the syntactic annotation of Telugu sentences. Another work on sandhi is *Automatic Sandhi Splitting Method for Telugu, an Indian Language* (Vempathy & Nagalla, 2011) which discusses the methodology of building a tool for sandhi splitting. *Sandhi Splitting Techniques for Different Indian Languages* (Deshmukh & Bhojane, 2014) again focuses on the various sandhi splitting techniques that are available in Indian languages. All these works that focus on sandhi are from the perspective of its applicability in NLP (Natural Language Processing).

The paper is organized into 7 sections. The first section discusses the aim of the paper along with the previous literature available on sandhi. Section 2 gives a brief overview of sandhi in general from the processes that it encompasses to its types. Section 3 scrutinizes and gives an account of svara sandhi and the rules of svara sandhi in Odia. Section 4 takes into account the methodology that was used to collect the data in order to conduct this research and also briefly discusses the theoretical framework that was used. Section 5 employs the Optimality theory to analyze the data and gives a description of the constraints that have been employed. Section 6 states the major findings of the paper and describes the changes that were noticed. Finally, section 7 concludes the paper by reiterating the major findings of the study and briefly summarizes the entire paper.

2. Sandhi

Sandhi is a Sanskrit word for 'joining' which has been borrowed from the grammarians of Ancient India to describe certain processes (Matthews, 1974). The processes under Sandhi are

- Assimilation: It is a phonological process by which one sound becomes more like a nearby sound. This can either occur within a word or between words.

    1. Regressive Assimilation: if a sound changes with reference to a following segment, it is called regressive assimilation.
        - ut + gʰaʈɔnɔ = udgʰaʈɔnɔ 'inauguration
    2. Progressive Assimilation: If a sound changes with reference to the preceding segment, it is called progressive assimilation.
        - sɪs + t = sɪsʈɔ 'polite'

- Dissimilation: It is a phenomenon whereby similar consonant or vowel sounds in a word becomes less similar.
    - bɪpɔd + ʤʰɔʈɪka = bɪpɔdʒʤʰɔʈɪka 'dangerous storm

- Epenthesis: It is the addition of one or more sounds to a word, especially to the interior of a word. Epenthesis can be divided into two types: excrescence, when a consonant is added and anaptyxis, when a vowel is added.
    - ɔbʰɪ + udɔjɔ = ɔbʰjudɔjɔ 'prosperity'
    - ɔnu + ɡʰedɔ = anuʧɡʰedɔ 'paragraph'

- Fusion: It is a sound change where two or more segments with distinctive features merge into a single segment. It can also be called coalescence.
    - sɔsɔ + ɔŋkɔ = sɔsaŋkɔ 'moon'

2.1 Types of Sandhi

Sandhi is of three types: internal sandhi and external sandhi and tone sandhi.

- *Internal sandhi*: internal sandhi occurs at morpheme boundaries. It is very similar to assimilation.
    - Syn+ pathy= sympathy.

- *External sandhi*: this is found in many Indian languages. Here the sound change occurs at word boundaries. When two words combine at the boundaries and merge to form one sound or there is an epenthesis of another sound, external sandhi takes place.
    - /uʈ/ + /ʤwɔlɔ/ = *uʤʤwɔlɔ* 'lighted' (ʈ+ʤ=ʤ)

3. *Tone sandhi*: Another important kind of sandhi is Tone Sandhi. Most tonal languages have tonal sandhi in which the tone of a morpheme or word changes according to the

pronunciation of its neighbouring morpheme. An example of this is tone 3 in Mandarin Chinese. When it occurs in isolation it is pronounced as a falling rising tone but when tone 3 occurs with another tone 3 it changes to a tone 2 (a rising tone). When tone 3 occurs with other tones it is pronounced as a low falling tone (Tone Sandhi, n.d.)

2.2 Types of External Sandhi

External Sandhi is of 3 types:

1. Svara sandhi
2. Vyanjana sandhi
3. Visarga sandhi

For the purpose of this paper, I will only be considering and examining svara sandhi in Odia.

3. Svara Sandhi

'Svara' means vowel sounds in Sanskrit. In this type of sandhi, the last vowel of the first word and the first vowel of the second word are combined. The neighbouring vowel sounds combine and give rise to one vowel sound in most cases. Sandhi rules have developed from Sanskrit, and they are not much different in Odia. Odia follows the same rules which are applicable in Sanskrit.

3.1 The Rules of Svara Sandhi in Odia

3.1.1 Condition 1 (This condition is similar to Dirgha Sandhi in Sanskrit)

- When one of the sounds is the open mid back vowel /ɔ/ and the other is the central and open vowel /a/ or even when both the sounds are /ɔ/ or /a/ the resultant sound is the open central vowel /a/ only.

  /ɔ/ + /ɔ/ = /a/

  (1) a. sɔsɔ + ɔŋkɔ = sɔsaŋkɔ 'moon'
  b. debɔ + ɔsurɔ= debasurɔ 'demon-god'

  /a/ + /ɔ/ = /a/

  (2) a. sud^{h}a + ɔnsu= sud^{h}ansu 'moon'
  b.ʧita +ɔnɔlɔ =ʧitanɔlɔ 'veins of the heart'

  /ɔ/ + /a/= /a/

  (3) a. uʧʧɔ + asɔnɔ= uʧʧs**a**ɔnɔ 'high position'
  b. sɪŋg^{h}ɔ + asɔnɔ = sɪŋg^{h} **a**sɔnɔ 'throne'

  /a/ + /a/ = /a/

(4) a. mɔha + anɔnɖɔ = mɔhn**a**ɔnɖɔ ‘great happiness’
b. sud^{h}a + akɔrɔ = su**d** ^{h}**a**kɔrɔ ‘moon’

3.1.2 Condition 2 (This condition is similar to yana sandhi in Sanskrit)

- The high vowel /ɪ/ when combined with any other vowel except /ɪ/ will result in the semivowel /j/.

/ɪ/ + anything but /ɪ/ = /j/

(5) a. ɪʈɪ + aɖɪ= *ɪʈjadɪ* ‘etcetera’
b. prɔtɪ + ɔhɔ = prɔtjɔhɔ ‘daily’
Here the /ɪ/ is deleted and a /j/ sound is epenthesized. The sound which follows the /ɪ/ is retained which in the above example is /a/

- When /u/ is combined with anything but /u/ the result is the semivowel /w/.

/u/ + anything but /u/ = /w/

(6) a. su + agɔʈɔ = swagɔʈɔ ‘welcome’
b. ɔnu + ɔjɔ = ɔnwɔjɔ ‘lineage’

3.1.3 Condition 3 (These are similar to Guna sandhi in Sanskrit)

- When back open mid /ɔ/ or central open /a/ sound combines with /ɪ/ the result is the close mid front sound /e/.

/ɔ/, /a/ + /ɪ/ = /e/

(7) a. gɔɳɔ + ɪsɔ = gɔɳesɔ ‘Lord Ganesha’
b. mɔha + ɪndrɔ = mɔhendrɔ ‘great Indra’

- When /ɔ/ or /a/ combines with the back and high vowel /u/ the result is the close mid back vowel /o/.

/ɔ/, /a/ + /u/ = /o/

(8) a. lɔmbɔ + uɖɔrɔ = lɔmboɖɔrɔ ‘another name for lord ganesha’
b. purusɔ + uttɔmɔ = purusottɔmɔ ‘Supreme being’

- When /ɔ/ or /a/combines with /ru/ the result is the sound /ɔr/

/ɔ/, /a/ + /ru/ = /ɔr/

(9) a. mɔha+ rusɪ = mɔhɔrsɪ ‘great sage’
b. radʒa + rusɪ = radʒɔrsɪ ‘royal saint’

3.1.4 Condition 4 (These are similar the Vriddhi sandhi in Sanskrit)

- When /ɔ/ and /a/ combine with /e/ or /ɔɪ/ then the result is /ɔɪ/.

/ɔ/, /a/ + /e/, /ɔɪ/ = /ɔɪ/

(10) a. ʤɔnɔ + ekɔ = ʤɔnɔɪkɔ 'everyone'
b. mɔha + ɔɪrabɔtɔ = mɔhɔɪrabɔtɔ 'great Aravat'

- When /ɔ/ or/a/ is combined with /u/ or /ɔu/ then the result is /ɔu/

/ɔ/, /a/ + /o/, /ɔu/ = /ɔu/

(11) a. mɔha + ɔusɔd^{h}ɔ = mɔhɔusɔd^{h}ɔ 'powerful medicine'
b. mɔha + udʒɔ = mɔhɔudʒɔ 'enjoyment'

3.1.5 Condition 5 (These are similar to Ayadi sandhi in Sanskrit)

- **When the vowels such as /ɔ/ /a/ /ɪ/ are preceded by /e/, /ɔɪ/, /o/, /ɔu/ then**

/e/ → /ɔjɔ/
/ɔɪ/ → /ajɔ/
/o/→ / ɔb/
/ɔu/→ /ab/

(12) ne + ɔnɔ = nɔjɔnɔ 'eyes'

(13) a. nɔɪ + akɔ = najɔkɔ 'actor'
b. gɔɪ + ɔkɔ = gajɔkɔ 'singer'

(14) b^{h}ɔu + ukɔ = b^{h}abukɔ 'emotional'

(15) a. b^{h}o + ɔnɔ = b^{h}ɔbɔnɔ 'building'
b. po + ɔnɔ = *pɔbɔnɔ* 'wind'

4. Methodology

The data has been collected from both primary and secondary sources. The data is qualitative in nature. The researcher has collected the primary data from the spontaneous speech of native Odia speakers and from her own speech as she herself is a native speaker of Odia. The primary data was collected from 20 native Odia speakers; 11 females and 9 males. Their age range was from 20-80 and all of them speak the standard variety of Odia which is spoken in the Khordha and Cuttack districts. The participants' speech was recorded and later transcribed manually. The secondary data was collected from Odia grammar books which discuss svara sandhi in Odia. Most of the secondary data has been collected from Mohapatra and Das (1943) and (Sanskrit Vyakaran, n.d.). The grammar books mention the alphabets that combine to produce a new alphabet or if there is an insertion of a new alphabet and the students are expected

to learn these rules through memorization. The researcher has tried to present the data in terms of phonology which makes the mechanics of these rules more concise and comprehensible.

The table presented below displays the categorization of the participants of the study.

Age Groups	No of participants	Sex	native odia speaker of the standard variety
20-40	10	Females- 6 Males – 4	✔
40-60	6	Females- 4 Males- 2	✔
60-80	4	Females-1 Males- 3	✔

Table 1 gives details of the interviewees

For the analysis of the data, which was achieved through transcription, the framework that has been used is Optimality Theory.

Optimality theory views Universal Grammar differently from other rule based generative theories. OT defines Universal grammar as a set of universal constraints. According to Kager (1999) there are two major forces embodied by constraints. The first is the *markedness constraints* which demand structural well formedness and *faithfulness constraints* which require some kind of similarity between the input and the output.

The two other assumptions which are made about OT constraints are that they are 1) universal, and 2) violable.

- *Universality:* constraints are universal which means that the meaning of the constraint will not change from language to language
- *Violability*: constraints are violable, but the violation must be minimal.

The components of OT are:

- Lexicon: contains lexical representations of morphemes, which form the input
- Generator: generates the possible output candidates
- Evaluator: evaluates the possible candidates and chooses the optimal candidate. The role of 'Eval' is to assess the 'harmony' of the outputs with respect to a given ranking of constraints. It is language specific.

Other additional features of OT are:

- Fallacy of perfection: no output form is possible that satisfies all constraints.
- In OT the candidate that incurs least violation is the optimal candidate and the symbol for the optimal candidate is ☞
- The candidate that violates the higher ranked constraints incurs fatal violation which is denoted by *!
- Freedom of analysis: any amount of possible output candidates maybe posited
- Strict domination: violation of higher ranked constraints cannot be compensated for by the satisfaction of lower ranked constraints.

5. The Analysis

In this study the following constraints are used. Since sandhi has not been worked on previously most of the constraints had to be created.

List of Constraints Used for Condition 1

1) low, back V + low, back V= /a/

This constraint covers all the possible changes that happen in condition 1. Whether open mid /ɔ/ combines with the central open vowel /a/ or vice versa the result will always be the central open vowel /a/. Here low and back covers both open mid vowel /ɔ/ and open back vowel /a/.

2) Coalescence

Here the linguistic meaning of coalescence has been slightly changed. Two neighbouring sounds come together to become one.

3) Max-V (Kager 1999)

This constraint says that no vowel should be deleted from the input.

OT Tableau 1

/ɔ/ + /ɔ/ = /a/

- sɔsɔ + ɔŋkɔ = sɔsaŋkɔ ‘moon’

sɔsɔ+ ɔŋkɔ	low,back V + low, back V= /a/	COALESCENCE	Max-V
a)☞sɔsaŋkɔ			*
b) sɔsɔŋkɔ	*!		*
c) sɔsoŋkɔ	*!		*
d) sɔsɔɔakɔ		*!	
e) sɔsɔaŋkɔ		*!	

Candidates b) and c) violate the highest ranked constraint as the combination of the back and low vowels should result in the open central vowel but in these cases that does not happen. The constraint COALESCENCE is violated by candidate d) and e) as no fusion happens. Max-V is a lower ranked constraint since for sandhi to happen in condition 1, a vowel has to be deleted. Our optimal candidate a) violates it but since it is lower ranked it does not make a difference.

OT Tableau 2

/ɔ/ + /a/= /a/

- uʧʧɔ + asɔnɔ = uʧʧasɔnɔ 'high position'

uʧʧɔ + asɔnɔ	low,back V + low, back V= /a/	COALESCENE	Max-V
a) ☞uʧʧasɔnɔ			*
b) uʧʧɔsɔnɔ	*!		*
c) uʧʧosɔnɔ	*!		*
d) uʧʧɔasɔnɔ		*!	

Candidate a) is the optimal candidate as it incurs least violation. The rest of the candidates violate one of the higher ranked constraints. Here two words, one having two syllables and the other having three syllables combine to form a quadrisyllabic word.

List of Constraints for Condition 2

1) $V_H + V = j/w + V_2$
   This constraint works for all the changes that come under Condition 2. When a high vowel combines with any vowel the resulting phoneme is /j/ if the high vowel is /ɪ/ and it is /w/ when the high vowel is /u/; this is followed by the vowel which was present in the beginning of the second word whereas the high vowel is deleted.

2) $*V_1 j/w V_2$
   A structure where the high vowel is followed by the epenthesized semivowel which again is followed by the first vowel sound in the second word is not permitted.

3) DEP-IO (Kager, 1999)
   This constraint simply forbids epenthesis.

OT Tableau 3

/i/ + anything but /i/ = /j/

- ɪt̪ɪ + ad̪ɪ= ɪt̪ jadɪ 'etcetera'

ɪt̪ɪ + ad̪ɪ	V_H + V= j/w +V_2	*V_1j/wV_2	DEP-I0
a) ɪt̪ɪadɪ	*!		
b) ɪt̪ɪjadɪ		*!	*
c) ☞ɪt̪ jadɪ			*
d) ɪt̪ adɪ	*!		
e) ɪt̪ ɪdɪ	*!		

The optimal candidate is c) as it incurs least violation. Candidates a), d) and e) violate the highest ranked constraint as they do not combine to form a glide. Candidate b) violates *V_1j/wV_2 as it has a semivowel sandwiched between two vowels. The optimal candidate violates DEP –IO as there is an epenthesis of the semivowel /j/.

OT Tableau 4

/u/ + anything but /u/ = /w/

- su + agɔt̪ɔ = swagɔt̪ɔ 'welcome'

/su/ + /agɔt̪ɔ/	V_H + V= j/w +V_2	*V_1j/wV_2	DEP-IO
a)suagɔt̪ɔ	*!		
b) sugɔt̪ɔ	*!		
c) sagɔt̪ɔ	*!		
d)☞swagɔt̪ɔ			*!
e) suwagɔt̪ɔ		*!	*!

The optimal candidate is candidate d). Candidates a), b) and c) violate constraint V_H + V= j/w +V_2. Candidate e) violates the constraint * V_1j/wV_2. The optimal candidate d) violates the lowest ranked constraint DEP-IO as there is an epenthesis of the semivowel /w/.

In the example above, two words having one and three syllables respectively combine to form a trisyllabic word.

List of Constraints for Condition 3

1) $V_{ɔ/a}$ + $V_{ɪ/u}$ = $V_{e/o}$

   The constraint encompasses all the changes that occur under Condition 3. When the vowels /a/ and /ɔ/ combine with the high vowels /ɪ/ and /u/ then the resultant phonemes are /e/ and /o/ respectively

OT Tableau 5

/ɔ/, /a/ + /ɪ/ = /e/

- gɔɳɔ + ɪsɔ = gɔɳesɔ ‘name for lord Ganesh’

/gɔɳɔ/ + /ɪsɔ/	$V_{ɔ/a} + V_{ɪ/u} = V_{e/o}$	COALESCENCE	MAX-V
a) gɔɳɔɪsɔ		*!	
b) ☞gɔɳesɔ			*
c) gɔɳɔsɔ	*!		*
d) gɔɳɪsɔ	*!		*
e) gɔɳɔesɔ		*!	*
f) gɔɳɪesɔ		*!	*

The optimal candidate is b) as it incurs least violation. The rest of the candidates violate the higher ranked constraints. This example is a case of vowel height adjustment. Two vowels one of which is a low vowel and the other which is a high vowel combine to form the close mid front vowel /e/.

OT Tableau 6

/ɔ/, /a/ + /u/ = /o/

- lɔmbɔ +uḍɔrɔ = lɔmboḍɔrɔ ‘another name for lord Ganesh’

/lɔmbɔ/ +/uḍɔrɔ/	$V_{ɔ/a} + V_{ɪ/u} = V_{e/o}$	COALESCENCE	Max-V
a) lɔmbɔuḍɔrɔ		*!	
b)lɔmbɔḍɔrɔ	*!		*
c) lɔmbuḍɔrɔ	*!		*
d) ☞lɔmboḍɔrɔ			**
e) lɔmbaḍɔrɔ	*!		**

Candidate d) is the optimal candidate as it incurs least violation. Candidate b), c) and e) violate the highest ranked constraint $V_{ɔ/a} + V_{ɪ/u} = V_{e/o}$ as the neighbouring vowels do not combine to form the close mid vowel /o/. Candidate a) has no fusion of the vowels and hence it violates COALESCENCE. The optimal candidate d) violates the least ranked constraint twice as both /ɔ/ and /u/ have been deleted in the output.

Both examples from Condition 3 show vowel height adjustment; a high and a low vowel combine to form a vowel whose height is somewhere in between.

Constraints for Condition 4

1) V_{LB} + V_{CM} / $V_BV_{H=}$ V_BV_H
   This constraint is the most important constraint for Condition 4. It says that when low and back vowel combines with the close mid front vowel/e/ or two consecutive vowels where the first one is /ɔ/ and the second one is a high vowel the result is /ɔɪ/ or /ɔu/.

2) Diphthong
   Odia does not have any diphthongs in its phonetic inventory but when two words are combined the resultant sandhi is a diphthong. This only happens in case of sandhi and because the sound /ɔɪ/ and /ɔu/ are present in the orthography of Odia.
   This constraint recognizes /ɔɪ/ and /ɔu/ as diphthongs.

3) IDENT-IO (Kager, 1999)
   This constraint expects there to be no change from the input to the output

OT Tableau 7

/ɔ/, /a/ + /e/, /ɔɪ/ = /ɔɪ/

- ʤɔnɔ + ekɔ = ʤɔnɔɪkɔ ‘everyone’

/ʤɔnɔ/ + /ekɔ/	V_{LB} + V_{CM} / $V_BV_{H=}$ V_BV_H	Diphthong	IDENT-IO
a) ☞ʤɔnɔɪkɔ			*!
b) ʤɔnɔekɔ		*!	
c)ʤɔnɔkɔ	*!		*
d) d) ʤɔnekɔ	*!		*
e) e) ʤɔnɪkɔ	*!		*

Candidate a) is the optimal candidate as it incurs least violation. Candidate b) violates the constraint Diphthong as Odia only recognizes two diphthongs /ɔɪ/ and /ɔu/, that too only in case of sandhi. The rest of the candidates c), d) and e) violate the highest ranked constraint as they do not yield the desired result.

OT Tableau 8

/ɔ/, /a/ + /o/, /ɔu/ = /ɔu/

- mɔha + ɔusɔdhɔ = mɔhɔusɔdhɔ ‘powerful medicine’

/mɔha/ + /ɔusɔd^{h}ɔ/	V_{LB} + V_{CM} / $V_BV_{H=}$ V_BV_H	Diphthong	IDENT-IO
a) mɔhaɔusɔd^{h}ɔ	*!		
b) ☞mɔhɔusɔd^{h}ɔ			*
c) mɔhausɔd^{h}ɔ		*!	*
d) mɔhosɔd^{h}ɔ	*!		*

Candidate b) is the optimal candidate. Candidates a) and d) violate the highest ranked constraint as the sandhi does not yield the desired output. Candidate c) violates the constraint Diphthongs as /au/ is not recognized as a diphthong in Odia sandhi.

Constraints for Condition 5

1) e/ ɔɪ + V = ɔjɔ/ ajɔ
   When the front, mid vowel or the vowel combination /ɔɪ/ combine with any other vowel the result is a three-part structure where a semi vowel is sandwiched between two vowels; /ɔjɔ/ and /ajɔ/ respectively.

2) o/ ɔu + V= ɔb/ ab
   When a back, mid vowel or the vowel combination /ɔu/ combine with any other vowel the result is VC structure where the V could be /ɔ/ or /a/ depending on the vowel in the first word and the C is always the bilabial stop /b/.

3) *VV
   Vowels should not be adjacent to each other.

OT Tableau 9
/e/ → /ɔjɔ/

- ne + ɔnɔ = nɔjɔnɔ ‘eyes’

If a vowel is preceded by the close mid vowel /e/ then /e/ is deleted and the result is /ɔjɔ/.

/ne/ + /ɔnɔ/	e/ ɔɪ + V = ɔjɔ/ ajɔ	* VV	IDENT-IO
a) ☞nɔjɔnɔ			*
b) neɔnɔ	*!		

c) nejɔnɔ	*!		*
d) neɔjɔnɔ		*!	*

The optimal candidate is a) as it incurs least violation. Candidate b) and c) violate the highest ranked constraint as they do not produce the desired phoneme combination. Candidate d) violates the constraint *VV as it has two adjacent vowels.

OT Tableau 10
/o/ → /ɔb/

- po + ɔnɔ= pɔbɔnɔ 'air'

po+ ɔnɔ	o/ ɔu + V= ɔb/ ab	*VV	IDENT-IO
a) poɔnɔ	*!	*!	
b) ☞pɔbɔnɔ			*!
c) pobɔnɔ	*!		*
d) poɔbɔnɔ		*!	*

Candidate b) is the optimal candidate as it incurs least violation. Candidate a) and c) violate the highest ranked constraint as they do not produce the desired VC structure. Candidate d) violates *VV as there are two adjacent vowels.

6. Discussion

From the above examples we can clearly see how svara sandhi functions in Odia. In some cases, two sounds combine to form a new sound as in sɔsɔ + ɔŋkɔ = sɔsaŋkɔ 'moon' **(/ɔ/ + /ɔ/ = /a/)** or one of the two sounds is deleted and a **glide formation** takes place. For example /**ɪ/ + anything but /ɪ/ = /j/** ɪt̪ɪ + ad̪ɪ= ɪt̪ jadɪ *'etcetera'*; in this case /j/ is inserted and in some cases a /w/ is inserted; **/u/ + anything but /u/ = /w/** /su/ + /agɔt̪ɔ/ = /swagɔt̪ɔ/ 'welcome'. Other times a **low vowel and a high vowel combine to form a vowel whose height is in between**, for example **/ɔ/, /a/ + /ɪ/ = /e/** /gɔɳɔ/ + /ɪsɔ/ = /gɔɳesɔ/ 'Lord Ganesha'. In certain other constructions, **vowels are preceded by certain specific vowels such as /e/, /ɔɪ/, /o/ and /ɔu/, the latter vowels and vowel clusters get deleted and are replaced by /ɔjɔ/ in place of /e/, /aj/ in place of /ɔɪ/,/ɔb/ in place of /u/ and /ab/ in place of /ɔu/.** In the first case there is a glide sandwiched between two vowels, in the second case there is a vowel + glide formation. In the third and fourth case there is a vowel + consonant combination. The consonant is also fixed. It is the voiced bilabial plosive /b/.

The researcher has tried to list down all possible svara sandhi combinations in this section of the paper. After careful analysis in the optimality theory framework the schema for constraints in svara sandhi in Odia is
MARKEDNESS>>MARKEDNESS>>FAITHFULNESS

In all the conditions above the markedness constraints are always higher ranked than the faithfulness constraints because in sandhi there is always a change. Even if a new sound is not added, one of the two sounds is deleted and hence the input and output always differ.

7. Conclusion

The paper exhaustively discusses the svara sandhi rules in Odia. The svara sandhi rules are first explained in phonological terms and then they are analyzed using the optimality theory framework. The OT framework helps in clearly explaining the changes that occur when two words combine with each other in external sandhi. The researcher has attempted to document all the types of changes that occur within svara sandhi and has introduced constraints which capture the changes that occur i.e., epenthesis or deletion of phonemes when sandhi changes occur at word boundaries. The rules of svara sandhi in Odia are similar to the ones found in Sanskrit and sandhi changes only occur in *tatsama* words. No sandhi changes have been documented in native Odia words.

The most common change that occurs in svara sandhi is when two sounds combine to form a new sound; either two short vowels give rise to a longer vowel or if there is one short vowel and one long vowel, the longer vowel is retained. Another change that is noticed is the epenthesis of a semivowel in certain constructions and finally in certain cases there is a type of vowel adjustment where a high vowel and a low vowel combine and give rise to a vowel that has characteristics of both these vowels. All of these changes have been documented with the help of OT tables.

The paper after investigating all the rules and changes that occur has put forth the constraint schema for svara sandhi in Odia which is

MARKEDNESS>>MARKEDNESS>>FAITHFULNESS.

==========

References

Deshmukh, R & Bhojane, V. (2014). Sandhi Splitting Techniques for different Indian Languages. *International Journal of Engineering Technology, Management and Applied Sciences. Vol 2, issue 7.* 18-28.

==========

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

Kolachina, S., Sharma, D.S., Gadde, P., Vijay, M., Sangal, R., & Bharati, A. (2011). External Sandhi and its Relevance to Syntactic Treebanking. *Polibits , 43*.

Matthews, P.H. (1974). *Morphology*. Cambridge University Press.

Matthews, P. H. (2007). *The Concise Oxford Dictionary of Linguistics*. (Rev.ed.). Oxford University Press.

Mahapatra, N., & Das, S. (1943). *Sarbarasa Byakarana*. M/s New Students Store.

Prince, A. & P. Smolensky. (1993). *Optimality Theory: Constraint Interaction in Generative Grammar.* Ms. Rutgers University and University of Colorado.

Sanskrit Vyakaran. (n.d.) SarkariHelp. Retrieved July 21, 2019 from https://sarkarihelp.com/sandhi-ki-paribhasa-aur-udahran/

Tone Sandhi. (n.d.) Wikipedia. Retrieved June 20, 2019 from https://en.wikipedia.org/wiki/Tone_sandhi

Vempaty, P & Nagalla, S. (2011). Automatic Sandhi Splitting Method for Telugu, an Indian Language. *Procedia - Social and Behavioral Sciences 27*. 218–225.

==========