Phonology of Deori: an ‘endangered’ language

DISSERTATION

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BY
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DECLARATION

This is to certify that the dissertation entitled "Phonology of Deori: an 'endangered' language", submitted by me to the Indian Institute of Technology Guwahati, for the award of the degree of Doctor of Philosophy in Linguistics, is an authentic work carried out by me under the supervision of Dr. Shakuntala Mahanta. The content of this dissertation, in full or in parts, have not been submitted to any other University or Institute for the award of any degree or diploma.

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CERTIFICATE

This is to certify that the dissertation entitled "Phonology of Deori: an 'endangered' language" submitted by Ms. Prarthana Acharyya (Registration Number: 136141007), a research scholar in the Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, for the award of the degree of Doctor of Philosophy in Linguistics, is a record of an original research work carried out by her under my supervision and guidance. The dissertation has fulfilled all requirements as per the regulations of the institute and in my opinion, has reached the standard needed for submission. The results in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

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Dear *FAMILY*, this dissertation is for you.
I am thankful for your relentless support, love, and understanding.

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ABSTRACT

This dissertation discusses the phonological characteristics of Deori, a Tibeto-Burman language belonging to the Bodo-Garo group which is listed as a 'definitely endangered' language in UNESCO (2009). Deori is considered an endangered language because of its less number of speakers (Brown, 1895) and lack of intergenerational language transmission (UNESCO, 2009). It is known that language contact has a significant influence on the linguistic structure and this is true of the Bodo-Garo group with respect to phonology, morphology, syntax, and semantics. Assamese, an Indo-Aryan language and the regional language of Assam, a state in Northeast India is in close contact with languages belonging to different language families resulting in asymmetric bilingualism. Bilingualism is widespread in Northeast India and Deori is no exception to this. Native speakers of Deori are competent bilinguals and use Deori and Assamese simultaneously in all social contexts. Thus, it is assumed that close contact with Assamese has had an influence on Deori phonology. The major goal of this work is to discuss the phonological characteristics of Deori which include – the phoneme inventory of Deori, word prosodic structure and prominence pattern of Deori, tone production, and tone perception by different generations and phonological processes such as vowel harmony and nasal harmony. Although there has been some work on Deori before, this is the first time that so many aspects of Deori phonology will be explored in detail and also augmented with acoustic evidence.

The findings show that Deori exhibits iambic stress pattern and no evidence of sesquisyllables were found in the language. Tone is on the verge of extinction in Deori. Acoustic evidence has been presented to show that there is a process of tonoexodus in Deori. Tone reversal is observed in the speech of younger generation speakers. Tone perception test results show that participants associate the low tone word with the high tone word and vice-versa (L>H; H>L) (though not across all words) which conforms to the production test results. The findings also show that Deori has a process of vowel harmony which is close to the vowel harmony pattern of Assamese, languages which are otherwise genealogically distant. Further, the nasal harmony pattern of Deori has been analyzed as per Optimality theory framework. The consonantal changes in Deori, in terms of nasal harmony, highlight some exceptional occurrences attested in the language which shows deviation from the cross-linguistic nasal harmony pattern.

CONTENTS

LIST OF ABBREVIATIONS AND SYMBOLS

ABL	Ablative marker
APPL	Applicative marker
ATR	Advanced Tongue Root
CAU	Causative Marker
DAT	Dative marker
DET	Determiner
FOC	Focus marker
f_0	Fundamental frequency
FUT	Future
Hz	Hertz
IMP	Imperative
INTR	Intransitive marker
LOC	Locative marker
NEG	Negation
OT	Optimality Theory
POSS	Possessive marker
PROG	Progressive
PRED	Predicative suffix
PRES	Present
PST	Past
Pwd	Prosodic word
SEL	Selective marker
SD	Standard deviation
SPA	Spatial Marker
TBU	Tone Bearing Unit
TB	Tibeto-Burman
THM	Thematic marker
TRANS	Transitive marker
VN	Verbal noun
1^{st}	First Person
2^{nd}	Second Person
3^{rd}	Third Person

LIST OF FIGURES

LIST OF TABLES

Chapter 1-Introduction

1.1 General Introduction

In a situation wherein two or more languages exist, the most commonly observed response is that speakers of the subordinate language use their mother tongue in local settings within the community, and use the dominant or influential language or dialect in such socialization spaces which provide the speakers with economic or educational benefit. Thomason and Kaufman (2001) state that the most likely outcome of language contact is that the dominant language of the region exerts at least some influence on the subordinate language which eventually leads to contact-induced language change, language mixture (resulting in pidgins and creoles and bilingual mixed languages), and language death. Language contact inevitably leads to bilingualism. It is noted that "Essentially, the greater the degree of bilingualism, the greater the degree of contact influence; if the contact and bilingualism were minimal, then there might just be a few loanwords adapted to the borrowing language's phonology and grammatical system, but if the contact and bilingualism were of a greater degree there would be an influence in the grammar and phonology of the affected language" (LaPolla, 2009, p. 227). LaPolla (2009) further states that prolonged bilingualism leads to two major situations: (a) speakers of the subordinate language shift to the dominant language of the region as happened with the Mon-Khmer speakers of Burma and Thailand, and (b) the speakers of both the languages maintain and retain their respective languages, but the languages develop certain common structural features. In language contact, lexical borrowing is a common and productive phenomenon, however, the structural similarity is also reflected despite the typological distance between the languages involved (van Coetsem, 1988; Jacobs and Gussenhoven, 2000). Sankoff (2002) states that contact-induced linguistic influence is found in all areas of language structure such as phonology, morphology, syntax, and lexical semantics.

In terms of language contact, Northeast India is home to many languages such as Indo-Aryan, Austro-Asiatic, Tibeto-Burman, and Tai languages. In addition to these language families, the Dravidian language family is also found in Northeast India in recent years. "The Bodo-Garo languages of Northeast India form one of the most clearly bounded and longest recognized subgroups of Tibeto-Burman. The group includes Boro, Dimasa, Tiwa, Rabha, Koch, and Deori in Assam; Garo, Atong, and Ruga in the Garo Hills; and Kok Borok to the south in the state of Tripura" (Burling, 2008, p. 80). "Geographically, Northeast India centers on the Brahmaputra River, which begins as the Tsangpo in Tibet, descends through the Eastern Himalaya as the Siang, and finally carves out the massive, fertile floodplain of Assam before turning southward and draining into the Bay of Bengal" (Post and Burling, 2017, p. 214). Assamese, the regional language of Assam, serves as the lingua franca in the state of Assam. Assamese is spoken by almost all speakers in the state of Assam, even if in many cases as a second language. Language contact has made the Brahmaputra valley of Assam known for its linguistic diversity. The egregious language contact situation has a significant influence on the language use and linguistic structure of the smaller languages in the Bodo-Garo group with respect to phonology, morphology, syntax, and semantics (Haudricourt, 1966; Matisoff, 1976).

Bilingualism is widespread in Northeast India. Deori, a Bodo-Garo language, belonging to the Tibeto-Burman language family, is no exception to this. Native speakers of Deori are competent bilinguals and use Deori and Assamese simultaneously in all social contexts. Jacquesson (2005) posits that "Deori is the most strongly differentiated language within Bodo-Garo, having lost all syllable-final stops and most nasals, at least some of which are retained in all other languages" (as reported in Post and Burling, 2017, p. 226). Burling (2012) states that Deori lacks a large number of cognates which are widespread in the other groups. Deori is classified as a 'definitely endangered' language in UNESCO (2009) and the existing literature on Deori (Brown, 1850; Brown, 1895; Goswami, 1994; Jacquesson, 2005) reports that Deori exhibits unique linguistic feature owing to language contact. The main thrust of this dissertation is to examine the phonology of Deori with some acoustic evidence, and additionally, examine if close proximity to a different language, more prominently to Assamese, has affected the phonological features of Deori.

1.2 Contact-induced linguistic changes

Contact induced language change is inexorable in a social setting where two or more languages are in close contact. Thomason and Kaufman (2001) suggest that the intensity of contact is a major social factor that mediates language change. Linguistic change in languages in contact are numerous, mention may be made of dialects of Pipil (Southern Uto-Aztecan) in which vowel length contrast has lost, /ts/ and /s/ have merged, and voiceless continuants no longer exist

(Campbell and Muntzel, 1989, p. 186). Goodfellow (2005) reports contact-induced phonological changes such as loss of word-medial glottal stop and the frequent loss of glottalization in consonants resulting in phonological neutralization in $K^{w}ak^{w}ala$ speaking (Wakashan) people of British Columbia as a result of influence from English. Pan (2004) reports that the Taiwanese voiced obstruent series is realized as prenasalized stops owing to language contact with Mandarin. Chaudangsi language, belonging to the Tibeto-Burman language family of the Pithoragarh District of Uttar Pradesh, India, have developed retroflex stop consonants and co-relative structures as a result of language contact (Krishan, 2001). In Northeast India, languages of different genealogical status share common linguistic features and this is due to longstanding language contact. For instance, a similar morphological structure is found among Tibeto-Burman subgroups such as Boro-Garo, Ao, Tani, and Idu-Tawrã, which are otherwise genealogically distant.

Contact induced tonal variation is also evident in many languages. While contact-induced tonal development is well-attested in the literature, contact-induced tonal variation is also reported in the existing literature. Schadeberg (2009) reports that tone language such as Swahili and the Northwest Mandarin Chinese variety, spoken in Wutun have lost their tonal distinctions owing to language contact with speakers of atonal languages. Zhang *et al.* (2011) report tonal variations in Wuxi dialect as a result of language contact with Putonghua. T4 tone in Wuxi dialect is merging with T2 and T6 owing to language contact. Noonan (2008) states that contour pitch distinctions that characterized the earlier Tamangic system are lost as a result of language contact with Nepali. Hildebrandt (2003) states that in Manage, tonal distinctions have reduced (in some speakers), owing to increased use of Nepali. In Assam, it is assumed that intense language contact of the tonal languages with non-tonal languages such as Assamese and Bengali (Indo-Aryan languages) has resulted in the reduction of tonal categories. For instance, Bodo belonging to the western boundaries of Northeast India in close contact with Assamese and Bengali exhibits only two lexical tones whereas Mizo belonging to the eastern boundaries of Northeast India and not close to tonal languages have four tonal categories. With a brief background on contact-induced linguistic changes, the next section discusses language endangerment with special reference to Deori.

1.3 Language endangerment and Deori

Fishman (1997), Grenoble and Whaley (2006), and Sallabank (2010) state that a working definition of an endangered language is a language situation where the native speakers cease to learn their mother tongue in response to an environment where their native language is not advantageous to them anymore. As the group of native speakers shrinks, the subordinate language undergoes language attrition leading to language endangerment (Krauss, 1992). UNESCO (2003a) mentions that languages are dying off rapidly and that at least half of the world's 6,000 languages are losing speakers and are likely to disappear by the end of this century. UNESCO (2003a) also posits that both external factors such as military, economic, religious, cultural, or educational subjugation and internal factors such as a community's negative attitude towards its language motivate language endangerment. People's language choice depends on a constellation of factors such as openness of the community (Lewis, 1985), urbanization, industrialization, and modernity (Gal, 1979), and people's social characteristics such as age, education, gender, and place of residence (Huang, 1988). The development of a language depends on the native speakers' positive attitude towards their heritage language which has a decisive influence on the survival of the language. A language is moribund when there is a reduction in the number of speakers, low competency in the heritage language, interruption of intergenerational language transfer and a drastic shift to the dominant language accompanied by a feeling of the heritage language being "inferior" to the dominant language (Krauss, 1992; Austin and Sallabank, 2011). The languages under pressure show shifting age profiles where it is the older generation speakers who continue speaking in the threatened language, and the younger generation shifts to the more powerful, dominant, and influential language of the region. The visibility of an endangered language declines as it is not taught in schools and has no official or national language status. While language loss becomes imminent in this situation, this also leads to the incorporation of various linguistic features of the language that the indigenous language is in contact with. The most salient factor that determines the vitality of a language is intergenerational language transmission.

Deori is listed as a 'definitely endangered' language in UNESCO (2009) which suggests that the language is no longer learned and spoken by the younger generation[1]. Brown (1895) in his

[1] As per the six degrees of endangerment listed in UNESCO (2003a), 'definitely endangered' language refers to a language which is mostly used by parental generation and up.

monograph categorizes Deori as the smallest of the Bodo-Garo languages based on the number of speakers. Brown reports a total of 4000 Deori speakers in the entire Deori community and notes that "Deori is different from other Bodo-Garo languages and a moribund language" (1895, p. 3). Burling lists Deori as a "little-known language which appears to be rather deviant" (2003, p. 177). Jacquesson (2005) explains Deori as a discrete group concentrated in Lakhimpur district, mainly by the Dibongiyas[2] who have retained the language so far. Van Driem states that Deoris are mainly settled down in Sivsagar and Lakhimpur districts of Upper Assam and "one would have to make an effort to localize them" (2007, p. 319). Unlike these predictions, Acharyya and Mahanta (2019) following the nine factors outlined in UNESCO (2003a) have shown that intergenerational language transmission is not completely hindered and younger generation speakers grow up learning Deori as their mother tongue. At the same time, it has also been highlighted that since Deori is in intense contact with Assamese, and all the native Deori speakers are competent bilinguals and for non-disruptive survival of Deori in the indefinite future, some measures have to be taken which includes developing some methods, materials, and means for teaching young children. The language vitality assessment, as reported in Acharyya and Mahanta (2019), shows that persistent bilingualism has not affected native Deori speakers' attitudes toward their language and the speakers have a positive inclination for the development of the language. Furthermore, Ethnologue (2019) has listed Deori as a 'developing' language which earlier listed Deori as an 'endangered' language. A summary of the language vitality assessment as reported in Acharyya and Mahanta (2019) has been discussed in chapter 7. Although in Acharyya and Mahanta (2019) language contact has been shown to not influence the positive attitude of the speakers, one of the aims of this dissertation is to understand if language contact has interfered with the phonological features of Deori.

1.4 Deori

Deori, also known by its endonym *Jimosaya* 'children of the sun and the moon' (Jacquesson, 2005), is a Tibeto-Burman language (Burling, 2003) spoken in the Northeastern States of Assam and Lohit and Changlang districts of Arunachal Pradesh. Brown (1895) has mentioned that the

[2] Deori has four territorial groups – Dibongiya, Patorgoyan, Tengaponiya, and Borgoyan. The territorial groups of Deori are discussed in detail in section 1.4.

Deoris were originally inhabited in the region beyond Sadiya[3]. Later they migrated to different areas of the Brahmaputra valley from Sadiya in the 17th, 19th, and 20th centuries due to various natural and socio-political causes (Deori, 2009). At present, they are mainly concentrated in Lakhimpur, Dhemaji, and Sonitpur districts of the north bank of the Brahmaputra valley and Tinsukia, Dibrugarh, Sibsagar, and Jorhat districts of the south bank of the Brahmaputra valley. They preferred the banks of the tributaries of river Brahmaputra as their place of settlement (Deori, 2009). Most of the Deori speakers are concentrated in the areas of Lakhimpur, Dhemaji, and Jorhat districts (highlighted by circles in Figure 1.1). Data for the present study has been collected from Bordeori village in Lakhimpur district and Upor Deori and Naam Deori villages in Jorhat district. Lakhimpur and Jorhat districts were chosen for data collection because they share the same language variety and have close connections, kinship, marriage, etc. A district map of Assam is shown in Figure 1.1 below. Dhemaji, Lakhimpur, and Jorhat districts are highlighted by circles.

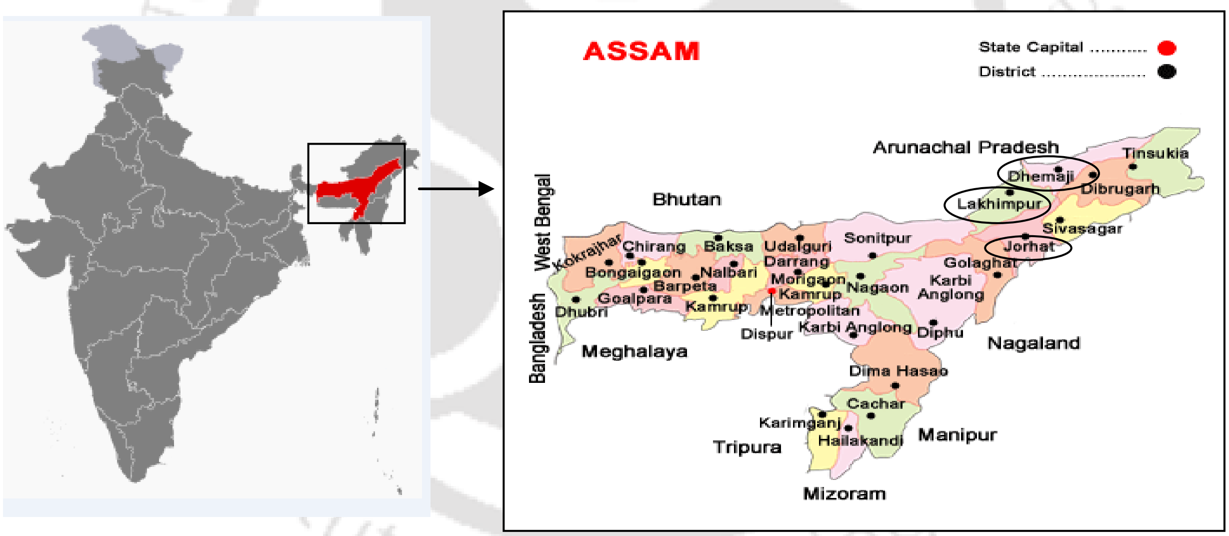

Figure 1.1: District map of Assam. (Source: https://assam.gov.in/assam-maps)

The Deori community is broadly divided into four main territorial groups: the Dibongiya, the Patorgoyan, the Borgoyan, and the Tengaponiya (Goswami, 1994; Jacquesson, 2005; Deori, 2009; Saikia, 2013). The classification of the four groups is based on the location around which they inhabited (Saikia, 2013). The Dibongiyas inhabited near the Dibang River, and hence they are called Dibongiyas. The Patorgoyans settled in a place called pat Sadiya in the extreme

[3] A place and subdivision of Tinsukia district of the Northeast Indian state of Assam.

eastern corner of Assam. The Borgoyans settled near the mighty Brahmaputra or Borluit, and the Tengaponiyas near the river Tengapani (Saikia, 2013). Presently, the Patorgoyan community has completely disappeared, and it is believed that during migration the Patorgoyans have merged with the other three communities, viz, the Dibongiyas, the Tengaponiyas, and the Borgoyans (Saikia, 2013). Among these three communities, the Borgoyan and the Tengaponiya community have completely shifted to Assamese in recent years (Goswami, 1994; Jacquesson, 2005). However, it is worth mentioning that despite their shift to Assamese, all social functions and religious rituals are practiced by the Borgoyan and the Tengaponiya communities following Deori customs (Deori, 2002). The Dibongiya community is found mainly in Lakhimpur and Jorhat districts of Assam (Goswami, 1994).

The term Deori is attached to the religious or priestly functionaries of various tribal and non-tribal communities of Assam (Kakati, 1948; Bose, 1967). Kakati (1948) mentions that the word Deori originated from the Sanskrit word *deva grhik*. The Deoris are considered to be "the old priestly caste and they perform the sacrificial ceremonies of the Ahom Kings" (Goswami, 1994:9). Even today the Deori community is better known for their religious devotion and maintaining their traditional beliefs and practices (Deori, 2002; Deori, 2004). Goswami (1994) states that Deoris follow a certain animistic religious tradition. It has been noted that "the Deoris have adopted Hindu religious practice as a result of constant contact with the Assamese community mainly in the state of Assam, but their original religious practice is a blend of animism and superstitious beliefs" (Deori, 2009, p. 4). They self-identify themselves as worshippers of *Kundimama*, whom they consider as the supreme power of nature and the creator of the universe (Deori, 2002). As per animistic beliefs, the chief deities of the Deoris are *Kundimama* or *Gira-Girasi* or *Bura-Buri*, *Pisa-Dema*, or *Baliababa*, and *Pisasi-Dema* or *Tamreswari* or *Kesaikhati* worshipped by Dibongiya, Tengaponiya, and Borgoyan community respectively (Goswami, 1994; Deori, 2002; Deori, 2009). The Patorgoyans, who have reportedly become extinct, propitiates the deity of the *Patorshal* at Pat- Sadiya (extreme eastern corner of Assam) (Goswami, 1994; Deori, 2002).

The extant literature (Brown, 1850; Brandreth, 1877; Brown, 1895; Grierson, 1909; Goswami, 1994; van Driem, 2007) on Deori associates the Deori language with the Chutiya language, "the original language of Upper Assam" (Brown, 1895, p. 5). These researchers have classified Deori-Chutiya under the Bodo-Garo group and considered Deori-Chutiya as the original language of the Chutiya community. The researchers have presented the cognate sets of Chutiya language and have referred it as the lexicon of the Deori-Chutiya language. However, the Deori community nullifies connection with the Chutiya community altogether. It has been noted that "Deoris are completely different from the Chutiya community, linguistically and ethnically. There is no commonality in the language of the two communities. There is not a single word in Deori vocabulary which matches the Chutiya language and vice-versa. No semblance of the traditional societal bond has also been traced between these two communities" (Deori, 2002, p. 11). Deori (2002) and Deori (2004) further state that the present generation believes that the Deoris are an indigenous group who settled in the Sadiya region before the migration of the Chutiyas to those areas and they were the priests of the Chutiya community instead of a branch of the Chutiya community. The speculation of relatedness between the Deori language and the Chutiya language is perhaps due to the reason that the Deoris belong to the priestly section and performed all religious rituals in the Chutiya Kingdom. Jacquesson (2008) also nullifies the association of the Deoris with the Chutiyas and states that the linguistic features[4] that have given Deori its "specific shift show that this language was shaped in the northeastern parts of Assam close to the Dibang valley" (p. 30), where there is no trace of the Chutiyas being settled in that particular area rather the Chutiyas were spread across Upper Assam.

1.4.1 Genetic affiliation of Deori

Grierson (1909) mentioned that Deori as a sub-group of Bodo-Garo language family exhibits an archaic grammatical form which makes the language distinct from other Bodo-Garo languages. Burling (2003) places Deori in the Bodo-Koch group. Burling's classification of Deori in the Bodo-Koch group instead of Bodo-Garo is that "Garo is closer to Bodo than to Koch, which is why I prefer to call the larger group Bodo-Koch" (176). Burling classifies Deori as a "little-known language and appears to be rather deviant" (2003, p. 176) and is farther away from its sister languages. It is somewhat excluded from the main branching which otherwise connects the other languages of the group. Jacquesson (2005) and Joseph and Burling (2006) classify Deori as a Bodo-Garo language and state that the features of Deori language are unique, unlike other

[4] Jacquesson (2005) here mainly refers to the presence of nasalized vowels in Deori, a rare feature among other Bodo-Garo language which is an outcome of language contact with the Tani and some Mishmi languages in the Dibang valley region.

Bodo-Garo languages. The classification of the Bodo-Garo group as proposed by Joseph and Burling (2006) is shown in Figure 1.2.

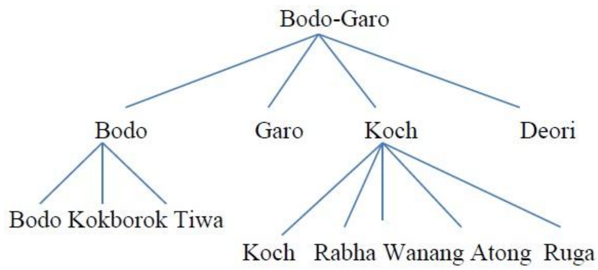

Figure 1.2: Bodo-Garo language family tree as proposed by Joseph and Burling (2006).

Figure 1.3 below shows the geographical distribution of Deori as shown in Burling (2003). It can be seen in the map that Deoris are mainly concentrated in the eastern parts of Assam and is surrounded by languages of the Tibeto-Burman group.

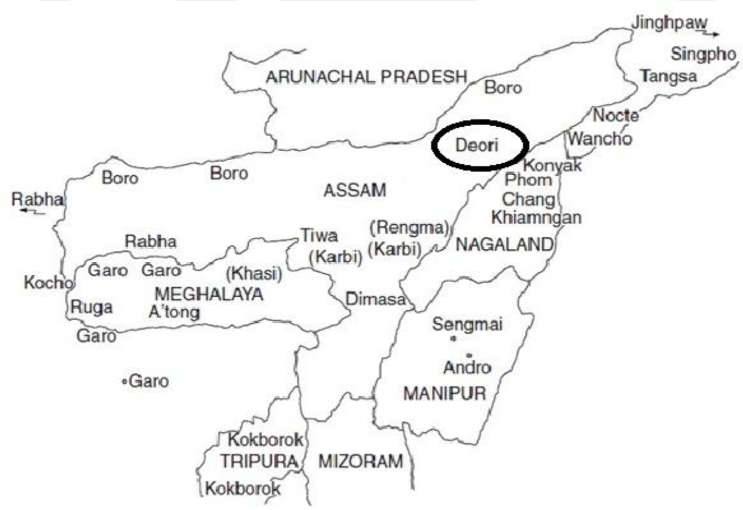

Figure 1.3: Map of language distribution of Bodo-Konyak-Jingphaw in Northeast India (Source: Burling, 2003, p. 176)

Assam is a land of diverse languages incorporating Indo-Aryan, Austroasiatic, Dravidian, and Tibeto-Burman language families. Assamese is the regional language of Assam and is the easternmost language in the Indo-Aryan language family. The 2011 census[5] estimates a total population of Assam as 31,205,576. As per the census, 1.5 million speakers speak Assamese as their first language, i.e., 48.37% of the total population of Assam speaks Assamese and rest

[5] Information accessed from the website of the Office of the Registrar General, Government of India (2011). Census of India 2011: India, States and Union Territories. *Table C-16*; accessed on 25th July, 2018 http://censusindia.gov.in

speaks other Indo-Aryan languages such as Bengali (28.92%), Hindi (6.73%), Nepali (1.91%), Punjabi (0.39%); Austroasiatic language such as Khasi (0.13%); Dravidian languages such as Malayalam (0.01%), Tamil (0.01%), Telugu (0.08%); and Tibeto-Burman languages such as Bodo (4.54%), Karbi (1.64%), Dimasa (0.42%), Deori (0.08%), Koch (0.04%), etc.

1.4.2 Population and the total number of speakers in Deori

Reports regarding the total number of speakers in Deori date back to 1895 when the first comprehensive grammatical description of Deori was published by W.B. Brown. Brown (1895) reports only 4,000 Deori speakers in the entire Deori community. The 1951[6] census estimates the total population of Deori as 12,503 and 6,715 as the total number of speakers. The 1961[7] census estimates a total number of 9,103 speakers out of the total population of 13,876. The 1971[8] census estimates 23,080 as the total Deori population and 14,937 as the total number of speakers. The 1991 census counts a total number of 35,849 Deori population and 17,901 as the total number of speakers. The 2001 census estimates 27,960 speakers out of 41,161 total Deori population. The Deori Autonomous Council, established under the Deori Autonomous Council Act 2005, estimates the Deori population to be 200,000. Jacquesson (2005) lists only 10,000-15,000 speakers in the Deori community (Jacquesson's source seems to be hearsay from community members). UNESCO (2009) reports 28,000 Deori speakers and the recent 2011 census report estimates 32,376 Deori speakers (16,234 males and 16,142 females) out of the total Deori population of 43,750 (21,987 males and 21,763 females). The data regarding the Deori population and number of speakers are summarized in Table 1.1.

[6] Information accessed from Census of India 1951: General Population Tables, Summary Figures for Districts, Social and Cultural Tables and Land Holdings of Indigenous Persons. Part IIIA; accessed on 10th July, 2018 http://censusindia.gov.in.

[7] Information accessed from the website of Department of Plain Tribes and Backward Classes, Government of Assam.

[8] Information regarding total population and total number of speakers of Deori from 1971-2011 is accessed from the website of the Office of the Registrar General, Government of India (2011). Census of India 2011: Growth of Non-Schedule Languages 1971-2011. *Statement 8*; accessed on 25th July, 2018 http://censusindia.gov.in

Reports	Total Deori Population	Decadal Growth		Total number of Deori language speakers	Decadal Growth	
		Absolute	Percent (in %)		Absolute	Percent (in %)
Brown (1895)	-	-	-	4000	-	-
1951 (Census)	12,503	-	-	6715	2715	67.87
1961 (Census)	13,876	1373	10.98	9103	2388	35.56
1971 (Census)	23,080	9204	66.33	14,937	5834	64.08
1981	No census			No census		
1991 (Census)	35,849	12769	55.32	17,901	2964	19.84
2001 (Census)	41,161	5312	14.81	27,960	10059	56.19
Deori Autonomous Council (2005)	200,000	158839	385	-	-	-
Jacquesson (2005)	-	-	-	10,000-15,000	-12960	-46.35
UNESCO (2009)	-	-	-	28,000	13000	86.6
2011 (Census)	43,750	2589	6.28	32,376	4376	15.62

Table 1.1: Total population of Deori as reported in census data 1951-2011 and by various authors and organizations.

The growth rate of the total population was highest in the year 1971 with 66.33% and lowest in 2011 with 6.28%. Similarly, the growth rate of the total number of speakers was highest in the year 2009 as reported by UNESCO (2009) with 86.6% and lowest in 2011 with 15.62%. However, the total population reported by Deori Autonomous Council is completely at variance with all other reported data on population, showing an increase of 385% in the population growth of Deori in the year 2005. Unfortunately, the Deori Autonomous Council has not included data regarding the total number of Deori speakers, and Jacquesson (2005) and UNESCO (2009) have not included data regarding the total number of population (as these two can be different). A comparison of the 1951 census with the 2011 census highlights that the population growth rate and the absolute number of speakers (except Jacquesson (2005)) are increasing after every decade.

1.4.3 Deori in the literature

The important documentation available in Deori is Brown (1895), Goswami (1994), and Jacquesson (2005)[9]. Brown (1895) and Goswami (1994) have documented the language background of Deori and have presented a grammatical description of Deori. Jacquesson (2005) is the first complete grammatical work on the Deori language and it gives a detailed analysis of the language's morpho-syntax. Deori Sahitya Sabha, a literary organization, founded in the year 1965, announced the use of the Assamese script as the main script for writing in Deori. Writings in Deori language using the Assamese script include pedagogical texts, prayer books, grammar books, and dictionaries. Some research conducted on Deori includes Ph.D. dissertations mainly on the geographical analysis of the migration and cultural transformation of Deoris in Assam (Deori, 2009), socio-linguistic analysis of the Deori speech community (Saikia, 2010), a semantic analysis of Deori (Nath, 2010)[10], and socio-cultural analysis of the lives of the Deoris (Deori, 2016). There were also research projects taken up by the Central Institute of Indian Languages (CIIL), Mysore, under the North Eastern Language Development Project on "Development of Deori Language", in 2004-2006. The Indian Institute of Technology, Guwahati has also completed a research project on "A phonological and sociolinguistic study of variation in Deori" during the year 2012-2014 funded by the Indian Council of Social Science Research (ICSSR), New Delhi. The Anundoram Barooah Institute of Language and Culture (ABILAC) in collaboration with Deori Sahitya Sabha, has published bilingual and trilingual dictionaries intending to preserve the language.

[9] It is worth mentioning that Brown (1850) and Grierson (1909) also include a description of the Deori language, but these works are not exclusive works on the Deori language. Brown (1850) is a book on the native languages of North East India and Grierson (1909) is a volume on Tibeto-Burman languages. In both the works a brief overview of Deori phoneme inventory has been discussed.

[10] The dissertation is mainly on the lexico semantic study of Tiwa and Deori, two endangered languages of the Tibeto-Burman family.

1.5 Data Collection

The data set incorporated in this dissertation is based on primary data collection from native Deori speakers through field studies for 5 years[11]. Data were recorded from Lakhimpur and Jorhat districts of Assam. These areas were selected for data collection for the reason that the majority of the Dibongiya community speakers reside in these areas (discussed in detail in section 1.4).

The first round of data collection was for the analysis of phoneme inventory in Deori. For this, the data was developed from the Swadesh list. The list was elicited and was recorded from native speakers of Deori. While eliciting the word list we came across many words that were borrowed from Assamese and English and the borrowed words were ruled out from the recording procedure. Since Deori uses the Assamese script as their main script for writing the words were elicited in Assamese.

During the elicitation and the recording procedure, a handful of homophonous words were found which highlighted that there is a process through which these homophonous words are differentiated. Referring to Brown (1895), Goswami (1994), and Jacquesson (2005) it became evident that Deori differentiates the homophonous words either through tone or intonation or nasalization. Based on the previous works (Brown (1895), Goswami (1994), and Jacquesson (2005)), a data list consisting of minimal pairs was prepared and elicited with the help of native Deori speakers and subsequently recording was done to examine the tonal distinction in Deori.

Further, the native Deori speakers used the orthographic symbol (ঁ)[12] while eliciting the data. It hinted to the presence of nasalization in the language. After a detailed overview of the relevant literature on Deori, it was discernible that Deori exhibits nasal vowels. However, no exhaustive analysis of the process of nasalization was available in the relevant literature on Deori. As such, considering the presence of nasalization in Deori and referring to the previous works, a data list was prepared and elicited which consists of both derived and non-derived lexical items. During the elicitation and the recording procedure of the data list on nasalization, the process of nasal harmony became apparent which spreads not only within roots but beyond the root boundary. Besides, another phonological process, vowel harmony in Deori, was evident in Deori. Thus, a data set was prepared for recording with all possible vowel sequences to analyze the vowel

[11] I have been working with the native Deori speakers from 2010.
[12] This orthographic symbol is used in Assamese to denote nasalization.

harmony process in Deori. While analyzing the data it was noticeable that the vowel harmony process in Deori was akin to the Assamese nasal harmony pattern[13].

During the elicitation of data, we requested the native speakers to translate the sentence “I X said” (here ‘X’ represents the target word) to Deori which was used for recording all data set. A fixed sentence frame was chosen for recording the data to avoid the intonational boundary effect. A total of 384 lexical items were recorded during field studies. The compiled data is presented in Appendix of this dissertation. The data consists of monosyllabic words, disyllabic words, derived and non-derived disyllabic lexical items, and a few trisyllables. Some valuable works available in Deori include Brown (1895), Goswami (1994), and Jacquesson (2005). However, an exhaustive analysis of the prosodic properties, tone, and phonological processes was not available in the existing literature. This dissertation presents a detailed study on the phonological properties of Deori and it is the first time that phonological processes, prosodic properties, and tone have been analyzed with primary data, collected for 5 years through field studies from native Deori speakers.

1.6 Aim of the dissertation

The main aim of this dissertation is to provide a detailed description of the phonological features of Deori. It aims to look at the contact-induced phonological changes in Deori (if any) and in this process, the phonological characteristics of Deori are examined in detail.

At the outset, the research aims to explore the phoneme inventory of Deori. It also aims to look at the word prosodic structure of Deori and word-level prominence pattern in Deori.

Since tone is a typical Tibeto Burman feature this dissertation aims to examine tonal distinctions maintained by younger generation speakers of Deori. The rationale behind choosing younger generation speakers is that very recently Mahanta *et al.* (2017) have shown that tone is minimally attested in Deori and is on the verge of extinction. The results reported in Mahanta *et al.* (2017) are based on the speech of older generation speakers. Hence, the interest in this work is to examine tonal distinctions maintained by younger generation speakers. This will further shed light on the status of lexical tones in Deori by different generations. It also examines the influence of language experience on the perception of lexical tones in Deori through a perception experiment that incorporates both older and younger generation speakers.

[13] Apart from similarities there are some dissimilarity in the vowel harmony pattern in both the languages, i.e., Deori and Assamese which is discussed in detail in Chapter 5.

The research also aims to describe the phonological processes such as vowel harmony and nasal harmony in Deori. The discussion of vowel harmony and nasal harmony is analyzed within the framework of Optimality Theory (Prince and Smolensky, 1993/2004). It is to be kept in mind that this dissertation is not a full-fledged theoretical analysis of Deori phonology. The Optimality theoretical analysis of vowel and nasal harmony has been incorporated in this study to illustrate the similarities of Deori vowel harmony pattern with that of Assamese, and to examine whether Deori conforms to the cross-linguistic typology of nasal harmony pattern. The discussion will show that in terms of vowel harmony, Assamese and Deori share a common vowel harmony pattern and can be analyzed descriptively and theoretically in similar ways. However, in terms of nasal harmony, it will be shown that Deori nasal harmony pattern cannot be straightforwardly analyzed following the unified analysis of the nasal harmony pattern formulated by Walker (1998).

1.7 Organization of the dissertation

To attain the aim of the dissertation, this research work is broadly classified into seven chapters. The chapters of this dissertation are organized in the following manner:

Chapter 1 *Introduction* - This chapter delineates the motivation of the research under consideration. It also gives a brief account of language contact, language endangerment, and language background concerning the Tibeto-Burman language family. Subsequently, this chapter discusses the aim of the dissertation, and in the end, an outline of the chapters and their arrangement in the dissertation is presented.

Chapter 2 *Distinctive phonemes in Deori* - This chapter aims to ascertain the number of contrastive phonemes in Deori. It gives an overview of the phonological features of the phonemes. A distinctive feature representation of the speech sounds in Deori is also taken into account.

Chapter 3 *Word Prosody and Prominence pattern in Deori* - The main goal of this chapter is to examine the word prosodic structure and word-level prominence pattern in Deori. The main focus is to analyze the word-internal structure in Deori concerning the Prosody Hierarchy (Selkirk, 1980).

Chapter 4 *Production and Perception of Tone* - This chapter aims to look at the tonal distinctions maintained by younger generation speakers. It also investigates the process of tone perception in Deori to examine how well a speaker perceives the contrastive lexical items and to investigate the impact of language experience on pitch perception. Production and perception experiment results unveil a process of tonoexodus in Deori owing to language contact with Assamese, a non-tonal language.

Chapter 5 *Vowel Harmony* - This chapter examines the vowel harmony pattern attested in Deori. This chapter mainly concentrates on the trigger and target segments of vowel harmony, the elements that block vowel harmony, and the directionality of vowel harmony in Deori. The analysis is couched within the framework of Optimality Theory (henceforth OT, Prince, and Smolensky 1993/2004). The descriptive and theoretical illustrations in this chapter highlight the similarities between Deori and Assamese vowel harmony patterns.

Chapter 6 *Nasal Harmony* - This chapter presents an analysis of the nasal harmony pattern attested in Deori. It discusses segments that allow and resist the spread of nasalization in Deori. In this process, the segments' compatibility with nasalization is taken into account within the unified typology formulated by Walker (1998). The Optimality theoretical analysis shows that Deori does not agree with the cross-linguistic nasalizability hierarchy scale. The exceptional occurrences of suffixal alternation indicate the emergence of a nasal harmony pattern in Deori which shows a deviation from the cross-linguistic nasal harmony pattern.

Chapter 7 *Conclusion* - This chapter presents a summary of the findings. In addition to this, the scope of future work is also highlighted.

Chapter 2 - Distinctive Phonemes in Deori

2.1 Introduction

Despite a large number of possible speech sounds, a language exploits only a small set of sounds to construct its phonology. This chapter presents a detailed analysis of the segmental phonology of Deori. In doing so, feature representation of the Deori phonemes is taken into account within the distinctive feature theory. The theory of distinctive feature was first developed by Trubetzkoy (1939). Since then, the theory was enormously expanded by Jakobson, Fant, and Halle (1952), which was subsequently revised by Jakobson and Halle (1956). The distinctive feature theory focusing mainly on articulatorily oriented features is derived from Chomsky and Halle (1968). The major goal of distinctive feature theory is to distinguish a set of features suitable for representing the segmental contrasts of the world's languages (Gussenhoven and Jacobs, 2005). Features are universal and these universal features are employed to represent the segmental system of a language in a language-specific way (Kenstowicz, 1994). Distinctive features represent a group of natural class segments such as: major class features, place features, tongue-body features, and manner features. The major class features [sonorant], [consonantal], and [syllabic] include associating sounds into functional types that include the distinction between vowels and consonants. Place feature [coronal] and [anterior] defines the consonantal place of articulation. Manner features [continuant], [nasal], [lateral], and [delayed release] are related to the manner in which a segment is produced. Tongue-body features/vowel features such as [high], [low], [back], and [round] which are used to distinguish vowels, also play an important role in defining consonants such as velar, uvular, and pharyngeal consonants. The laryngeal features [±spread glottis], [±constricted glottis], [±stiff], [±slack], introduced by Halle and Stevens (1971) distinguishes voiceless aspirated and voiceless unaspirated segments in the stop and the affricate series and also to distinguish modal voice vowels from creaky voice vowels. Features are specified by binary values, which represent segments with two values [+F] and [-F]. Features can be distinctive in one language and non-distinctive in another language. For instance, in Korean, the feature [±spread glottis] is distinctive as the language has contrastive minimal pairs on aspiration (e.g. /tal/ 'moon' vs. /t^hal/ 'mask'), but non-distinctive in English as voiceless aspirated stops [p^h, t^h, k^h] are the allophonic realization of voiceless unaspirated stops /p, t, k/ (Kean, 1970). Cross-linguistically, some features are more likely to occur in correspondence to others, which is in the domain of markedness theory[14]. The more likely feature specification of a segment is termed *unmarked* and the unlikely feature specification of a segment is termed *marked* feature. For instance, nasal vowels are marked than oral vowels, aspirates and glottal segments are marked in a phonological inventory of a language compared to its unaspirated and unglottalized segments.

This chapter presents a detailed analysis of the segmental phonology of Deori based on the speech data collected from Deori native speakers of Bordeori village of Narayanpur, Lakhimpur district, and Naam Deori and Upor Deori village of Jorhat district of Assam. Before commencing on the phonological feature analysis of the phonemes based on collected speech data, an overview of the segmental phonology of Deori available in the existing literature is presented to highlight the commonalities and the irregularities of the segmental inventory of Deori.

The organization of the chapter is as follows: Section 2.2 and 2.4 enumerate a detailed overview of the consonants and vowels in the language and highlight the commonalities and irregularities in the description of the phoneme inventory as reported in the existing literature. Section 2.3 and section 2.5 discuss the consonant and vowel inventory of the language based on the collected speech data and section 2.6 summarizes the findings.

2.2 Deori consonants: a literature review

This section presents a detailed literature review of the Deori segmental properties elaborately described in the works of Brown (1850), Brown (1895), Goswami (1994), Jacquesson (2005), Nath (2012), Deori (2012), and Saikia (2013). While reviewing the literature on the phoneme inventory of Deori, IPA symbols of the phonemes are used alongside the generic alphabets[15] or non-standard symbols used by the researchers.

Brown (1850) reports eighteen consonants in Deori[16] (as cited in Jacquesson, 2005). The phoneme inventory in Brown (1850) comprises of six obstruent stops /p, b, t, d, k, ɡ/, three nasal consonants /m, n, ŋ/, three fricatives /s/, <sh>, /h/, three affricates <j>, /ts/, <ch>, two liquids /l, r/, and one glide <y>. We follow the IPA conventions to represent the phonemes identified in

[14] The theory of markedness has played a central role in phonology since its inception in 1930s by Trubetzkoy and Jakobson.

[15] The generic alphabets or non-standard symbols used by the researchers are presented within brackets '< >' and the IPA symbols of the phonemes are presented surrounded by '//' in transcription.

[16] The description of Brown (1850) is derived from Jacquesson (2005). Jacquesson (2005) presents a list of words from Brown (1850) which shows the existence of the total number of phonemes in Deori.

Brown (1850): <sh> is voiceless palato alveolar fricative /ʃ/ (for example: <sha> ~ /ʃa/ ‘one’); <j> is voiced palatal-alveolar affricate /dʒ/ (for example: <ji> ~ /dʒi/ ‘water’); <ch> is palatal alveolar affricate /tʃ/ (for example: <chi> ~ /tʃi/ “blood”); and <y> is palatal approximant /j/ (for example: <ya> ~ /jɑ/ “moon”). Brown explains that voiceless alveolar affricate /ts/ occurs only word-initially: e.g., *tsima* “mother”, *tsagu* “road” and *tsinga* “fish” and not elsewhere.

Brown (1895) reports twenty consonants in Deori. The consonant inventory in Brown (1895) comprises of six obstruent stops /p,b,t,d,k,g/, three aspirated obstruent stops /t^h, k^h,d^h/, three nasal consonants /m/,/n/,<ng>, three fricatives /s/,<sh>,/h/, two affricates <ch,j>, two liquids /l,r/, one glide <y>. Brown states that the voiceless alveolar fricative /z/ does not occur in the language and the alveolar and the velar nasal /n/ and <ng> are often dropped in the syllable-final position. Brown states that aspirated obstruent stops /t^h/, /k^h/, and /d^h/ are phonemic in Deori. Following the IPA convention of representing the phonemes, <sh> in Brown is voiceless palato alveolar fricative /ʃ/ (for example: <mishi> ~ /miʃi/ “wife”, <mousha> ~ /mouʃɑ/ “child”); <ng> is voiced velar nasal /ŋ/ (for example: <sing> ~ /siŋ/ “salt”, <*ding*> ~ /*diŋ*/ “grandfather”); <ch> is palatal alveolar affricate /tʃ/ (for example: <chi> ~ /tʃi/ “blood”, <chimi> ~ /tʃimi/ “tail”); <j> is voiced palatal alveolar affricate /dʒ/ (for example: <jabura> ~ /dʒɑburɑ/ “vegetables”, <jiti> ~ /dʒiti/ “star”) and <y> is palatal approximant /j/ in IPA (for example: <yua> ~ /juɑ/ “bamboo”).

Goswami (1994) reports twenty consonants in Deori. The consonants are six obstruent stops /p,b,t,d,k,g/, three nasal consonants /m/,/n/,<ṅ>, five fricatives /s/,/z/,<ś>,/x/,/h/, two affricates <c>, <j>, two liquids /l,r/ and two glides <y>, /w/. Goswami suggests that the palatal voiceless fricative <ś> (equivalent to /ç/ in IPA: e.g., *çu* “bark”, *çui* “high”) is rare in the language and is not found occurring finally. Except for voiceless velar fricative /x/, all the consonants occur initially and medially. The phoneme /x/ occurs only word-initially (for example: *xouba* “there”, *xidu* “to enter”). The IPA symbol of phoneme <ṅ> is /ŋ/ (for example: <ṅada> ~ /ŋada/ “verandah”, <ṅi> ~ /ŋi/ “cloth”, <ṅe> ~ /ŋe/ “fire”). Goswami states that velar nasal /ŋ/ occurs both word-initially and word-finally. The consonants licensed to the final position are the voiceless stops /p, t/, the nasals /m, n, ŋ/, and the liquids /l, r/. The IPA symbol of the phonemes <c> and <j> in Goswami (1994) are voiceless palatal alveolar affricate /tʃ/ and voiced palatal alveolar affricate /dʒ/ respectively.

Jacquesson (2005) reports seventeen consonants in Deori. This includes six obstruent stops /p,b,t,d,k,g/, three nasal consonants /m,n,ŋ/, two fricatives /s,h/, two affricates /tʃ,dʒ/, two liquids

/l/,[r], and two glides /j/, [w]. Liquid [r] and approximant [w] are the allophonic variations of liquid /l/ and bilabial plosive /p/ respectively. The phoneme /l/ is licensed to occur at the beginning of a word and [r] occurs elsewhere except the beginning of the word. Jacquesson (2005) posits that /l/ occurring intervocalically (for example: *biloni* "plant for rice-beer", *bilahi* "tomato", *gila* "knee-cap"[17]) and [r] occurring word-initially (for example: *roja* "king", *roŋ* "colour") are borrowed Assamese words[18]. Labial approximant [w] which is a conditioned variant of bilabial plosive /p/ occurs intervocalically mainly in compound words such as *hela-wa*[19] "this", *gime-wa* "respectable person". Jacquesson (2005) further states that except for /ŋ/, [r], and [w] all other consonants occur word-initially. Coda consonants are rare in Deori. Only the nasal consonants /m, n, ŋ/, and liquid [r] occurs word finally. He further states that the velar nasal /ŋ/ in the coda position mostly gets deleted inducing nasalization of the preceding vowels and hence its occurrence in the language is very rare. However, there are a few lexical items with velar nasal /ŋ/ in the final syllable such as *kiŋ* "hair", *siŋ* "salt", *guŋ* "grasshopper", *yuŋ* "insect, worm", and *yeŋ* "ginger". He further states that *guŋ* "grasshopper" is today pronounced as *gũ*, however, words like *kiŋ* "hair" and *siŋ* "salt" are pronounced with velar nasal /ŋ/ in the final position. Jacquesson also posits that there is a suffix *-ŋ* "honorific marker" which gets attached to kinship terms such as *ba-ŋ* "father", *yo-ŋ* "mother", *di-ŋ* "grand-father", *ji-ŋ* "grandmother". Except for this handful of occurrences, velar nasal /ŋ/ in Deori is rarely used. Jacquesson further states that the voiceless alveolar fricative /s/ does not occur word finally. Aspiration in Deori is not phonological. Jacquesson (2005) also reports some instances of free variation: voiceless palatal alveolar affricate /tʃ/ is realized variably as voiceless alveolar affricate /ts/; voiced palatal-alveolar affricate /dʒ/ is realized variably as voiced alveolar fricative /dz/, and voiceless alveolar fricative /s/ is realized variably as voiceless palato alveolar fricative /ʃ/. Jacquesson (2005) also posits that the native speakers use both voiceless alveolar fricative /s/ and voiceless palato alveolar fricative /ʃ/ interchangeably but never /h/, unlike Assamese.

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[17] /gʰila/ in Assamese.

[18] Jacquesson cites Burling (1961) in which evidences of /r/ and /l/ featuring in complementary distribution in Garo is reported. In Garo, the place of occurrence of /r/ and /l/ are opposite to Deori. In Garo, /r/ occurs at the beginning of the word and /l/ occurs in the middle of the word. Jacquesson also cites Bhattacharyya (1977) in which the phonemic status of /r/ and /l/ in Dimasa and Kokborok are reported. In Dimasa and Kokborok /r/ and /l/ are two distinct phonemes occurring in all syllabic position maintaining phonemic contrasts. Jacquesson thus mentions that Deori and Garo have "simplified" one old opposition in Bodo-Garo in reverse ways.

[19] *-wa* is a thematic marker as reported in Jacquesson (2005).

Nath (2012) reports seventeen consonants in Deori. The consonants are six obstruent stops /p,b,t,d,k,g/, three nasal consonants /m,n,ŋ /, three fricatives /s,z,ɦ/, one affricate /ts/, two liquids /l, ɾ/, two approximants /ʋ, j/. Nath (2012) states that voiced glottal fricative /ɦ/ changes to voiceless velar fricative /x/ word-medially (for example: *muɦini* > *muxini* "two"[20]). Nath (2012) states that voiceless palato alveolar fricative /ʃ/ as reported in Grierson (1909) has changed to voiceless alveolar fricative /s/ (for example: *ʃiŋ* > *siŋ* "seven", *piʃa* > *pisa* "son").

Deori (2012) reports seventeen consonants in the language /p,b,t,d,k,g,m,n,ŋ,s,tʃ,dʒ,l,r,h,j,w/. The consonants are six obstruent stops /p,b,t,d,k,g/, three nasal consonants /m,n,ŋ/, two fricatives /s,h/, two affricates /tʃ,dʒ/, two liquids /l,r/ and two approximants /j,w/. Unlike Jacquesson (2005), Deori (2012) considers labial approximant /w/ and alveolar lateral /l/ as contrastive phonemes. Deori (2012) further suggests that the voiceless palato- alveolar /tʃ/ is extensively used in the language and there are no aspirated stops in the language.

Saikia (2013) reports seventeen consonants /p,b,t,d,k,g,m,n,ŋ,s,tʃ,dʒ,l,r,h,j,w/ in Deori which complies with Deori (2012). Saikia (2013) mentions that the velar nasal /ŋ/ occurs word-initially and word-finally whereas semi-vowel /w/ can occur only word-medially. The stop consonants /p,b,t,d,k,g/, alveolar fricative /s/, palato-alveolar voiced affricate /dʒ/, laterals /l, r/, glottal fricative /h/ and palatal approximant /j/ are used extensively word initially and word medially. Saikia also reports that the language lacks aspirated stops.

A review of the available literature reveals that there exist both commonalities and irregularities in the description of Deori consonants. Table 2.1[21] below summarizes the consonant inventory of Deori proposed by various researchers.

[20] Nath (2012) has specified only one instance of voiced glottal fricative /ɦ/ changing to voiceless velar fricative /x/ intervocalically.

[21] In table 2.1, the IPA symbols are used to represent the phonemes.

	Stops	Nasals	Fricatives	Affricates	Liquids	Approximants
Brown (1850)	p b t d k g	m n ŋ	s ʃ h	ts tʃ dʒ	l r	j
Brown (1895)	p b t d k g t^h d^h k^h	m n ŋ	s ʃ h	tʃ dʒ	l r	j
Goswami (1994)	p b t d k g	m n ŋ	s ç z x h	tʃ dʒ	l r	j w
Jacquesson (2005)	p b t d k g	m n ŋ	s h	tʃ dʒ	l (r)	j (w)
Nath (2012)	p b t d k g	m n ŋ	s z ɦ	ts	l ɾ	j ʋ
Deori (2012)	p b t d k g	m n ŋ	s h	tʃ dʒ	l r	j w
Saikia (2013)	p b t d k g	m n ŋ	s h	tʃ dʒ	l r	j w

Table 2.1: Deori consonants as reported by different researchers

As can be seen in Table 2.1, most of the consonants are uniform and only a few consonants tend to vary across different studies. The most agreed upon consonants among all the researchers are the stop consonants /p,t,k,b,d,g/, nasal consonants /m,n,ŋ/, alveolar fricative /s/, voiced palatal alveolar affricate /dʒ/ (except Nath 2012), voiceless palatal alveolar affricate /tʃ/, liquids /r,l/, glottal fricative /h/, and palatal approximant /j/. Glottal fricative /h/ is described as voiced (phonetic symbol /ɦ/) by Nath 2012, unlike other researchers. However, although the liquid consonants /r/ and /l/ are uniformly present in the description of the phoneme inventory of all the researchers, Jacquesson considers [r] and [w] as an allophonic variation of /l/ and /p/ respectively. Nath (2012) reports lateral /ɾ/ as tap or flap.

The consonants which stand exclusively unique are voiceless alveolar affricate /ts/ (Brown, 1850; Nath, 2012); aspirated obstruent stops /t^h/, /k^h/and /d^h/ (Brown, 1895); voiceless palatal fricative /ç/ (Goswami, 1994), voiced alveolar fricative /z/, voiceless velar fricative /x/ (Goswami, 1994; Nath, 2012), voiceless palato-alveolar fricative /ʃ/ (Brown, 1850; Brown, 1895) and labio-dental approximant /ʋ/ (Nath, 2012). It is observed that the voiceless velar fricative /x/ in Goswami (1994) changes to glottal fricative /h/ in Jacquesson (2005) (for example: *xouba* (Goswami, 1994) > *houba* "there" (Jacquesson, 2005), *xizẽ* (Goswami, 1994) > *hizẽ* "to see" (Jacquesson, 2005), *xidu* (Goswami, 1994) > *hidu* "to enter" (Jacquesson, 2005). Nath (2012) reports that voiced glottal fricative /ɦ/ in Grierson (1909) changes to voiceless velar fricative /x/

in present-day Deori. The lexical items with voiceless alveolar affricate /ts/ in Brown (1850) and Nath (2012) is reported as voiceless palatal alveolar affricate /tʃ/ in Brown (1895), Goswami (1994), Jacquesson (2005), Saikia (2013), and Deori (2012) (for example: *tsima* "mother" (Brown, 1850; Nath, 2012) > *tʃima* (Brown, 1895; Goswami, 1994; Jacquesson, 2005; Saikia, 2013; Deori, 2012), *tsipa* "father" (Brown, 1850; Nath, 2012) > *tʃipa* (Brown, 1895; Goswami, 1994; Jacquesson, 2005; Saikia, 2013; Deori, 2012), *tsagu* "road" (Brown, 1850; Nath, 2012) > *tʃagu* (Brown, 1895; Goswami, 1994; Jacquesson, 2005; Saikia, 2013; Deori, 2012). Similarly, the lexical items with voiceless palatal fricative /ç/ in Goswami (1994) are reported as voiceless alveolar fricative /s/ in Brown (1850), Brown (1895), Jacquesson (2005), Nath (2012), Deori (2012), and Saikia (2013) (for example: *çu* (Goswami, 1994) ~ *su* "bark" (Brown, 1850; Brown, 1895; Jacquesson, 2005; Nath, 2012; Deori, 2012; Saikia, 2013), *çui* (Goswami, 1994) ~ *sui* "high" (Brown, 1850; Brown, 1895; Jacquesson, 2005; Nath, 2012; Deori, 2012; Saikia, 2013). While Brown (1895) considers aspiration as phonemic in Deori, other researchers (Brown, 1895; Goswami, 1994; Jacquesson, 2005; Deori, 2012; Nath, 2012; Saikia, 2013) state that aspiration is not attested in Deori.

The detailed overview of the existing literature discussed in this section has provided an insight into the description of the consonants of Deori and highlights both commonalities and irregularities in the number of consonants in Deori. The use of voiced alveolar fricative /z/ in Goswami (1994) and Nath (2012) and voiced palatal alveolar affricate /dʒ/ in Brown (1895), Jacquesson (2005), Deori (2012), and Saikia (2013) for the same set of lexical items; free variation of /s/ and /ʃ/, /tʃ/ and /ts/, /dʒ/ and /dz/ (Jacquesson, 2005) and changes from /x/ (Goswami, 1994) to /h/ (Jacquesson, 2005) and /ɦ/ to /x/ (Nath, 2012) raises some concern on the phonemic status of the consonants in Deori. Keeping in mind the observations of the earlier researchers, the next section examines the number of contrastive consonants in Deori. The consonants are discussed with reference to the distinctive feature theory to classify the phonemic contrasts of the consonants.

2.3 Consonants in Deori

The consonants described in this section are based on the Deori speech data recorded for this dissertation. Deori native speakers are proficient bilinguals; they are well versed in both Deori and Assamese. In the initial stage of consultation with our informants, a word list with all possible vowels and consonants were prepared (Appendix 1 and Appendix 2). It was ensured that all the vowels and consonants were present in the word list. The word list was constructed with mainly CV type syllables (C being the consonant, however, there were some disyllabic words as well). In the word list, we also incorporated words with nasal vowels to examine the oral-nasal vowel contrasts in Deori. At first, the consonant inventory of Deori will be discussed. Table 2.2 below shows the consonant inventory of Deori pertinent to our analysis. They are arranged according to their manner and place of articulation. The total number of phonemically distinct series of consonants in Deori includes 14 consonants, and three allophones: [+nasal] [ŋ], [-lateral] [ɹ] and [+continuant] [w].

	Bilabial	Alveolar	Palato-Alveolar	Palatal	Velar	Glottal
Plosives	p b *p^{h}[22]	t d *t^{h}			k g *k^{h}	
Nasals	m	n			(ŋ)	
Fricatives		s				ɦ
Affricates		dz	tʃ			
Approximant		(ɹ)		j	(w)	
Lateral Approximant		l				

Table 2.2: Consonant inventory of Deori

A brief description of Deori consonants according to their place and manner of articulation is given below.

2.3.1 Stops

Deori has six stops. This includes voiced and voiceless bilabial stops /b/ and /p/, voiced and voiceless alveolar stops /d/ and /t/ and voiced and voiceless velar stops /g/ and /k/. The glottal stop /ʔ/ is absent in Deori, unlike the other neighboring Bodo-Garo languages, which can be assumed to be a contact-induced change. Table 2.3 exemplifies the voicing contrast of the stop categories in Deori. Phonemic distribution of the stops suggests that all stop consonants can occur word-initially and word-medially.

[22] Consonants with asterisks (*) indicates free variation and consonants within parentheses are allophonic variation.

Initial	Gloss	Medial	Gloss
pu	'weave'	pipɔ[23]	'tree'
bu	'wife of an elder brother'	bibɔ̃	'granary'
tu	'oil'	tʃiti	'fruit'
du	'cock'	midi	'deity, God'
kɛ	'go'	ɑkũ	'ear/upland'
ɡɛ	'hard'	ɑɡũ	'knee'

Table 2.3: Voicing contrasts in Deori stop consonants

The voicing contrast of alveolar stops /t/ and /d/ in word-medial position is represented by words exhibiting near minimal pair /tʃiti/ and /midi/ respectively. The laryngeal features that characterize Deori voiceless stop consonants /p/, /t/, /k/ are [-voice, - spread glottis] and voiced stop consonants /b/, /d/, /ɡ/ are [+voice, -spread glottis]. Aspiration is non-phonemic in Deori, unlike Brown (1895). [-voice, -spread glottis] /p/, /t/ and k/ are realized variably as [-voice, +spread glottis] /pʰ/, /tʰ/ and /kʰ/ (though not a common property across speakers) in word-initial and word-medial position. The distribution of [-voice, ±spread glottis] /p/, /t/, /k/, and /pʰ/, /tʰ/, /kʰ/ are random and appear as a free variation (Table 2.4). Hence, aspiration in Deori is non-distinctive.

Initial	Gloss	Medial	Gloss
pi/pʰi	'break'	mɛ̃pu/mɛ̃pʰu	'lizard'
pɛ/pʰɛ	'sell'	tɔpɛ̃/tɔpʰɛ̃	'blanket'
tu/tʰu	'deep'	tʃitũ/tʃitʰũ	'rope/old'
ti/tʰi	'louse'	ɑtiri/ɑtʰiri	'stone
kɛ/kʰɛ	'go'	ɑkũ/ɑkʰũ	'ear/upland'
ku/kʰu	'fall'	bekũ/bekʰũ	'beans'

Table 2.4: Distribution of [±spread glottis] segments in Deori

The waveform presented below shows the voice onset time (VOT) of the unaspirated and the aspirated stops. VOT is defined as the time interval between the onset of glottal pulsing and the release of the initial stop consonant (Lisker and Abramson, 1964, 1967). The VOT analysis helps to distinguish an aspirated stop from an unaspirated stop based on the voicing lead and voicing lag. Voicing detected before the release, i.e. the unaspirated or aspirated voiced stop is called the voicing lead while voicing detected after the release i.e. the unaspirated voiceless or aspirated voiceless stops is called voicing lag. The VOT values of the voiced stop (both aspirated or

[23] /pipɔ/ is also pronounced as /pɔpɔ/ containing same meaning with both nasalized vowel.

unaspirated) is assigned negative values which represent the pre-voicing period of the voiced stop and the VOT values of the voiceless stop (both aspirated and unaspirated) is assigned positive values to represent the voicing after the release (Lisker and Abramson, 1964).

(a) (b)

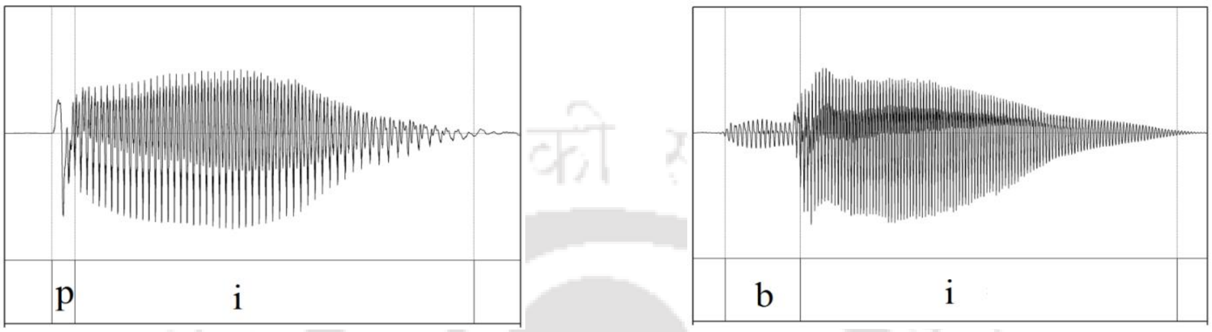

Figure 2.1: Waveform of word-initial unaspirated voiceless bilabial /p/ and unaspirated voiced bilabial /b/

(a) (b)

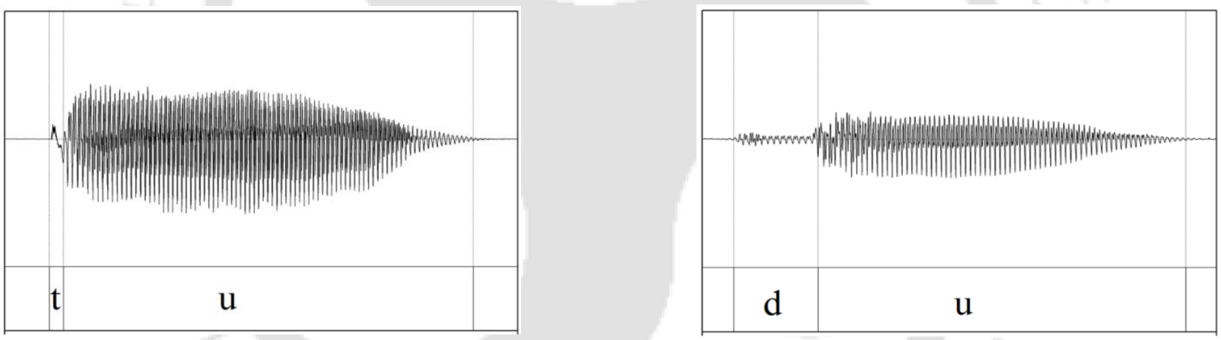

Figure 2.2: Waveform of word-initial unaspirated voiceless alveolar /t/ and unaspirated voiced alveolar /d/

(a) (b)

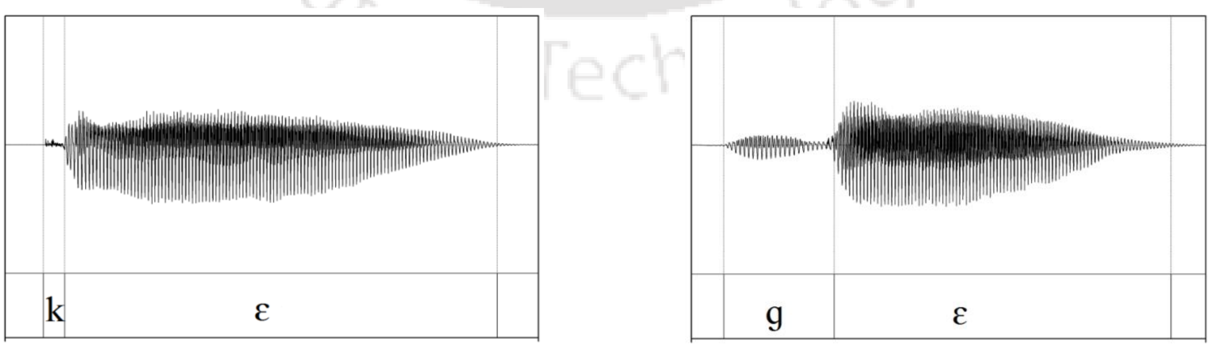

Figure 2.3: Waveform of word-initial unaspirated voiceless velar /k/ and unaspirated voiced velar/g/

(a) (b) (c)

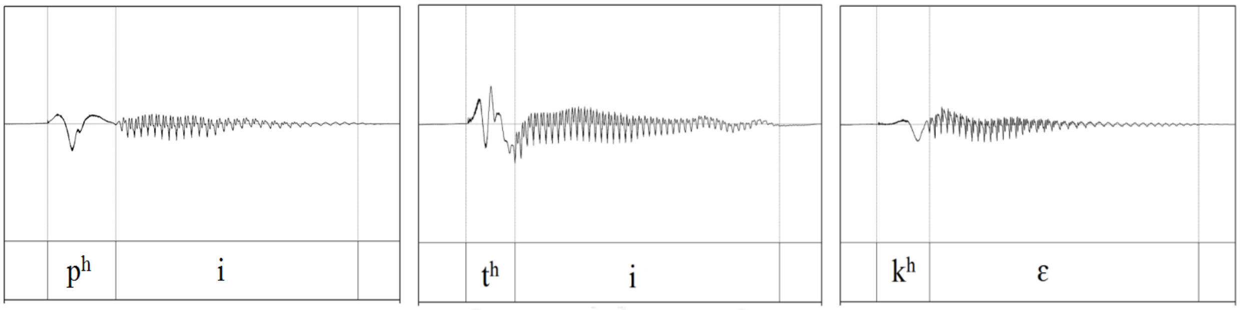

Figure 2.4: Waveform of word-initial aspirated voiceless bilabial /p^h/, aspirated voiceless alveolar /t^h/, and aspirated voiceless velar /k^h/

The waveforms in Figure 2.1(b), 2.2(b), and 2.3(b) indicate pre-voicing in the voiced stop before the release of the consonant; whereas Figure 2.1(a), 2.2(a) and 2.3(a) suggest voicing after the release of the consonant. The average VOT values of the voiced unaspirated stop series in Deori are: labial stop /b/ is -126.07 msec, alveolar stop /d/ is -128.20 msec, and velar stop /g/ is -130.60 msec. The average VOT values of the voiceless unaspirated stop series in Deori are: labial stop /p/ is 25.76 msec, alveolar stop /t/ is 26.91 msec, and velar stop /k/ is 30.38 msec. The waveforms in Figure 2.4 (a), (b), and (c) display voice onset lag behind the release which represents the aspirated voiceless stops in Deori. The average VOT values of the voiceless aspirated stop series are: voiceless aspirated labial stop /p^h/ is 72.97 msec, voiceless aspirated alveolar stop /t^h/ is 73.43 msec, and voiceless aspirated velar stop /k^h/ is 81.85 msec.

The place features that distinguish the bilabials, the alveolar and the velars in Deori from each other are the [coronal], [anterior], and [distributed]. In Deori, the bilabial stops /p/ and /b/ are represented with the feature specification [+anterior, -coronal], alveolar stops /t/ and /d/ are represented with the feature specification [+anterior, +coronal], and velar stops /k/ and /g/ are represented with the feature specification [-anterior, -coronal] and [+back, +high] as the velar stops are produced with raised and retracted tongue body.

2.3.2 Nasals

Deori has three nasals representing three distinct places of articulation namely bilabial, alveolar and velar. The nasals in Deori are bilabial /m/, alveolar nasal /n/, and velar nasal [ŋ]. Velar nasal [ŋ] occurs word-finally in a limited set of words which complies with Jacquesson (2005). While alveolar nasal /n/ occurs word-initially, velar nasal [ŋ] is only attached to the word-final position;

hence, velar nasal [ŋ] is an allophonic variant of alveolar nasal /n/. Table 2.5 illustrates the distinction between the three nasal consonants in Deori.

Initial	Gloss	Medial	Gloss	Final	Gloss
mi	'paddy'	simi	'needle'	siŋ	'salt/iron'
ni	'drink'	-	-	kiŋ	'hair'
mu	'name'	gumi	'elder sister's husband'	-	-
nu	'boat'	-	-	-	-

Table 2.5: Nasal consonants in Deori

The bilabial nasal /m/ and alveolar nasal /n/ are two distinct phonemes occurring word-initially. Alveolar nasal /n/ occurs word-finally as a future marker as in *ɦa.n* "eat.FUT[24]", *kɛ.n* "go.FUT" and occurs intervocalically in derived sequence such as *ni.ni* "drink.CONT[25]", *tʃĩjã.nɛ̃* "fish.FOC[26]". Bilabial nasal /m/ occurs in a syllable-final position such as *jɔmtu* "spade", *dumdzu* "face", and *amsu* "mat". In words like *ni* "drink" with preceding and following high vowel, alveolar nasal /n/ is apico-alveolar with place feature [-distributed]. The place features that distinguish the nasal consonants from each other are [anterior], [coronal] and [distributed]. While phoneme /m/ and /n/ are [+anterior] and allophone [ŋ] is [-anterior]; phoneme /m/ and allophone [ŋ] are [-coronal] and phoneme /n/ is [+coronal]. The vowel features that represent these set of nasals are high, low, back, and round. While allophone [ŋ] is [+high, +back], phoneme /m/ and /n/ are [-high, -back].

2.3.3 Fricatives

Deori exhibits one alveolar fricative /s/ and one glottal fricative /ɦ/, maintaining a phonemic contrast as exemplified in Table 2.6.

Initial	Gloss	Medial	Gloss
ɦɑ	'eat'	-	-
sɑ	'ill'	mɛ̃sɑ	tiger
ɦu	'clean'	-	-
su	'wash'	isɑ	'say'

Table 2.6: Fricatives in Deori

Glottal fricative /ɦ/ is voiced in Deori which agrees with Nath (2012). Unlike Goswami (1994) and Nath (2012), voiced alveolar fricative /z/ is not underlyingly present in the phoneme

[24] Future marker
[25] Present continuous Tense
[26] Focus marker

inventory of Deori; instead, voiced alveolar affricate /dz/ is variably used as voiced alveolar fricative /z/ in word-initial and word-medial position. The use of voiced alveolar fricative /z/ regardless of its position is discussed with more detail in the next section (§ 2.3.4). The voiceless alveolar fricative /s/ is variably used as voiceless palatal affricate /tʃ/ and vice-versa, unlike Jacquesson (2005). For instance, *tʃi* "blood" is variably used as *si* and vice-versa and *su* "speech" is variably used as *tʃu* and vice-versa. The two underlying [±continuant ±anterior] segments /s/ and /tʃ/ exhibit alternation from both the directions, i.e. aspirate to fricative and fricative to aspirate, variably in syllable-initial and syllable-medial position as exemplified in Table 2.7.

Initial	Gloss	Medial	Gloss
sɑ/tʃɑ	'sun'	disɔ̃/ditʃɔ̃	'pot'
su/tʃu	'milk'	gisɔ̃/gitʃɔ̃	'lower rack above fire-place'
tʃijɑ/sijɑ	'old'	pitʃu/pisu	'meat'
tʃɑgu/sɑgu	'road'	ɑtʃɔ̃/ɑsɔ̃	home'

Table 2.7: Distribution of [±continuant, ±anterior] /s/ and /tʃ/ in Deori

The examples in Table 2.7 show the unconditioned fluctuation in the distribution of the [±continuant ± anterior] segments. The variation is not associated with positioning and is rather unpredictable and is an instance of free variation or random variation.

The distribution of glottal fricative /ɦ/ in Deori is limited to word-initial position such as *ɦidzɛ̃* "see", *ɦidu* "enter". The phoneme /ɦ/ also occurs as a locative marker *ɦɔ* in derived words: e.g., *ba-ɦɔ* "there.LOC[27]", *atʃɔ̃-ɦɔ̃* "home.LOC". The features that distinguishes an alveolar fricative /s/ from a glottal fricative /ɦ/ are the major class feature [consonantal] and place features [strident], [anterior], and [coronal]. While /s/ is [+consonantal +strident +anterior +coronal], /ɦ/ is [+consonantal -strident –anterior –coronal].

2.3.4 Affricates

Deori exhibits two affricates, voiceless palatal affricate /tʃ/ and voiced alveolar affricate /dz/. Voiceless palatal affricate /tʃ/ is variably used as voiceless alveolar fricative /s/ as discussed in the previous section. Table 2.8 exemplifies the voicing contrast of the two affricates /tʃ/ and /dz/ in Deori.

[27] Locative marker

Initial	Gloss
tʃi	‘blood’
dzi	‘water’
tʃu	‘milk’
dzu	‘call’
tʃɛ	‘breast’
dzɛ	‘give birth’

Table 2.8: Affricates in Deori

Jacquesson (2005) has mentioned that Deori exhibits voiced post-alveolar affricate /dʒ/ as the underlying phoneme which variably changes to voiced alveolar affricate /dz/. However, we found after a detailed examination of the data that Deori affricate is more like voiced alveolar affricate /dz/ rather than voiced post-alveolar affricate /dʒ/. Hence, we consider voiced alveolar affricate /dz/ as the underlying phoneme which changes variably to voiced alveolar fricative /z/.[28] [-continuant] /dz/ is variably used as [+continuant] /z/ (though not a common property across speakers) for the same set of lexical items, as exemplified in Table 2.9.

Initial	Gloss	Medial	Gloss
dzu/zu	‘call’	udzũ/uzũ	‘navel/bamboo tube’
dzi/zi	‘water’	kudzi/ kuzi	‘spade’
dzɛ/zɛ	‘give birth’	sudzɛ̃/suzɛ̃	‘rice-beer’
dzɔ/zɔ	‘run’	ɑdzi/azi	‘son-in-law’

Table 2.9: Distribution of [±continuant, ±delayed release] /z/ and /dz/ in Deori.

Cross-linguistically, voiced affricates in a phoneme inventory are more unstable and they change to other sounds while their voiceless counterparts do not (Kenstowicz, 1994.) However, in Deori both voiced affricate /dz/ and voiceless affricate /tʃ/ variably changes to /z/ and /s/ respectively. The shift from /dz/ ~ /z/ (though not a common property across speakers) can be considered as an outcome of language contact. In Assamese, the underlying contrastive phoneme is voiced alveolar fricative /z/ which is often pronounced as voiced alveolar affricate /dz/. Hence, the presence of /z/ as a free variant of /dz/ in Deori reflects a contact-induced phonological change.

The manner feature that distinguishes /dz/ and /z/ are [continuant] and [±delayed release] feature. While voiced alveolar affricate /dz/ is [-continuant] and [+delayed release], voiced alveolar fricative /z/ is [+continuant] and [-delayed release]. The occurrence of /dz/ and /z/ did not reveal any principle patterns governing the usage of this shift and hence, are considered as an

[28] Articulatory studies will be useful in establishing it as a /dz/. For the time being we have relied on acoustic studies.

instance of free variation. The waveform presented in Figure 2.5 and Figure 2.6 shows free-variation of /dz/ and /z/ in word-initial and medial position.

(a) (b)

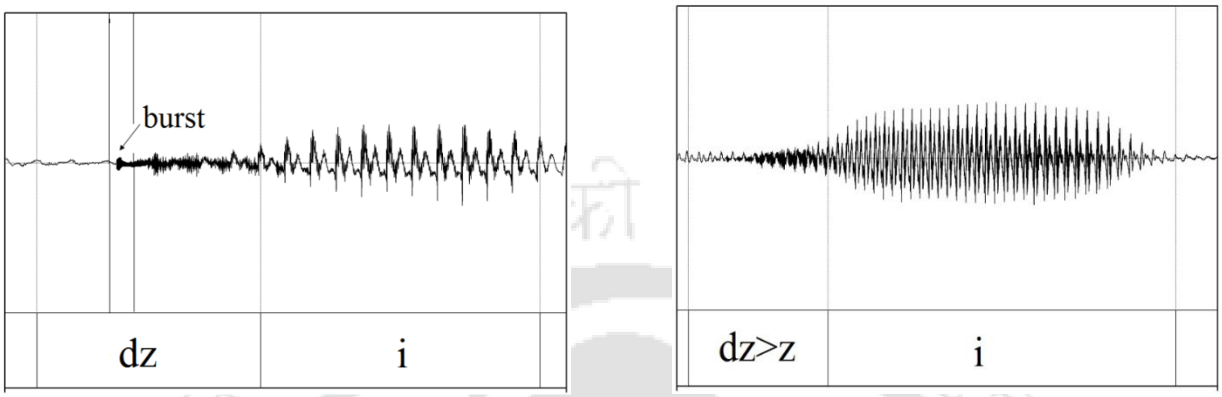

Figure 2.5: Waveform of word-initial /dz/ and /z/ in /dzi/ ‘water’

(a) (b)

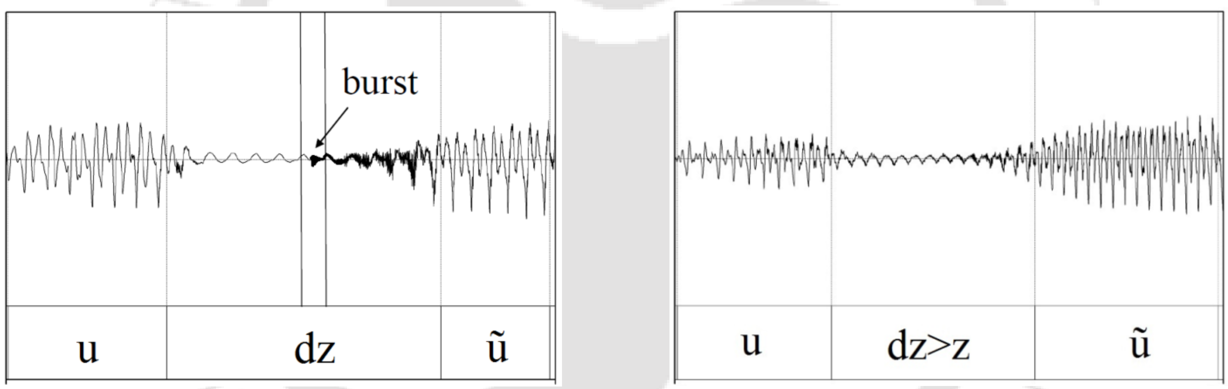

Figure 2.6: Waveform of word-medial /dz/ and /z/ in /udzũ/ ‘navel’

The waveform in Figure 2.5 (a) shows a pre-voicing burst of /dz/ word-initially and Figure 2.5 (b) shows the process of deaffrication of voiced affricate /dz/ to voiced fricative /z/ word-initially in the same lexical word. Similarly, the waveform in Figure 2.6 (a) shows a pre-voicing burst of /dz/ word-medially, and Figure 2.6 (b) shows the process of deaffrication of voiced affricate /dz/ to voiced fricative /z/ word-medially in the same lexical word.

2.3.5 Approximants

Deori has four approximants which include an alveolar lateral approximant /l/, an alveolar approximant [ɹ], a labial approximant [w], and a palatal approximant /j/. Unlike Nath (2012), [ɹ] in Deori is an approximant. Intervocalically, [-lateral] [ɹ] is realized with short duration and small intensity. The phonotactic restriction reveals that /l/ and [ɹ] are in complementary distribution and [ɹ] as an allophonic variation of /l/, which agrees with Jacquesson (2005). While lateral /l/ occurs word-initially, [-lateral] [ɹ] occurs initially in suffix as in *ɹu* "past perfect", *ɹi* "present progressive", *ɹɔm* "past" and also occur word medially as in *kiɹi* "poor", *siɹɛ* "world" and word finally as in *lepeduɹ* "goat". [-lateral] [ɹ] also occurs in an underived context, both with nasal and oral vowels (for example: *kiɹi* "poor", *giɹa* "old person", *siɹɛ* "world", *gãɹ̃ɔ̃* "pot", *mĩɹ̃ũ* "uncooked rice"). In the context of nasal harmony approximant [ɹ] changes to nasal sonorant stop /n/ which is pursued in detail in Chapter 6.

Palatal approximant /j/ occurs word-initially as in *jã* "moon", *jɛŋ* "ginger" and also as a suffix *ja* "negative marker".

Labial approximant [w] is an allophonic variant of bilabial stop /p/. While bilabial stop /p/ occurs word-initially and word medially (for example: *pipɔ* "tree", *pu* "sell", *apasu* "leg"), labial approximant [w] occurs only as a suffix (for example: *wa* "thematic marker"). The manner feature and the tongue body feature that distinguishes an approximant and a bilabial stop consonant are [continuant] and [voice]. While labial approximant [w] is [+continuant +voice], bilabial stop /p/ is [-continuant -voice].

2.3.6 Discussion

Deori exhibits 14 distinctive consonants and 3 allophones. Velar nasal [ŋ] is an allophonic variation of alveolar nasal /n/, labial approximant [w] is an allophonic variation of bilabial stop /p/ and alveolar approximant [ɹ] is an allophonic variation of alveolar lateral /l/. The distinctive feature values for the consonants of Deori are given in Table 2.10. The allophones are represented within parentheses.

	stops						nasals			fricatives		affricates		approximants			
	p	b	t	d	k	g	m	n	(ŋ)	s	ɦ	tʃ	dz	j	(ɹ)	l	(w)
syllabic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sonorant	-	-	-	-	-	-	+	+	+	-	-	-	-	+	+	+	+
consonantal	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-
continuant	-	-	-	-	-	-	-	-	-	+	-	-	(-)	+	+	+	+
delayed-release	-	-	-	-	-	-	-	-	-	(-)	-	(+)	(+)	-	-	-	-
lateral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
strident										+		+	+				
nasal	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-
voice	-	+	-	+	-	+	+	+	+	-	+	-	+	+	+	+	+
constricted glottis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
spread glottis	(-	-	-	-	-	-)	-	-	-	-	-	-	-	-	-	-	-
anterior	+	+	+	+	-	-	+	+	-	(+)	-	(-)	+	-	+	+	-
coronal	-	-	+	+	-	-	-	+	-	+	-	+	+	-	+	+	-
high	-	-	-	-	+	+	-	-	+	-	-	+	-	+	-	-	+
low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
back	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	+
round	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+

Table 2.10: Distinctive feature representation of consonant phonemes in Deori

The assignment of the feature [spread glottis] in Deori in Table 2.10 is within parentheses because both the feature values [+spread glottis] and [-spread glottis] are found on the surface. The feature value [-spread glottis] is used in the underlying form which changes variably to [+spread glottis] /p^h/, /t^h/, and /k^h/. The feature values [-delayed release, +anterior, +strident] representing voiceless fricative /s/ are within the parentheses and [+delayed release, -anterior, +strident] representing voiceless affricate /tʃ/ is within the parentheses as both /s/ and /tʃ/ are used variably on the surface. Similarly, the feature values [continuant] and [delayed release] are within the parentheses because both the feature values [-continuant, +delayed release] and [+continuant, -delayed release] representing /dz/ and /z/ respectively are found on the surface. While [-continuant, +delayed release] /dz/ is the underlying phoneme, [+continuant, -delayed release] /z/ is the free variant of /dz/. Deori uses four pairs distinguished by voicing /p/-/b/, /t/-/d/, /k/-/g/, /tʃ/-/dz/. Except for approximant [w] which is pronounced with a protruding lip, no consonants have been assigned the feature [round]. The distinctive feature representation of consonants in Table 2.10 provides the entire set of features applied to the consonants in Deori highlighting the contrastive set of segments.

2.4 Deori vowels: a literature review

In this section, a review of Deori vowels as reported in the existing literature (Brown, 1850; Brown, 1895; Goswami, 1994; Jacquesson, 2005; Nath, 2012; Deori, 2012; Saikia, 2013) is discussed. Brown (1850) records six vowel phonemes in Deori /a, i, e, o, u, ü/ (as cited in Jacquesson, 2005). The close back vowel /ü/ (phonetic symbol /ɯ/) in Brown (1850) changes to high front vowel /i/ in Jacquesson (2005) (for example: *asü* "mountain" (Brown, 1850) > *asi* (Jacquesson, 2005), *süŋ* "salt" (Brown, 1850) > *siŋ* (Jacquesson, 2005)).

Brown (1895) reports nine vowels in Deori. The IPA symbol of the vowels proposed by Brown (1895) as mentioned in Matisoff (1996) is shown in Table 2.11 below:

Brown	ă	å	a	i	u	e	é	o	ó
IPA	ə	ɒ	æ	I	ʊ	ɛ	e	ɔ	o

Table 2.11: Vowels in Deori (Brown, 1895) as cited in Matisoff 1996

Brown (1895) states that vowel length in Deori is non-phonemic. The vowel duration is longer only when the vowels are accented and are shorter when they are unaccented[29].

Goswami (1994) reports seven vowels in Deori /i, e, E, ā, a, o, u/. Goswami (1994) presents no explanation on the vowel qualities of <E> and <ā>, except that the occurrence of the vowel /E/ is rare and occur word-initially and word-medially in disyllabic words. Goswami further mentions that the sequences of two vowels are possible in the language and in such a sequence if the second vowel is a high vowel, then both the vowels form one syllable; i.e. they are diphthongs (for example *āiyā* "daughter in law", *kuwāi* "weaves bamboo tray"). Goswami also posits that Deori exhibits phonemic nasal vowels, but presents no evidence of nasal vowel.

Jacquesson (2005) accounts for five oral /a,e,i,o,u/ and five nasal vowels /ã,ẽ,ĩ,õ,ũ/ in Deori. Jacquesson (2005) mentions some contextual variations of oral vowels as shown in (1).[30]

(1)

(a) [a]+[y] → [ey] > [e]	maimaica > meimeica > memeca	'slowly'
(b) [e]+[y] → [i]	meyõ > miõ	'elephant'
(c) [o] → [u]	otuŋ > utuŋ	'belly'

[29] Here Brown refers to duration in stressed and unstressed syllables. The stressed vowels bear longer duration than the unstressed counterparts. This will be discussed in detail in Chapter 3 of this dissertation.
[30] The superscript '²' indicates high tone in Jacquesson (2005).

According to Jacquesson, the mid vowel /o/ in Deori is derived from the ancient /a/ and has ‘softened’ under Assamese influence. For instance, <ashti> “finger” (Brown, 1895) is now pronounced as <osti> ~ /ɔsti/ (Jacquesson, 2005), <barga> “to boil” (Brown, 1895) is now pronounced as <borga> ~ /bɔɹgɑ/ (Jacquesson, 2005), <cã> “alive” (Brown, 1895) is now pronounced as <cõ> ~ /tʃɔ̃/ (Jacquesson, 2005). Jacquesson further suggests that there is always some influence of a rounded vowel in the preceding vowel e.g. midi-muma > midi-mumo-ho ~ /midi-mumɔ-hɔ/ “religious ceremony”, la-ho > loho ~ /lɔhɔ/ “here”, jabura > jubura ~ /dʒuburɑ/ “vegetables” ba-ho > boho ~ /bɔhɔ/ “there”. There are also instances of vowel rounding /i/→/u/ when followed by a high round vowel /u/ and vowel lowering /i/ → /e/ when followed by a low mid vowel /e/. For instance, <echigu> ~ /ɛtʃigu/ “ladder” (Brown, 1895) changes to <etʃugu> ~ /etʃugu/ (Jacquesson, 2005); <cimeci> ~ /tʃimetʃi/ “ant” (Brown, 1895) changes to <cemeci> ~ /tʃemetʃi/ (Jacquesson, 2005). The contextual variation of the vowels as reported in Jacquesson (2005) indicates a process of vowel chain shift where the vowel agrees with the feature specification of the following vowel. Jacquesson also states that the development of /e/ and /o/ depends significantly on the syllabic context. Jacquesson states that phonologically or phonetically Deori exhibits neither mid centralized vowel /ə/ nor /ɯ/[31], unlike other Bodo-Garo languages. Jacquesson (2005) further states that Deori exhibits nasal vowels and is considered as a unique feature of Deori which assigns Deori a distinct identity among the Bodo-Garo languages in the vicinity, e.g., Bodo, Dimasa, Kokborok, Tiwa, and Garo. Nasal vowels are not a common feature in other Bodo-Garo languages[32]. Jacquesson (2005) mentions that nasalization in Deori is an areal feature and is acquired from the Northern Mishmi and the Tani dialects with whom the Deoris were in close contact with, before migrating to the eastern parts of Assam. Jacquesson (2005) considers nasal vowels in Deori to have arisen from a deletion of the nasal consonant at a syllable-final position at a certain stage of the development of the language as shown in Table 2.12[33] below.

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[31] Jacquesson (2005) states that belonging to a Bodo-Garo language, the absence of the centralized vowel /ə/ in Deori is an atypical feature of Deori. He further states that in other Bodo-Garo languages such as Boro and Kokborok, there exist not only /ə/ (which is often phonetically more a [ɨ]), but there are also diphthongs consisting of /ə/. In Garo, there is a phonetic [ə] which is the allophonic variation of /i/ which occur in closed syllables, for instance, <*ching*> changes to /čəŋ/. Rabha too exhibits the centralized vowel /ə/.

[32] However, it is seen in Dimasa, though rarely, in words like [bõa] “five”, derived from /boŋa/

[33] The words in the table are presented following the generic alphabets or non-standard symbols used by the researchers. The IPA representation of phonemes is discussed in section 2.2.

Brown (1895)	Jacquesson (2005)	Gloss
an	ã	‘1st person singular’
sa(n)	sã	‘sun’
cho(n)	chõ	‘sugarcane’
aku(n)	akũ	‘ear’
chitu(n)	citũ	‘rope’
gubo(ŋ)	gubõ	‘head’
gutu(ŋ)	gutũ	‘nose’
iku(ŋ)	ikũ	‘cloth’
uju(n)	ujũ	‘navel/bamboo tube’

Table 2.12: Nasal effacement in the syllable-final position leading to nasal vowels (Jacquesson, 2005)

The word sets in Table 2.12 suggest that Deori underwent syllable-final consonant deletion that results in vowel nasalization. Jacquesson further states that Deori also exhibits underlying nasal vowels and presents some homophonous words maintaining nasal-oral contrasts which have no evidence of final nasal consonant deletion as shown in Table 2.13[34].

Oral	Gloss	Nasal	Gloss
ka	‘climb’	kã	‘hot’
ge	‘hard’	gẽ	‘put a garment’
bi	‘settle’	bĩ	‘wear’
co	‘contain’	cõ	‘grow’
ju	‘call’	ju	‘call’

Table 2.13: Minimal pairs with nasal-oral contrasts (Jacquesson, 2005)

Jacquesson further opines that the most important proportion of the nasal vowels in Deori is found in the monosyllabic verbal roots and the presence of a nasal vowel syllable leads to nasalization of vowels of all subsequent syllables within the boundary of the word. This spreading of nasality naturally involves the vowels, but also some consonants which in the context of the harmony of nasality present a variant of nasals: [r] changes to /n/ and /b/ changes to /m/ which Jacquesson terms as an allophonic variation. Jacquesson also states that this instance of consonant alternation in Deori is absent in other languages of North - Eastern India, even among those having nasal vowels. The alternation of consonants in the context of nasalization will be discussed elaborately in Chapter 6.

[34] The words in the table are presented following the generic alphabets or non-standard symbols used by the researchers. The IPA representation of phonemes is discussed in section 2.2.

Nath (2012) reports five oral vowels in Deori /i,u,e,ɔ,ɐ/. Nath also reports the presence of nasalized vowels in Deori which is an outcome of the deletion of the final nasal consonant. Nath further states that Deori exhibits vowel shortening where diphthongs in word-final position shorten and changes to a monophthong (for example: *bario* > *barɔ* "their"). Nath also suggests that there occurs vowel shift in Deori where the front and the back high vowels are lowered except for open-mid central vowel /ɐ/ which rises to low mid vowel /ɔ/. However, Nath (2012) has not presented any evidence to substantiate his claim.

Deori (2012) presents a five-vowel system in Deori /i,e,a,o,u/. Deori (2012) suggests that vowels can occur in all three positions, initial, medial, and final.

Saikia (2013) reports seven vowels in the language /i,e,ɛ,a,o,ɔ,u/. Saikia posits that while the mid-central vowel /e/ and /o/ has very limited usage in Deori, the high central vowel /ɛ/ and /ɔ/ is used extensively in the language. Saikia (2013) suggests that the high vowel /u/ has a length distinction as it is realized both as a short vowel in words like *akũ* "ear", *giku* "brain", *tʃu* "good" etc and as long vowel in words like *tʃikuru*: "skin", *hakuru*: "face". Vowels /a, ɛ, i, ɔ, u/ occur word-initially, medially and finally and mid-central vowel /e/ and /o/ occur word-initially and word-medially but not finally. The analysis of the vowels by Saikia (2013) highlights the co-occurrence restriction of vowels in Deori which will be explored more elaborately in section 2.5 of this chapter.

From the analysis, it is evident that similar to the consonant inventory there are inconsistencies in the proposed vowel inventory of Deori. Table 2.14 below summarizes the different vowel inventories[35] proposed by various researchers,

[35] Vowel inventories as proposed by various researchers are represented by IPA symbols in table 2.14.

	Low					High					Mid				
	open back	back		open mid central vowel	near open	front		back		near back	front		back		central
Brown (1850)	a					i		u		ɯ	e		o		
Brown (1895)			ɒ		æ		ɪ		ʊ		e	ɛ	o	ɔ	ə
Goswami (1994)		ɑ				i		u			e			ɔ	ə
Jacquesson (2005)	a					i		u			e		o		
Nath (2012)				ɐ		i		u			e			ɔ	
Deori (2012)	a					i		u			e		o		
Saikia (2013)	a					i		u			e	ɛ	o	ɔ	

Table 2.14: Vowel inventory of Deori proposed by various researchers.

This shows that more than one vowel inventory is proposed for the same language. A set of nine vowels is the largest vowel inventory in Deori proposed by Brown (1895). While Goswami (1994), Jacquesson (2005), and Nath (2012) propose that there are five oral vowels in the language, they vary in their description of the low vowel. While Goswami (1994) and Jacquesson (2005) report the presence of a low back vowel /ɑ/ in the vowel inventory, Nath (2012) reports the presence of an open-mid central vowel /ɐ/ in the vowel inventory. The most agreed upon vowels among the researchers are low back vowel /ɑ/, close-mid front vowel /e/, front high vowel /i/, close-mid back vowel /o/ and front-back vowel /u/.

Vowels which stand out as unique in the description of the researchers are: close back vowel /ɯ/, low back vowel /ɒ/, high back vowel /ʊ/, high front vowel /ɪ/ (Brown, 1895), reduced centralized vowel /ə/ (Brown, 1895; Goswami, 1994) and open-mid central vowel /ɐ/ (Nath, 2012). Jacquesson (2005) and Saikia (2013) have stated that the occurrence of close-mid front vowel /e/ and close-mid back vowel /o/ have co-occurrence restrictions which provide a clear insight into the phonological process of vowel harmony in the language. Apart from the oral vowels, Goswami (1994) and Jacquesson (2005) have stated that nasalization in Deori is phonemic. Jacquesson (2005) has listed five oral and five nasal vowels in Deori. The irregularities in the description of the vowels in the existing literature led us to examine the vowel inventory of Deori to ensure the number and quality of vowels in the language. Similar to the consonants, the vowels are discussed in terms of distinctive features. The number of distinct oral vowels and the vowel height difference of oral and nasal vowels are also validated acoustically.

2.5 Vowels in Deori

Deori has ten vowels: 5 oral vowels /ɑ, ɛ, i, ɔ, u/ and 5 nasal vowels /ɑ̃, ɛ̃, ĩ, ɔ̃, ũ/. At first, we will discuss the oral vowels in Deori followed by nasal vowels. Table 2.15 shows the possible minimal pairs in Deori with five distinctive oral vowels, represented by /i, ɛ, ɑ, ɔ, u/.

Minimal pairs	
tʃɑ	'bad'
tʃi	'blood'
tʃu	'good'
tʃɛ	'milk'
tʃɔ	'to contain'

Table 2.15: Vowel minimal pairs in Deori

Phonologically, mid vowels are marked compared to high and low vowels (e.g. Beckman, 1997). Cross-linguistically, the occurrence of high vowels is persistent in vowel inventories, and the presence of mid vowels implicit the presence of high vowels in an inventory, but not vice-versa (Kenstowicz, 1994). The list of contrastive minimal pairs in Table 2.15 highlights the presence of two high vowels /i/, /u/, two mid vowels /ɛ/, /ɔ/, and one back vowel /ɑ/ in the vowel inventory of Deori. Phonemic vowel length was not found in Deori which agrees with Brown (1895). Low vowel /ɑ/ in Deori is a back unrounded vowel, unlike Brown (1850), Brown (1895), Jacquesson (2005), Deori (2012), Nath (2012), and Saikia (2013). The distinctive feature specification of the oral vowels is illustrated below.

	Front	Back	
high	i	u	+ATR
mid	ɛ	ɔ	-ATR
low		ɑ	-ATR

Table 2.16: Distinctive feature representation of oral vowels in Deori

Table 2.16 demonstrates that the high vowels /i/ and /u/ are represented with the feature specification [+high +ATR], the mid vowels /ɛ/ and /ɔ/ are specified as [-high -ATR] and the low back vowel /ɑ/ is specified by the feature [-high -ATR]. A full examination of the vowels highlights that the occurrence of the mid vowels [e] and [o] in the stem phonology of Deori is derived through vowel harmony. The mid vowels [e] and [o] occurs when followed by high vowels /i/ and /u/ and not elsewhere. The mid vowels [e], [o] are specified with the phonological feature of [+ATR] as it is pronounced with an advanced tongue root. Let us consider the following examples:

(2) Co-occurrence restriction of the mid vowels [e], [o] and /ɛ/, /ɔ/.

(i) Mid vowels [e], [o]

a.	ekũ	'smoke'
b.	beku	'beans'
c.	tʃegu	'bow'
d.	joɹu	'bride'
e.	sosi	'middle'

(ii) Mid vowels /ɛ/, /ɔ/

a.	gubɔ	'head'
b.	ditɔ̃	'neck'
c.	sudzɛ̃	'rice beer'
d.	siɹɛ	'world'
e.	pɔpɔ	'tree'
f.	tʃɛpɛ	'cold'
g.	gɛpɑ	'basket'
h.	mɔ̃sɑ	'child'

Example 2 shows the co-occurrence restriction imposed on the occurrence of [+ATR] mid vowel [e], [o] with [-ATR] mid vowels /ɛ, ɔ/ within a word domain. Mid vowels [e], [o] and /ɛ, ɔ/ cannot freely co-occur. High vowels /i, u/ which are [+ATR] co-occur with each other and themselves in all positions of a word, such as *kiɹi* "poor/thread", *simĩ* "needle"; *pitʃu* "meat", *tidzu* "jackfruit", *dubu* "snake", *mũsu* "cow". The [-ATR] mid vowels /ɛ/ and /ɔ/ occurs to the right of the [+high, +ATR] vowels, for instance, *siɹɛ* "world", *gimɛ̃* "respectable person", *pidzɔ* "unripe", *sitɔtɔ* "sour", *sudzɛ̃*, "rice beer", *gubɔ̃* "head", whereas [+ATR] mid vowels occur to the left, for instance, *ekũ* "smoke", *tʃegu* "bow". Low vowel /ɑ/ occurs with both [-ATR] vowels /ɛ/, /ɔ/ and also with [+ATR, +high] vowels /i/, /u/, *asi* "mountain", *pisa* "son". Example 2 exemplifies that [+ATR] mid vowels [e] and [o] are the allophonic variation of [-ATR] mid vowels /ɛ/ and /ɔ/, unlike Brown (1850), Brown (1895), Goswami (1994), Jacquesson (2005), Deori (2012), Nath (2012), and Saikia (2013). The occurrence of [±ATR] mid vowels is determined by the following [+ATR] high vowels /i/ and /u/. The surface alternations are due to vowel harmony which will be explored in more detail in Chapter 5.

Deori also exhibits 5 distinct nasal vowels /ɑ̃, ɛ̃, ĩ, ɔ̃, ũ/. From the markedness perspective, nasalized vowels are more marked than oral vowels (Kenstowicz, 1994). The existence of nasal vowels in a language implies the presence of oral vowels in the language, but not vice-versa. It is attested in the literature (Ferguson, 1963; Greenberg, 1966; Schane, 1968, 1972; Lightner, 1970; Hyman, 1972; Foley, 1972; Stahlke, 1971a) that nasalization of vowels necessitates two stages. First, a syllable-final nasal triggers regressive vowel nasalization, and secondly, the syllable-final nasal gets deleted but the feature [nasal] remains. This context of nasalization of vowels is referred to as "nasal effacement" by Foley (1975). Thus the presence of nasal vowels may be the outcome of a context where a sequence of oral vowels existed in close adjacency with nasal consonants before the deletion of the consonant. Jacquesson (2005) states there is evidence of Deori exhibiting VC syllable types, the coda consonant being the nasal consonant which in due course of time got deleted and the feature [nasal] is attributed to the preceding vowel, for instance, *aŋ* > *ã* "first person singular", *tʃituŋ* > *tʃitũ* "rope/old" *utuŋ* > *utũ* "belly", *akuŋ* > *akũ* "ear/upland", *gĩɹiŋ* > *gĩɹĩ* "second month of the Assamese calendar", *dzuɹɔŋ* > *dzuɹɔ̃* "summer", *tʃĩjaŋ* > *tʃĩjã* "fish/wife of younger brother", *ãjaŋ* > *ãjã* "daughter in law", and *gijaŋ* > *gijã* "planter". This process of nasalization in Deori can be referred to as a process of "nasal effacement". Here, data have been provided to show nasal effacement, a diachronic process. Whether or not all nasalized vowels in Deori are a result of nasal effacement is open to conjecture. Nasal effacement in Deori is diachronic, not synchronic. Jacquesson (2005) also posits that Deori exhibits distinct nasal vowels and presents a list of homophonous words maintaining oral-nasal vowel contrasts, exemplified in (3).

(3) Contrastive Nasalization (Jacquesson, 2005)

	Oral		Nasal	
a.	bi	'peel'	bĩ	'carry'
b.	dzu	'call'	dzũ	'pierce'
c.	pɛ	'rice cake'	pɛ̃	'sell'
d.	bɔ	'beat'	bɔ̃	'put on hat'
e.	kɑ	'bitter'	kɑ̃	'burn'

The presence or absence of a nasal vowel in Deori as exemplified in (3) changes the lexical meaning of a word. For instance, the words *bi* "peel" and *bĩ* "carry" have different meanings because of the nasal-oral vowel contrasts. Furthermore, vowels in proximity to nasal consonants are also nasalized in Deori (for example: *mɛ̃ba* "fat", *mɔ̃sa* "child", *timũ* "mango", *tʃimĩ* "tail" etc.). It has been well-attested in the literature that the number of contrastive nasal vowels in a language is often less than that of oral vowels (Ruhlen, 1975, 1978; Bhat, 1975; Crothers, 1978; Beddor, 1983; Wright, 1986; Padgett, 1997 among others). Perceptual distinctiveness of vowels are supposed to be reduced by the presence of nasalized vowels and hence the less number of nasal vowels. For instance, Lakhota (North and South Lakhota) has five contrastive oral vowels (ɪ, u, o, ɛ, a) but only three nasal vowels (ĩ, ũ, ã) (Boas and Delora, 1941). However, in Deori, all phonemic oral vowels /i, ɛ, ɔ, u, ɑ/ have their nasal counterparts /ĩ, ɛ̃, ɔ̃, ũ, ɑ̃/. The presence of nasal vowels is symmetrical in Deori as all oral vowels irrespective of vowel height have their nasal counterparts. Nasalized mid vowels [ẽ] and [õ] also appear in Deori as in *timõɹu* "coconut" *amõdzi* "dirty" *kemõdzi* "cotton" *tʃemẽtʃi* 'ant'. However, there are some lexical words which do not exhibit nasalized mid vowels [ẽ] and [õ], for instance, *jɛ̃.si* "fire. SEL[36]", *disɔ̃.si* "pot.SEL", *bibɔ̃.si* "granary.SEL"[37]. At this point, we consider that the occurrence of nasalized mid vowels in some cases and non-occurrence of nasalized mid vowels in some cases as an exceptional instance and more research is required to analyze these processes if any. Hajek (1997) notes that languages differ in their preference for nasal vowels. While in Chamorro, an Austronesian language high vowels are nasalized, in Thai low vowels appear to be preferred targets. In Deori, there are no height preferences observed in terms of nasal vowels.

The oral vowels in Deori found in our analysis is similar to the vowel inventory proposed by Jacquesson (2005), Nath (2012), Deori (2012), and Saikia (2013), except for the mid vowels [e] and [o] which are found to be allophones in Deori. Based on our analysis we have found that the lexical items with the close back vowel /ɯ/ (as proposed by Brown, 1850) have changed to back high vowel /u/; low back vowel /ɒ/ and open-mid central vowel /ɐ/ (as proposed by Brown 1895 and Nath 2012 respectively) have changed to low back vowel /ɑ/; high back vowel /ʊ/ (as proposed by Brown, 1850) has changed to back high vowel /u/ and high front vowel /ɪ/ (as proposed by Brown, 1895) has changed to high front vowel /i/. The centralized vowel /ə/ (as proposed by Brown, 1895; Goswami, 1994) is not attested in the vowel inventory of Deori which can be considered as an outcome of language contact resulting in simplification of vowels in Deori. Furthermore, the distinct nasal vowels in Deori found in our analysis agree with Jacquesson (2005) as shown in Table 2.17 below.

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[36] Selective marker

[37] It is to be noted that [-ATR] mid vowels /ɛ/ and /ɔ/ change to [+ATR] [e] and [o] when followed by high vowels /i/ and /u/. But in this case, [-ATR] nasalized mid vowels /ɛ̃/ and /ɔ̃/ do not change to nasalized [+ATR] [ẽ] and [õ] even when followed by high vowels /i/ and /u/. The occurrence of [±ATR] vowels /ɛ/ and /ɔ/ and [e] and [o] will be discussed in detail in Chapter 5.

	Front	Back	
high	i ĩ	u ũ	+ATR
mid	ɛ ɛ̃	ɔ ɔ̃	-ATR
low		ɑ ɑ̃	-ATR

Table 2.17: Oral and Nasal vowels in Deori

After discussing the phonological properties of the vowels, an acoustic analysis of the oral and the nasal vowels has been conducted to corroborate the number of oral and nasal vowels in Deori. We first discuss the analysis of the oral vowels which will be followed by nasal vowels.

2.5.1 Acoustic analysis of oral vowels in Deori

This section presents a detailed acoustic description of the oral vowels based on their phonetic features. The acoustic description of vowels is based on vowel formant frequencies. The following sections present the acoustic-phonetic properties of Deori vowels based on the formant frequency measurements.

2.5.1.1 Methodology

The data used for the production test was constructed after multiple meetings with the native speakers as stated earlier. The word list, reported in Appendix 1, was used for the analysis of the vowels. The target words were recorded using a fixed carrier sentence such as [ã X nina itʃabɛm] *I said X* where 'X' is the target word. Data were recorded in a quiet environment in Bordeori village, Narayanpur, Lakhimpur district, and Naam Deori and Upor Deori village, Jorhat district of Assam. The speakers were between 40-55 years of age at the time of data collection. All the speakers were bilingual; they were equally fluent in Assamese apart from Deori. The word list was thus implemented among the speakers four times each among a set of seven native speakers and was asked to utter at a moderate pace. From the four recorded tokens of each word, three of the samples were selected for analysis. The samples were collected using a Shure SM-10 head-mounted microphone connected to a Tascam DR 100 MK II recorder and digitized at a sampling frequency of 44.1 kHz and 32-bit resolution.

2.5.1.2 Procedure

Acoustic analysis of the vowels was done in Praat 5.3 (Boersma & Weenick, 2016). For the analysis, vowel formants were extracted from vowel midpoint of steady-state vowel formants using a Praat script. To show the perceptual difference between the vowels, the formant frequencies of vowels were converted from Hertz to Mel using Praat's inbuilt function Hertz to Mel. Vowels are represented based on their first three formant frequencies (F1, F2, and F3). For instance, the first formant (F1) is inversely related to the height feature of the vowel. Thus, a low vowel has a high F1 value and a high vowel has low F1 value. The second formant (F2) is associated with the frontness and backness and is directly related to the frontness and backness of the vowel and the third formant (F3) is related to the roundedness of the vowel. The F3 value is dependent on languages which maintain the contrast between rounded and unrounded vowels. Since in Deori there are no roundedness contrasts, only F1 and F2 frequencies are taken into consideration.

2.5.1.3 Results and Discussion

Duration

Table 2.18 shows the average vowel duration of the contrastive vowels in Deori.

Vowels	Duration (SD)
i	131.35 (22.83)
ɛ	124.12 (16.23)
ɑ	140.15 (10.11)
ɔ	144.23 (15.07)
u	139.27 (15.20)

Table 2.18: Average vowel duration of Deori with standard deviations (SD)

Average vowel duration in Table 2.18 is represented in the bar diagram with standard deviation as error bars in Figure 2.7 below.

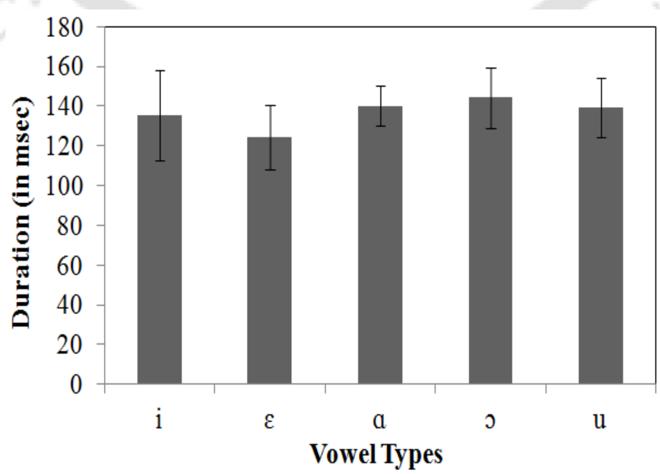

Figure 2.7: Average vowel duration of vowels in Deori with standard deviations as error bars.

To discern the systematic interaction of the individual vowels a posthoc Bonferroni test was conducted. The findings of the posthoc Bonferroni test reveal that the vowels are not significantly different (p>0.05) from one another in terms of duration. Phonemic durational contrast is not attested in Deori, however, Brown (1895), Goswami (1994), Jacquesson (2005), and Mahanta *et al.* (2017) have stated that duration plays a key role in terms of prominence. Prominent syllables exhibit a longer duration and non-prominent syllables exhibit shorter duration which indicates that duration in Deori is predictable. The durational difference of vowels in stressed and unstressed syllables is elaborated in detail in Chapter 3.

Formant Frequency

The values for the first two formants were normalized using Lobanov's (1971) normalization procedure for speaker effects and were plotted on an F1, F2 plane using NORM (Thomas and Kendell, 2007) as presented in Figure 2.8.

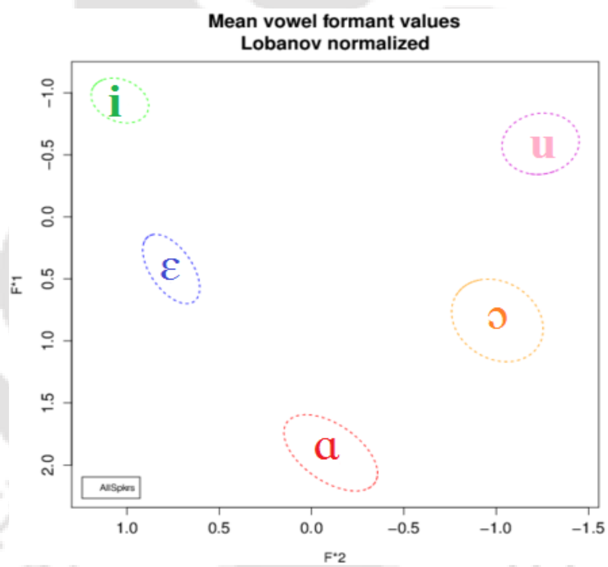

Figure 2.8: Deori vowels.

Vowel plot in Figure 2.8 shows five distinct oral vowels in Deori and confirms the absence of centralized vowel /ə/ in Deori. Non-normalized F1 and F2 formant frequencies (calculated in Mel) are shown in Table 2.19.

Vowel	F1 (SD)	F2 (SD)
i	234.38 (21.72)	893.08 (23.90)
ɛ	346.56 (26.22)	858.59 (26.83)
ɑ	490.88 (23.22)	691.73 (22.46)
u	267.83 (16.28)	512.45 (24.08)
ɔ	391.27 (28.11)	536.60 (23.68)

Table 2.19: Non-normalized average formant values of oral vowels (in Mel) for Deori (male) speakers with standard deviations (SD)

The formant frequency measurements of the vowels /i, ɛ, ɑ, u, ɔ/ in Deori provides evidence that the five vowels are categorically distinct. The frequency of F1 bears an inverse relation to vowel height, lower the value of F1 higher is the vowel. To see the systematic interaction on formant frequencies a pair-wise comparison was done using a post hoc Bonferroni test. The result revealed that in the case of F1, all the vowel pairs differ significantly from each other [(F (4, 416) = 213.33, p <0.05). It suggests that with respect to their vowel heights Deori vowels are categorically distinct from each other. Similarly, in case of F2, we noticed a significant difference [(F (4, 416) = 326.12, p <0.05)] among the vowels which suggest that concerning their vowel backness Deori vowels are categorically distinct from each other. Thus the vowel plot in Figure 2.8 and the statistical results substantiate the distinctiveness of Deori monophthongs.

2.5.2 Acoustic analysis of nasal vowels in Deori

This section provides an acoustic analysis of the nasal vowels in Deori. It is well known that nasalized vowel inventories are a subset of their oral counterparts in a given language (Padgett, 1997). There have been many observations on vowel quality and extent of nasalization, vowel height for phonemic nasal vowels, and spectral variations of nasal vowels. Ohala *et al.* (1986) states that "nasal high vowels (contextual and non-contextual) are lowered (e.g. nasalization lowers [i] and [u] in Bengali, Ewe, Gadsup, Inuit, and Swahili) and the nasal low vowels (contextual and non-contextual) are raised (e.g. nasalization raises [a] in Breton, Haida, Nama, Seneca, and Zapotec). Mid non-contextual nasal vowels, i.e. distinctive nasalized vowels are lowered, mid-back contextual nasal vowels are raised, and mid-front contextual nasal vowel is raised in a language where mid-back contextual nasal vowel is also raised" (p. 199). While the vowel height of the nasal high vowel and nasal low vowel lowers or raises irrespective of the context, the vowel height of the mid vowel is context-dependent. Padgett (1997) refers to Wright (1986) and Beddor (1993) and enunciates that the reason for the vowel height difference of the nasal vowels is the nasal formant (FN) which has a relatively low and fixed frequency. The nasal formant FN is introduced near to F1 and is perceptually integrated with F1. This means F1 of the nasal vowels are affected by nasalization which results in a change of the nasal vowel height. Researchers like Maeda (1982), Steven (2000), Fant (2004), and Beddor (1991) illustrate that spectral variations of nasal vowels are an indicator of the presence of nasality in a vowel. They further suggest that the first formant (F1) of a nasal vowel is widened and there is an overall reduction in the amplitude of a nasal vowel which evinces the nasality feature in a vowel.

2.5.2.1 Methodology

The methodology adopted for the study of nasal vowels is similar to that of the oral vowels as discussed in section 2.5.1.1. To analyze the distinct nasal-oral contrasts, nasal and oral vowels in CV and CṼ (C being any non-nasal consonant) context were taken into consideration. In total there were ten minimal pairs examined for the experiment. The word list was thus implemented among the speakers four times each among a set of ten speakers and was asked to utter the words at a moderate pace. From the four recorded tokens of each word, three of the samples were selected for analysis. The word list used for the study is presented in Table 2.20.

Oral	Gloss	Nasal	Gloss
kɑ	'bitter'	kɑ̃	'burn'
dzɑ	'dance'	dzɑ̃	'sharp'
pɛ	'rice cake'	pɛ̃	'sell'
dɛ	'big'	dɛ̃	'sound'
gɛ	'hard'	gɛ̃	'paint'
bi	'peel'	bĩ	'carry'
di	'draw a line'	dĩ	'pull'
bɔ	'beat'	bɔ̃	'put on a hat'
dzu	'call'	dzũ	'pierce'
pu	'weave'	pũ	'nasal'

Table 2.20: Nasal-Oral vowels minimal pairs in Deori

2.5.2.2 Results and Discussion

The acoustic correlate F1, in a nasal vowel, increases for a high vowel and decreases for a low vowel. F1 is the acoustic cue for vowel height distinction of oral-nasal vowels. Table 2.21 demonstrates the non-normalized F1 values of oral-nasal vowels in Deori.

Oral vowels	F1 (SD)	Nasal vowels	F1 (SD)
i	234.38 (21.72)	ĩ	230.24 (25.27)
ɛ	346.56 (26.22)	ɛ̃	372.45 (29.65)
ɑ	490.88 (23.22)	ɑ̃	452.92 (21.19)
ɔ	391.27 (28.11)	ɔ̃	432.77 (23.07)
u	267.83 (16.28)	ũ	263.15 (24.94)

Table 2.21: Non-normalized F1 values (measured in Hz) of oral and nasal vowels with standard deviations (SD)

The F1 values in Table 2.21 show that the high nasal vowels /ĩ/ and /ũ/ exhibit almost the same F1 values with that of their oral counterpart /i/ and /u/. The F1 of nasal high vowel /ĩ/ (230.24 Hz) and /ũ/ (263.16 Hz) are only 4 Hz lower than their oral counterpart /i/ (234.38 Hz) and /u/ (267.83 Hz) and are not statistically different from each other. The mid oral vowels /ɛ/ (346.56 Hz) and /ɔ/ (391.27 Hz) has lower F1 values than its nasal counterparts /ɛ̃/ (372.45 Hz) and /ɔ̃/ (432.77 Hz) respectively and the difference is statistically significant (/ɛ/ ~ /ɛ̃/ [(F (1,598) = 112.31, $p<0.05$)]), (/ɔ/ ~ / ɔ̃/ [(F (1,598) = 201.11, $p<0.05$)]). The low oral vowel /ɑ/ has a higher F1 value (490.88 Hz) than the low nasal vowel /ɑ̃/ (452.92 Hz) and the difference is statistically significant (/ɑ/~/ɑ̃/ [(F (1,598) = 175.34, $p<0.05$)]). The F1 values are represented in a bar diagram with standard deviation as error bars in Figure 2.9 below.

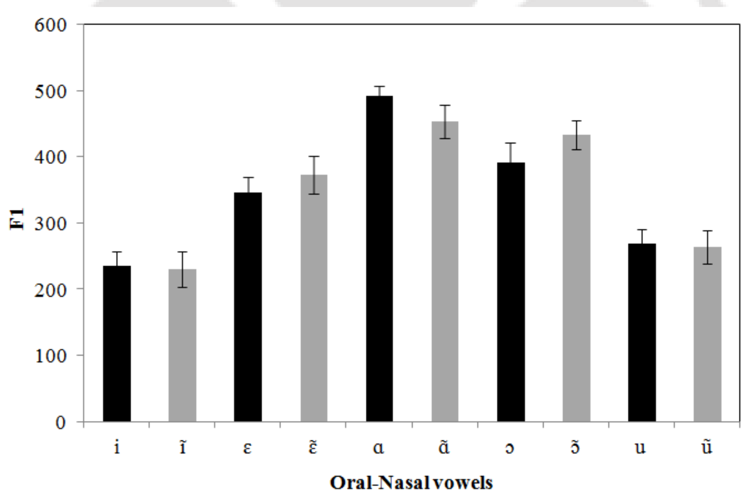

Figure 2.9: Average non-normalized F1 of oral and nasal vowels in Deori with standard deviations as error bars

The bar diagram in Figure 2.9 shows that the low nasal vowel /ɑ̃/ has less F1 than the oral counterpart /ɑ/ which indicates that the vowel height of the low nasal vowel is higher than the low oral vowel. The F1 of the mid nasal vowels is higher than the oral vowels and hence the perceived vowel height of the mid nasal vowels is lower than its oral counterpart. While vowel height of the mid nasal vowels and low nasal vowel is affected by nasalization, the vowel height of the front and back high vowel is not affected by nasalization in Deori.

2.6 Conclusion

This chapter has mainly reviewed the segmental properties of Deori and has presented a detailed analysis of the contrastive phonemes in Deori based on collected speech data. The detailed feature representation of the phonemes is described within the theoretical framework of distinctive feature theory. The findings suggest that Deori has 14 distinct consonants /p,t,k,b,d,g,m,n,s,tʃ,dz,j,l,h/ and three allophones [ŋ], [ɹ], and [w]; 10 distinct vowels (5 oral /ɑ,i,ɛ,ɔ,u/ and 5 nasal vowels /ɑ̃,ĩ,ɛ̃,ɔ̃,ũ/) and two allophones ([e] and [o]). The phonemes [+nasal] /n/, [+lateral] /l/ and [+stop] /p/ have three allophonic variations, [+nasal] [ŋ], [-lateral] [ɹ], and [+continuant] [w] respectively. Nath (2012) reports /ɾ/ as a tap or flap, whereas our analysis suggests it as an alveolar approximant [ɹ]. Furthermore, Jacquesson (2005) reports voiced post-alveolar affricate /dʒ/ as the underlying phoneme, whereas our findings suggest voiced alveolar affricate /dz/ as the underlying phoneme in Deori. Deori has retained the phonological contrast of [±voice] segments in obstruent stop category; however, the [spread glottis] feature has surfaced as a free variation, unlike Brown (1895). The most ubiquitous segments in the phonological inventory of Deori are the [±voice] stops and [+voice] nasal segments. Deori has also retained the [±voice] affricate /tʃ/ as proposed by Brown (1850), Brown (1895), Goswami (1994), Jacquesson (2005), Deori (2012), and Saikia (2013). The underlying phoneme [±continuant +delayed release] /dz/ variably changes to [+continuant] /z/ which can be attributed to contact-induced language change. [-continuant] /tʃ/ occurs as a free variant of [+continuant] /s/ instead of [+continuant] /ʃ/, unlike Goswami (1994), Jacquesson (2005), and Nath (2012). [-voice +continuant] /x/ is reported as a distinctive phoneme in Deori by Goswami (1994), however, our findings specify that [-voice +continuant] /x/ does not occur in the inventory. The lexical items with [-voice +continuant] /x/ in Goswami (1994) surfaces as /h/ in Jacquesson (2005) and Saikia (2013), as well as in our findings. Nath (2012) mentioned that voiced glottal fricative /ɦ/ changes to /x/ intervocalically and cites an example: *muɦini* > *muxini* “two”; however, no such change was noticed in our findings. A full examination of the consonant inventory highlights that Deori exhibits a wide range of free variation, of which the salient phonological variations are (a) free variation of [±spread glottis] /p/, /t/, /k/ and /p^h/, /t^h/, /k^h/ (b) free variation of [±delayed release,

±anterior] /s/ and /tʃ/ and vice-versa and (c) free variation of [±delayed release] /dz/ and /z/. The lack of glottal stop /ʔ/ in Deori unlike other Bodo-Garo languages in the vicinity can be assumed to be an outcome of acute language contact with Assamese.

Deori exhibits five contrastive oral vowels /i,ɛ,ɑ,ɔ,u/, unlike other Bodo-Garo languages in its vicinity[38]. The absence of reduced vowel /ə/ in the phoneme inventory of Deori can be considered as a unique linguistic feature of Deori belonging to the Bodo-Garo language family. [+ATR] vowel [e] and [o] are allophones in Deori which occurs in the stem phonology of Deori when followed by [+high +ATR] vowel /i/ and /u/. Duration is non-phonemic in Deori. Contrastive nasal vowels are sparsely distributed in the world's languages than corresponding oral vowels; but, in Deori all five contrastive oral vowels have their nasal counterparts. The presence of phonemic nasal vowels and the absence of a centralized vowel in Deori is an unusual linguistic feature of Deori, unlike other Bodo-Garo (Tiwa, Dimasa, Bodo, and Garo) languages.

The absence of glottal stop /ʔ/ and reduced centralized vowel /ə/ in the phoneme inventory of Deori and inclusion of voiced alveolar fricative /z/ as a free variant of voiced alveolar affricate /dz/ show that language contact has gradually influenced the phoneme inventory of Deori. It can be assumed that proximity to Assamese[39] is affecting the phonology of Deori leading to the simplification of phonemes in Deori. Although Deori has retained most of the phonemes as discussed in the existing literature, the absence of glottal stop and reduced centralized vowel highlight that Deori phoneme inventory has changed. Moreover, the wide range of free variation in Deori stipulates that the phonemes are not stabilized in Deori which might lead to a complete phonological reconstruction of the underlying distinctive phonemes in Deori in the long run.

After a detailed examination of the phoneme inventory of Deori in this chapter, the next chapter (Chapter 3) discusses the word prosodic structure of Deori. The main focus of the chapter is to examine the syllable structure of Deori and the prominence pattern attested in the language. Syllables are linked to both segmental and suprasegmental level, hence a detailed description of the syllable structure has an important role in the phonology of a language.

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[38] Garo, Rabha, and Bodo have 6 vowels (Joseph and Burling, 2006). Centralized vowels /ə, ɨ/ are characteristic features of these languages (Post and Burling, 2017).

[39] Although Assamese vowel inventory (8 vowels - /ɑ,ɛ,e,ɔ,o,i,u,ʊ/) and consonant inventory (23 consonants - /p,b,t,d,k,g,p^h,b^h,t^h,d^h,k^h,g^h,m,n,ŋ,s,z,x,ɦ,ɹ,j,w,l/) are greater in number than Deori, it can be assumed that absence of centralized vowel and glottal stop in Deori is a result of language contact leading to simplification of phonemes in Deori.

Chapter 3 - Word Prosody and Prominence pattern in Deori

3.1 Introduction

This chapter investigates the syllable structure and word-level prominence pattern in Deori. The word-internal structure is analyzed based on the Prosodic Hierarchy (Selkirk, 1980) and the prominence pattern is discussed within the framework of the metrical theory of stress assignment. The central assumption of *metrical phonology*, a theory developed in the 1970s, "is that stress is a rhythmic phenomenon, encoded by strong-weak relations between syllables" (Liberman and Prince, 1977; Hayes, 1980, 1995; Halle and Vergnaud, 1987). To represent stress, *metrical theory* assumes a set of universal prosodic constituents to be organized into a hierarchy: the prosodic hierarchy[40] (Selkirk, 1980; McCarthy and Prince, 1986).

(4) Prosodic Hierarchy

Pr WD	Prosodic Word
|	
FT	Foot
|	
σ	Syllable
|	
μ	Mora

The basic intuition of the prosodic hierarchy is that phonological words are constructed of foot, where foot is constructed of sequences of syllables and syllables are formed of prosodic units called moras. Mora plays a fundamental role in phonotactic processes including stress assignment and word shape in many languages. In this chapter, it will be shown that in Deori the lexical word can be analyzed into the foot (feet), which is analyzable into syllables and which in turn contain morae. An acoustic experiment has also been conducted to investigate phonetic cues to stress in Deori.

The structure of this chapter is as follows. Section 3.2 gives a brief exposition to metrical phonology. Section 3.3 discusses the morphology of Deori. Section 3.4 discusses the Deori

[40] Here we are referring to the part of the prosodic hierarchy that is relevant to stress. In general, larger constituents above the word have been proposed for the prosodic hierarchy.

syllable structure and distribution of phonemes in different syllable types. Section 3.5 elucidates the prominence pattern in Deori and presents the analysis of foot construction in Deori. Section 3.6 reports acoustic results conducted to investigate phonetic cues to prominence in Deori and the chapter ends with concluding remarks in section 3.7.

3.2 Metrical Phonology

The grounded theory of metrical phonology pioneered by Liberman and Prince (1977) is based on the "radical revision for the representation of stress" (Hayes, 1980, p. 6). Stress in metrical phonology is considered to be a matter of relative prominence among syllables which is rhythmic. The representation of the relative prominence pattern is exhibited using a binary branching tree structure. In a binary branching tree, each pair of sister nodes are labeled 'strong' and 'weak' based on the relative strength of one node over the other as in (5).

(5)

(Hayes, 1980)

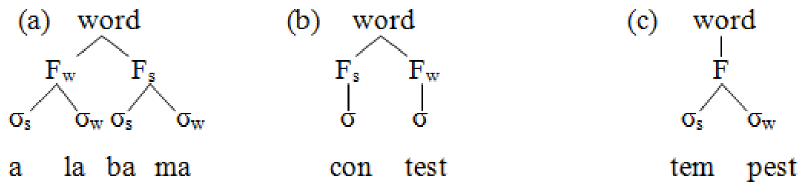
Stress placement in (5) indicates that in a word domain a syllable attains its prominence in relation to its adjacent lesser prominent syllable. For example, in (5a) the initial syllable *car* of the word *carrot* is prominent in relation to the adjacent syllable *rot* which is weak. Similarly, in (5b) *attain* the word-final syllable *tain* is prominent in relation to the word-initial syllable *at*.

A relative prominence structure was proposed by Liberman and Prince (1977). However, they could not completely do away with the segmental feature [±stress]. The feature [±stress] was retained to address prominence distinctions in English which the metrical tree failed to handle (Hayes, 1980). For instance, in word pairs such as *cóntèst* vs. *témpe̱st* (Kager, 1995), the prominence level among the syllables are identical but the degree of stress assignment of the two syllables differ. Thus, Liberman and Prince (1977) retained the segmental feature [±stress] with a greatly reduced role[41] and used it to represent the prominence pattern of word pairs whose strong-weak trees were indistinguishable. In this regard, *metrical feet* was proposed by Halle and

[41]The segmental feature [stress] was represented by values such as [´,ˆ,` , and ˇ] by Tager and Smith (1957) and (1,2,3,4) by Chomsky and Halle (1968). Later, Liberman and Prince (1977) reduced the scope of the feature [stress] and represented it in binary (±) values.

Vergnaud (1978), Prince (1980), and Selkirk (1982 a) in favor of replacing [±stress]. The representation of the prominence pattern after incorporating feet is given below:

(6)



(Kager, 1995)

According to the schematic representation in (6), each foot consists of a stressed syllable, and the main stress bearing syllable is the strongest syllable of the foot. Syllables are classified as either light or heavy and this division of light and heavy syllables is essential for stress assignment (Newman, 1972; McCarthy, 1979b; Steriade, 1982; Clements and Keyser, 1983; Zec, 1988; Hayes, 1989; Kager, 2007). The bifurcation of light and heavy syllables or syllable weight is accounted for by *mora* which is considered as a unit of quantity (Hayes, 1980, 1985; McCarthy, 1979b; Kager, 1993). Thus, the introduction of *mora* in the metrical theory justifies the hierarchical representation in (4).

3.2.1 The universal metrical inventory

Kager (1993) states that the defining property of stress other than the rhythmic property is it's "culminative, hierarchical and lack of assimilatory property" (p. 369). The properties of stress are discussed below:

(7) Foot type – Maximal Foot Construction Principle governs foot construction "which ensures that the largest possible foot must be constructed" (Kager, 1993, p. 371). Culminativity and exhaustivity lead to monosyllabic expansion or degenerate feet. Culminativity means that each content word needs to have at least one stressed syllable which forms a well-formed foot and exhaustivity means that all syllables of a word must be structured into feet (Kager, 1993). Further, words with an odd number of syllables which cannot be parsed in maximal feet, the remaining syllable remains unparsed.

(8) Directionality – Directionality determines "the direction in which foot construction scans the stress domain: starting at the right edge (right-to-left), or the left edge (left-to-right)" (Kager, 1995, p. 373). Foot construction starts at word edge where the stress pattern is fixed and on the other edge, the stress pattern varies depending upon the number of syllables in a word.

(9) Foot dominance – The position of the foot where the head is located is governed by foot dominance. In right-dominant feet, right nodes are dominant, and left nodes are recessive and in left-dominant feet, it is the other way round.

A primary assumption of the metrical theory is that there is a small universal inventory of foot types and languages can only select types from this inventory (Kager, 1996, p. 6). Cross-linguistically, the foot typology consists of the following:

(10) Syllabic trochee (σ σ)
Moraic Trochee (L L) or (H)
Iamb (L σ) or (H)

A syllabic trochee is a metrical foot wherein prominence lies in the initial syllable and it lacks a syllable weight contrast. Similar to syllabic trochee, in moraic trochee initial syllable bears prominence, however, unlike syllabic trochee, moraic trochee consists of two moras. An iamb is a metrical foot with final prominence. This universal foot inventory is based on the Iambic-Trochaic law formulated by Hayes (1985, 1987).

(11) Iambic-Trochaic Law (henceforth ITL) (Hayes, 1985, 1987).
a. Elements contrasting in intensity naturally form groupings with initial prominence.
b. Elements contrasting in duration naturally form groupings with final prominence.

The ITL predicts an asymmetry between iambic and trochaic stress rules. Kager (1993) restates the law as follows:

(12) a. Trochaic systems have durationally even feet.
b. Iambic systems have durationally uneven feet.

In iambic and trochaic stress patterns the stress is placed on a particular syllable on the left or right orientation of a word. "In trochaic languages, lengthening is uncommon whereas in iambic languages lengthening is frequent and fulfills a rhythmic target" (Hayes, 1995, p. 84). A well-formed hierarchical representation of the foot construction (Prince, 1991) shows that both uneven quantitative trochee [$\sigma_{\mu\mu}$ σ_{μ}] and a monomoraic foot [σ_{μ}] are permissible, but both occupy a low rank in the hierarchy.

(13) a. Trochees: $[\sigma_{\mu\mu}]$, $[\sigma_{\mu}\ \sigma_{\mu}] > [\sigma_{\mu\mu}\ \sigma_{\mu}] > [\sigma_{\mu}]$

b. Iambs: $[\sigma_{\mu\mu}\ \sigma_{\mu}] > [\sigma_{\mu\mu}]$, $[\sigma_{\mu}\ \sigma_{\mu}] > [\sigma_{\mu}]$ (Prince, 1991)

The markedness in the foot typology in (13) and in the well-formed ranking typology in (10) is a result of the Binarity Principle as in (14) (Prince, 1991). Binarity Principle states that a well-formed foot must contain two syllables or two moras minimally.

(14) Binarity

Feet should be analyzable as binary

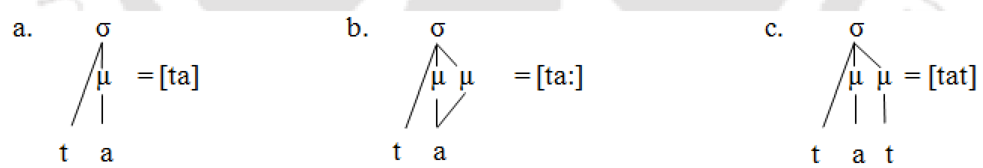
The Binarity principle suggests that every prosodic word must minimally be a disyllabic or bimoraic foot depending on the prosodic typology of the language.

In the next section, we discuss the moraic theory and syllable structure.

3.2.2 Moraic theory and syllable structure

Moraic Theory (McCarthy and Prince, 1986, 1988, 1990 a, b; Archangeli, 1989; Hayes, 1989; Itô, 1989) is the notion of syllable weight which determines whether a syllable is monomoraic or bimoraic. Hayes (1989, p. 254), following the moraic theory schematically represents few syllable patterns as in (15).

(15)



From the above schematic representation, it is evident that (15a) is a light syllable as it contains only one mora, whereas (15b) and (15c) are heavy syllables based on their bimoraic content. The schematic representations in (15b) and (15c) suggest that CVV and CVC syllables differ from each other, not in terms of moraic configurations but in terms of segmental associations. Languages vary in their speculation as to which syllables will be considered as heavy and which as light. While in Latin CV syllables are counted as light syllables and CVV and CVC as heavy syllables, in languages like Huasteco Mayan (Hyman, 1977) and Tiberian Hebrew (McCarthy, 1979) CV and CVC syllables are considered as light syllables and CVV syllables are considered as heavy syllables. In languages where coda consonants are counted as heavy is assigned a mora as in (15c). Hayes (1985) formulates *Weight by Position* rule to distinguish between weight pattern typologies termed. Languages wherein CVC syllables are considered as heavy obey Weight by Position rule, where the coda consonant is assigned a mora.

With a general background on the metrical theory of stress systems, we now proceed to discuss the word prosodic structure of Deori followed by word-level prominence pattern from the perspective of metrical phonology discussed briefly until this point. Before discussing the syllable structure of Deori, the morphology of Deori is discussed.

3.3 Morphology of Deori

Bodo-Garo languages are rich in suffixes and prefixes are less prominent and they are usually derivational rather than inflectional (Joseph and Burling, 2006). In terms of morph syntax, Deori too conforms to the morphological structure of Bodo-Garo languages. Deori is a verb-final language and has extensive zero nominal anaphora (Jacquesson, 2005). Suffixes are extensive in number and the prefixes in Deori have fully got attached to the main root of the word and now it is difficult to differentiate between a prefix and a stem root (Jacquesson, 2005).

Deori morphology consists mostly of disyllabic words and monosyllables are rare in Deori (Jacquesson, 2005). Jacquesson (2005) states that except for a few Assamese loan words, the most common monosyllables are personal and demonstrative pronouns and a disyllabic word is often possible to split into monosyllabic morphemes, for instance, e.g. *durô* "kite" can be split into *du-rô*. Prefixes provide examples of the way most of the trisyllabic words are derived in Deori. A prefix like *apa-* precedes the name of body parts related to legs like *apa-su* "leg", *apa-ti* "thigh", *apa-kuɹ* "shoe". However, there are some trisyllables/quadrisyllables in the Deori lexicon which have no evidence of being derived and is considered as monomorphemic trisyllables by Jacquesson (2005); for example *mĩdige* "cat", *lepedur* "goat", *sipere* "door", *gupɔnĩ* "cover, lid" etc. The number of trisyllabic roots in the Deori lexicon is minimally attested in the language as reported in Jacquesson (2005).

Classifiers in Deori are added to the numerals which describe nouns (Jacquesson, 2005). For instance, the cardinal numeral *tʃa/dza* "one" is preceded by the classifier *gu-* when it refers to nouns denoting bamboo, pencil, and animals as in *gudza mɛgɔ̃* "one lion" and the cardinal numeral *tʃa/dza* "one" is preceded by *pɛ-* when it refers to nouns denoting body parts as *pɛtʃa* *gutũ* “one nose”. Classifiers such as *du*- precedes nouns referring to birds such as *duka* “crow”, *dupa* “cock”, *duɹɔ̃* “hawk”, *dudi* “peacock”, *dudzi* “peasant” and exceptionally in *durɛ* “donkey”. Classifier *mɛ̃*- precedes the name of quadrupeds such as *mɛ̃sa* “tiger”, *mɛ̃si* “deer”, *mɛ̃gɔ* “elephant”; however, words such as *tʃi* “dog” and *mĩdigu* “cat” are not preceded by the classifier *mɛ̃*. The classifier *mɛ̃* is also used as a free morpheme which means ‘goat’.

Deori has six nouns that contain the first syllable *pi*- which is considered as a possible prefix by Jacquesson (2005). The nouns that the prefix *pi* gets attached to are *pisa* “son”, *pisu* “grandson”, *pidzɔ̃* “raw”, *pitʃu* “flesh”, *pipɔ̃* “tree”, *pitʃɔ̃* “front”.

Deori is an agglutinative language with abundant suffixation and few prefixations. In this dissertation, mostly monosyllabic and disyllabic words, and very few polysyllabic words are considered for analysis. This is because nonderived polysyllabic words are minimally attested in Deori (as discussed in this section).

3.4 Syllable structure and distribution of phonemes in Deori

The findings reported in this chapter reveal that disyllabic roots are predominantly found in Deori which agrees with Jacquesson (2005). Monosyllables other than personal and the demonstrative pronoun also exist in the language, unlike Jacquesson (2005). The frequently occurring syllable combinations in Deori are as follows:

(16) Basic syllable structure of Deori

a.	V(C)	ĩ(n)	‘cloth’
b.	V.CV	udzũ	‘navel/bamboo tube’
c.	VC.CV	ɑmsu	‘mat’
d.	CV(C)	tʃi(n)	‘blood’
e.	CV.CV	tʃipɑ	‘father’
f.	CVC	dɑm	‘wh-word’
g.	CVC.CV	kundi	‘God’
h.	CVV	gui	‘betel-nut’
i.	CV.CV.CV	kipiɹɑ	‘caterpillar’

Following the universal syllable typology (Leben, 1980; McCarthy, 1981a; Steriade, 1982; Clements and Keyser, 1983), Deori employs CV syllable type as the unmarked syllable type. The canonical syllable structure in Deori is (C)V(C), with an optional onset and an optional coda. Examples in (16), shows that Deori exhibits mostly open syllables. Phonologically, a vowel is necessary to construct a well-formed syllable; thus in Deori, a vowel can constitute a syllable while a consonant alone cannot constitute a syllable. Therefore in Deori, only vowels are syllabic. Vowel length is not distinctive in Deori (as discussed in Chapter 2), hence, the predictability of length distinction has led us to ignore the moracity of CVV syllable types in Deori. In the next section, the phonotactic restrictions on the occurrences of vowels and consonants in initial and final syllables will be discussed.

3.4.1 Final syllables

Consonants in the coda position of the CVC syllable type are rare in Deori. Hence, coda is a marked position in Deori as fewer segments can occur in this position. There are four sonorant consonants /m/, [ŋ], and [ɹ], [-voice] fricative /s/, and [-voice] obstruent stop /k/ which sometimes occur in the coda position. The nasal consonant /n/ in the coda position subsequently gets deleted leading to the spreading of the [+nasal] feature to the preceding vowel as in (17) (g), (h). Some representative words with restricted coda consonants are shown in (17).

(17)	a.	dɑm	'what'
	b.	kiŋ	'hair'
	c.	ɔs.ti	'finger'
	d.	duk.tʃɑ	'CL[42].one'
	e.	lepeduɹ ~ lepeduɹu	'goat'
	f.	dekumuɹ ~ dekumuɹu	'duck'
	g.	ɑ(n) ~ ɑ̃	'first person singular'
	h.	ɑgu(n) ~ ɑgũ	'knee'

Approximant [ɹ] as a coda is not consistent across the speakers. For instance, words like *lepeduɹ* "goat" and *dekumuɹ* "duck" are pronounced as *lepeduɹu* and *dekumuɹu* (though not a common property across speakers) with a final high vowel /u/ after [ɹ]. Since lexical words with coda consonants are very rare in Deori, we ignore the moracity of CVC syllable types in Deori[43].

There is no occurrence restriction of vowels in the final syllable, for instance, *sɛlɔ* "home-made cigarette", *bɔsɛ* "towel", *tʃegu* "bow", *budzi* "sister-in-law", *gisa* "comb". Vowels co-occur with each other on either side of a word as in *asa* "far", *midi* "God", *pɔpɔ* "tree", *tʃɛpɛ* "cold", *buɹu* "stomach". However, [-high –ATR] vowels /ɛ/ and /ɔ/ and [-high +ATR] vowels [e] and [o]

[42] Classifier
[43] The lengthening in Deori happens to the second syllables and there seems to be no tendency in Deori to choose CVC in these syllables to attract stress.

have co-occurrence restrictions. While [-high –ATR] vowels /ɛ/ and /ɔ/ can co-occur with each other (*tʃɛpɛ* "cold", *mɔ̃kɔ̃* "rice", *sɛlɔ* "homemade cigarette", *bɔsɛ* "towel", *sirɛ* "night", *bibɔ* "granary", *dɛma* "big" etc.) and can occur in both the syllables, [-high +ATR] vowels [e] and [o] can occur only in the initial syllable of an underived disyllabic word (for example: *tʃegu* "bow", *beku* "beans") and in the initial and the medial syllable of an underived trisyllabic word (for example: *lepeduɹ* "goat", *tʃemẽtʃi* "ant"). [-high +ATR] vowels [e] and [o] never occur in the syllable-final position. This is an instance of vowel harmony which will be pursued further in Chapter 5. [-high +ATR] vowels [e] and [o] are allophones in Deori as discussed in Chapter 2 and the occurrences of these vowels are determined by the following [+high +ATR] vowels /i/ and /u/. Nasal vowels in Deori mostly occur in the final syllable as nasalization in Deori can be traced to a final nasal consonant that got deleted (at a previous stage of development of the language) inducing nasalization on the preceding vowel.

3.4.2 Pre-final syllables

Typologically, onsets are unmarked and codas are marked and the same is true for Deori as well. In monosyllabic and disyllabic roots, all consonants except velar nasal consonant [ŋ] can occur in the pre-final position. In Deori, disyllabic roots are preponderant and except [+lateral] /l/ which is restricted to the word-initial position, there is no positional restriction on the occurrence of consonant segments in different syllable positions. The phonotactic restrictions reveal that in Deori the vowels /ɑ,ɛ,i,ɔ,u/ have no positional restriction in its occurrence in the first and the second syllable (for example: *sɛlɔ* "home-made cigarette", *bɔsɛ* "towel", *budzi* "sister-in-law", *gisa* "comb", *asi* "mountain" etc.). The occurrence of [-high +ATR] vowels [e] and [o] is licensed to the word-initial position in monomorphemic disyllabic words as discussed in the previous section.

The unrestricted vowel inventory in both the syllables of disyllabic roots shows that sesquisyllables are not attested in Deori. The term *sesquisyllable* was first coined by Matisoff (1973 b). Sesquisyllable refers to a structure comprising of an unstressed 'minor' syllable followed by a stressed 'major syllable'. The vowel of the minor syllable is typically a schwa or harmonizes with the vowel of the major syllable. This implies that a short centralized vowel occurs in the minor syllable, whereas the major syllable includes the full inventory (Matisoff, 1973 b). While the 'major' syllable is considered a normal syllable, 'minor' syllable is characterized as phonologically and phonetically reduced. The sesquisyllabic structure is considered as one of the important features in Mon-Khmer languages and Proto Tibeto-Burman languages. Tibeto-Burman languages are often divided into ‘schwa-languages’ vs. ‘non-schwa languages’ based on whether they are *sesquisyllabic* or strictly monosyllabic (Matisoff, 1973 b). In his study on Tai languages, Pittayaporn (2005) states that the ‘minor’ syllable includes a more restricted inventory and most often a centralized vowel compared to the ‘major’ syllable. Butler (2014), in her study on South Asian languages, posits a slightly different view on sesquisyllables. She states that vowels other than a centralized vowel can occur in the ‘minor’ syllable, but the vowel quality in the ‘minor’ syllable is lost and transforms into a schwa-like vowel when unstressed. Sesquisyllabicity has been noted in many Tibeto-Burman languages such as Lahu (Matisoff, 1973a), Mizo (Matisoff, 1990), Tangkhul Naga (Matisoff, 2003), Turung (Morey, 2005), and Sumi (Teo, 2014). Deori does not have reduced initial syllables like other Tibeto-Burman languages and thus exhibits no evidence of sesquisyllables. There is no positional occurrence restriction of vowels found in the prefinal syllable in Deori, moreover, vowels in the unstressed position do not transform to a schwa-like vowel which further validates the absence of sesquisyllables in Deori.

3.4.3 Vowel Epenthesis

Vowel epenthesis, as mentioned in Goswami (1994) and Jacquesson (2005), repairs marked syllable structure. Vowel epenthesis[44] in Deori breaks word medial adjacent consonants thereby re-syllabifying CVC.CV syllables as CV.CV.CV as in (18) which shows that CV syllable type is the unmarked syllable type in Deori. The epenthetic vowel in example (18) appears to be an instance of an epenthetic and harmonized vowel. The vowel on the right is copied and shares the same [±ATR] feature of the adjacent vowel. For example, the epenthetic [+high] vowel /i/ in *kokriŋ* → *kokiriŋ* “crab” (18 a), have the same quality as the vowel on the right. Vowel epenthesis also breaks word-initial complex onsets as in (18 d).

[44] A corpus of Deori have been put together to understand epenthesis in the language. At the moment we only have these examples.

(18)	Goswami (1994)			Jacquesson (2005)		Gloss
a.	<kokring>	/kokriŋ/	~	<kokiring>	/kokiriŋ/	‘crab’
b.	<sipre>	/siprɛ/	~	<sipere>	/sipɛrɛ/	‘door’
c.	<lepedru>	/lepedru/	~	<lepeduru>	/lepeduru/	‘goat’
d.	<griji>	/gridzi/	~	<giriji>	/giridzi/	‘sweat’

Vowel epenthesis also repairs a marked syllable structure of borrowed words in Deori. In example (19), the borrowed lexical words from English are epenthesized to fall in line with Deori syllable onsets which shows that complex onsets are disfavored in Deori. The epenthetic vowel /i/ and /ɑ/ breaks the ill-formed consonant cluster *br, *pl, and *gl in Deori.

(19) Epenthesis in loan words (Jacquesson, 2005)

	English	*Deori*
a.	brush	bɑrɑs
b.	plate	pilɛt
c.	glass	gilɑs

The epenthetic vowel in (19) breaks the illicit syllable type CCVCC and CCVCV and creates CV.CVC syllable type.

The next section discusses the word level prominence pattern in Deori. The prominence pattern in Deori will give us insights into the shape of the foot in Deori, i.e. whether the language makes use of a moraic [$o_{\mu\mu}$] or syllabic [$o_{\mu}o_{\mu}$] foot.

3.5 Metrical Prominence in Deori.

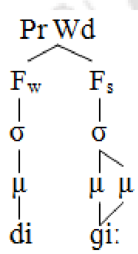
As discussed in section 3.4.1, consonants in coda position are rarely attested in Deori and hence CVC syllable type is not considered heavy. Similarly, the moracity of CVV syllable type is disregarded since vowel length in Deori is non-phonemic. From the evidence provided by the data, it has been found that Deori manifests an iambic foot with final prominence. Vowel duration in Deori is non-phonemic; however, the vowels in stressed positions are longer than the vowels in unstressed positions. The lengthening of the final vowel known as ‘rhythmic’ lengthening (Hayes, 1895), leads to the addition of a mora to the stressed syllable which forms a well-formed bimoraic foot. Rule-derived lengthening is transcribed using diacritics /:/. The foot formation of the syllables in Deori is as follows:

(20) Underlying Surface

a. /LL/	tɑdu	→	L(**H**)	→	tɑ.'dũː	'spoon'
b. /LL/	sɛlɔ	→	L(**H**)	→	sɛ.'lɔː	'home-made cigarette'
c. /LL/	tɔpɛ	→	L(**H**)	→	tɔ.'pɛ̃ː	'blanket'
d. /LL/	tʃegu	→	L(**H**)	→	tʃe.'guː	'bow'
e. /LL/	joɹu	→	L(**H**)	→	jo.'ɹuː	'bride'
f. /LL/	giku	→	L(**H**)	→	gi.'kuː	'brain'
g. /LL/	buɹu	→	L(**H**)	→	bu.'ɹuː	'stomach'

In (20) the foot maintains an iambic rhythm with the final vowel more prominent than the initial. Iambic stress pattern with the lengthening of the final vowel complies with the Binarity Principle in (14), which entails that a foot must be minimally bimoraic or bisyllabic. The underlying light syllables in (20) fulfill the bimoracity of a foot by lengthening the final stressed vowel to attain an extra mora and hence it becomes eligible to form a well-formed foot. Deori follows a weak-strong rhythmic profile, in which a foot is always bimoraic, as prominence always requires a bimoraic minimum. The lengthening of the final vowel forms a well-formed bimoraic foot $[LL]_F$ into canonical iambs $[LH]_F$ which is in agreement with Hayes (1995). The foot formation of two light syllables in Deori is as follows $[\sigma_\mu\ \sigma_\mu] \rightarrow [\sigma_\mu\ \sigma_{\mu\mu}]$. A schematic representation of the foot formation in Deori is shown in (21).

(21)



Deori lacks syllable weight distinction; however, the iambic stress pattern leads to the *unevenness* at the surface by lengthening the final vowel. Stress in Deori is non-phonemic and hence predictable.

In (22 a-d), it is evident that the stressed vowels in the open syllable are relatively longer than the unstressed vowels irrespective of the vowel quality. The length of the vowel assigns syllable weight to the vowel. In an odd-numbered syllable, the final syllable remains unparsed and Deori seems to satisfy the theoretical considerations.

(22)	Underlying			Surface		
	a. /LLL/	gupɔni	→	L(**H**)L	gu.ˈpɔː.ni	‘cover, lid’
	b. /LLL/	kiɹetu	→	L(**H**)L	ki.ˈɹeː.tu	‘window’
	c. /LLL/	sipɛɹɛ	→	L(**H**)L	si.ˈpɛː.ɹɛ	‘door’
	d. /LLL/	kipiɹɑ	→	L(**H**)L	ki.ˈpiː.ɹɑ	‘caterpillar’

As far as headedness is concerned, in Deori, the right-most foot constitutes the metrical head of the word and rightward parsing is the optimal foot parsing in Deori. The prominence assignment rules in Deori can be summarized below:

(23) a. Deori maintains iambic rhythm.

b. Deori foot construction is characterized by right-headedness, i.e. the rightmost foot is prosodically the head.

c. In the trisyllabic word domain, the penultimate syllable bears stress and the final syllable is left unparsed.

The examples in (20) and (22) also exemplify that the unstressed vowels are not phonologically reduced and are not realized as a schwa-like vowel. The unstressed vowel remains phonologically a full vowel rather than reducing to the most predictable central vowel [ə]. This further validates that Deori shows no instance of sesquisyllables. Butler (2014) posits that sesquisyllables necessitate word-final prosodic prominence (i.e. stress or tone) which leads to phonologically reduced non-final syllables. Although prosodic prominence in Deori is word-final, the non-final syllables do not exhibit a restricted vowel inventory. Hence Deori does not conform to the properties of sesquisyllables in any particular way.

3.5.1 Summary of prominence in Deori

Deori maintains a weak-strong rhythmic profile and a well-formed foot is formed by lengthening the stressed vowel which attains a mora. Thus in Deori, the domain for the foot construction is always a mora. In trisyllables, word-final syllable remains unfooted. The foot shape in Deori is $[\sigma_{\mu}\ \sigma_{\mu}] \rightarrow [\sigma_{\mu}\ \sigma_{\mu\mu}]$ which shows that every foot in Deori dominates precisely two moras, satisfying binarity.

Kager (2007) posits that “cross-linguistically, relations between segmental properties and stress are common. The vowels of stressed syllables are prone to lengthen, while those of unstressed syllables may undergo reduction. Stressed syllables tend to license a larger set of vowels than unstressed syllables" (p. 194). Jacquesson (2005) states that "when a vowel is unstressed, it shortens and loses its quality and becomes centralized but not similar to a mid-schwa vowel" (p. 123). In our analysis, it has been found that phonologically the vowels in the unstressed position do not lose its quality in Deori. Additionally, an attempt has been made to examine the vowel quality of stressed and unstressed vowels in Deori acoustically. We have also examined the acoustic correlates of stress in Deori and the results are discussed in the next section.

3.6 Phonetic correlates of stress in Deori

In this section, the phonetic correlates of stress in Deori are discussed. For this purpose, an experiment was conducted on Deori words which have been reported below. The discussion is preceded by a brief introduction to the cross-linguistically attested cues of prominence.

3.6.1 Acoustic correlates of stress

The properties which exhibit stress in the acoustic domain and considered as the common correlates of stress in most of the world's languages are heightened fundamental frequency (*f*0), increased loudness, greater duration, and sometimes vowel quality. Phonological prominence differs phonetically in many languages. In American and British English, stressed syllables are normally longer, louder, and at a higher pitch than the unstressed counterparts (Fry, 1955). In Japanese, phonologically accented syllable of a word exhibits higher pitch but not louder or longer than the unstressed syllables (Beckman, 1986). Languages, where accentual patterns have a considerable effect on loudness, higher pitch, and greater duration, are termed as 'stress accent' such as English and languages where the only pitch is a dominant cue to indicate prominence is termed as 'pitch accent' such as Japanese (Beckman, 1986). The fundamental frequency is an important acoustic cue in many languages such as English (Lieberman, 1960; Fry, 1955; Hyman, 1978), Polish (Jassem, 1959), French (Rigault, 1962), and Japanese (Beckman, 1986). However, languages such as Pirahã (Everett, 1998), Diuxi (Pike, 1976) do not use *f*0 for stress. As for vowel quality, Lindblom (1963) states that unstressed vowels are shorter than the stressed counterparts and this durational difference correlates with formant undershoot leading to the neutralization of vowels. Sluijter and Van Heuven (1996b) state that stressed vowels are characterized by a fuller vowel quality than an unstressed vowel.

In the next section, all the four cues to prominence (duration, intensity, *f*0, and vowel quality) will be discussed to determine acoustic correlates of stress in Deori.

3.6.2 Methodology

Acoustic analysis was conducted for disyllabic and trisyllabic words. The target words selected for the production experiment were nouns of CVCV syllable types. 25 monomorphemic disyllabic words (Appendix 4) were used for the experiment. The words were elicited from speakers within a fixed sentence frame *a X nina itʃabɛm* "I said X" to avoid any effect of post-lexical prosodic boundaries. The informants were asked to read the sentence at a moderate speed.

3.6.3 The participants

The data reported here were collected from seven Deori native speakers residing in Naam Deori village in Jorhat. The age of the speakers ranged between 40 to 55 years at the time of data collection. All the speakers were bilingual; they were well versed in Assamese and Deori. The recording was done using a Shure SM-10 head-mounted microphone connected to a Tascam DR 100 MK II recorder. In case the speakers made a mistake they were asked to repeat the same sentence four times each. Three of the four repetitions of each test word were used for measurement; the last repetition was discarded to avoid post-lexical boundary effect. The recordings took place in quiet environments either in the participants' house or in the nearby school premise. The recordings were digitized at a sampling frequency of 44.1 kHz and 32-bit resolution.

3.6.4 Data analysis

After a successful collection of data, the target words were extracted from the recorded sound file using the PRAAT software (Boersma & Weenink, 2017). Each of the iterations of the isolated words and target words was separated from the sentence and saved as an individual sound file. The target words were segmented both at the syllable and phoneme level. With the aid of a Praat script, duration, intensity, and pitch measurements of the target words were measured. The extracted values were then analyzed for variance and a one way ANOVA test was conducted considering duration, pitch, and intensity as the dependent variables and syllable position as the factor.

3.6.5 Findings

The results show that vowel duration is a significant cue for prominence in Deori, and intensity and pitch are not suggestive of Deori lexical prominence pattern.

3.6.5.1 Duration

The duration values of the disyllabic words indicate that the vowel at the right edge is consistently longer than the pre-final syllable irrespective of the vowel quality. The durational distinction is uniformly found across speakers irrespective of vowel quality. The average duration for a stressed vowel is 76 msec and for an unstressed vowel is 59.88 msec which is significantly different (p<0.05 [F (1, 1090] = 48.42, *p*=.000). Since the data set used for the experiment comprises of the entire vowel inventory it can be inferred that the increase in duration is due to stress and not due to vowel quality. A significant increase in the duration of the stressed vowels than the unstressed counterpart is shown in the figures below:

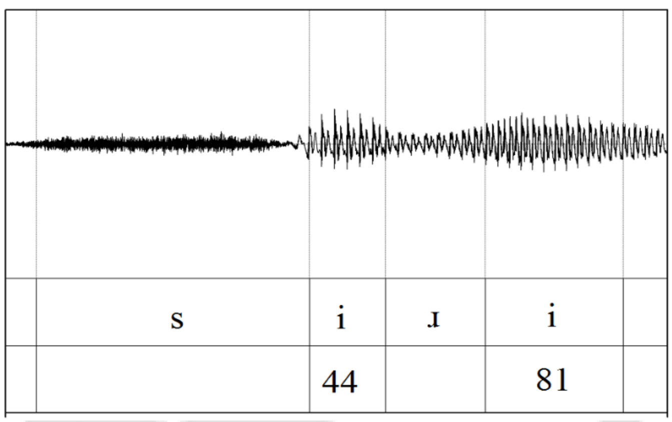


Figure 3.1: Vowel duration in stressed and unstressed syllable in /siɹi/ 'night'

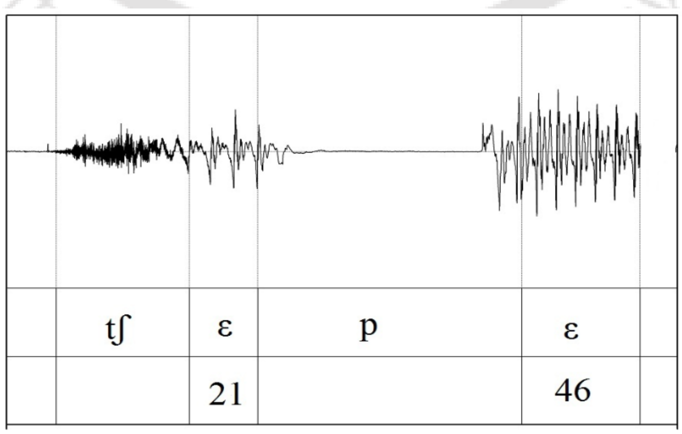


Figure 3.2: Vowel duration in stressed and unstressed syllable in /tʃɛpɛ/ 'cold'

Figure 3.1 and Figure 3.2 show that the duration of the final vowel is consistently longer than the initial vowel.

3.6.5.2 Intensity

The average intensity for the second vowel is 72.22 dB and the first vowel is 70.39 dB. Although intensity is higher in the second syllable than the first syllable, it does not differ significantly ($p>0.05$ [F (1, 1090)] = 7.538 p=.070). It reflects that loudness does not significantly mark the stressed vowels in Deori.

3.6.5.3 Fundamental Frequency

Fundamental frequency (f_0) is considered to be one of the major acoustic correlates for stress in many languages but is not the case in Deori. Deori shows no significant change in f_0 both in the stressed and the unstressed position. The average f_0 of the stressed vowel (138.88 Hz) is higher than the average f_0 of the unstressed vowel (130 Hz) but they do not differ significantly from each other ($p>0.05$ [F (1, 1090)] = 2.29, p=.132). Beckman (1986) states that while in trochaic language f_0 shows a simple rising pattern, in iambic language f_0 shows a falling pattern, indicating prominence in each. However, in Deori, it has been found that there is no substantial difference in f_0 both in the stressed and unstressed syllables and thus f_0 is not considered as a dominant cue for stress in Deori.

3.6.5.4 Vowel Quality

Cross-linguistically, lack of stress tends to affect vowel quality (Kager, 2007). While phonological vowel reduction refers to the neutralization of vowel contrasts often resulting in a [ə] like pronunciation (but not always), phonetic vowel reduction refers to shrinkage of the overall vowel space under decrease duration but do not necessarily involve schwa-like realizations (Padgett and Tabain, 2005).

The formant values of stressed and unstressed vowels (only monomorphemic disyllabic words were taken into consideration for this experiment) were plotted in the Lobanov normalization suite to examine whether prosodic prominence affects Deori vowel formants leading to change of vowel quality. Vowel formants reported here are extracted from vowel midpoint of steady-state vowel formants and formant frequency is converted from Hertz to Mel scale using Praat's inbuilt function Hertz to Mel to show the perceptual difference between the vowels (stressed and unstressed) and was normalized for speaker effects using the Lobanov normalization method in

NORM (Thomas and Kendell, 2007). The F1and F2 frequency of the vowels in the first and the second syllable are plotted next to each other on the same plot. Figure 3.4 below shows the plotting of the stressed and the unstressed vowel.

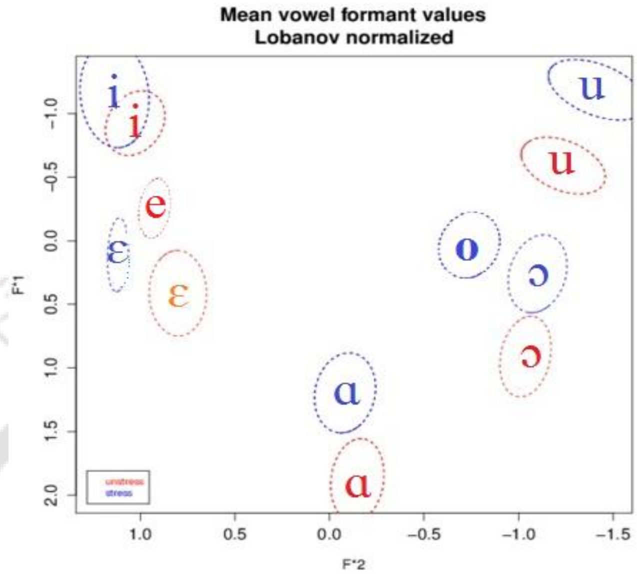


Figure 3.3: Lobanov normalization of the vowels in stressed and unstressed position

Figure 3.3 suggests that the unstressed [+high] vowel /u/, [+mid] vowel /ɔ/ and /ɛ/, and [+low] vowel /ɑ/ are lower in the vowel space (have higher F1) than the stressed [+high] vowel /u/, [+mid] vowel /ɔ/ and /ɛ/, and [+low] vowel /ɑ/ respectively in the acoustic vowel space. Stressed and unstressed [+high] vowel /i/ is seen to overlap in the acoustic vowel space. Mid vowels [e] and [o] have low F1 than mid vowels /ɛ/ and /ɔ/. Mid vowels [e] and [o] occur only in an unstressed position in monomorphemic disyllabic and trisyllabic words. The occurrence of mid vowels [e] and [o] is determined by following high vowels /i/ and /u/. The syllable position has affected the formant frequencies of the vowels both in the stressed and the unstressed position as can be seen from the positioning of the vowels in Figure 3.3, however, the quality of the vowel in unstressed position does not change. The F1 and F2 values of the stressed and the unstressed syllables are presented in Table 3.1 below.

Unstressed	F1 (SD)	F2 (SD)	Stressed	F1 (SD)	F2 (SD)
i	289.62 (31.99)	923.35 (28.62)	i	277.11 (26.22)	885.28 (27.19)
ɛ	346.56 (26.22)	858.59 (26.83)	ɛ	321.11 (31.19)	812.44 (26.31)
ɑ	468.59 (23.22)	743.13 (31.17)	ɑ	411.12 (32.12)	718.18(16.93)
u	295.83 (11.16)	624.34 (24.65)	u	267.21 (30.62)	596.61 (19.08)
ɔ	391.27 (28.11)	536.60 (23.68)	ɔ	366.35 (25.71)	511.06 (29.14)
e	309.74 (22.84)	824.01(20.29)	-	-	-
o	351.34 (29.25)	614.34(27.14)	-	-	-

Table 3.1: Formant values of stressed and unstressed vowels.

Table 3.1 shows the formant values of vowels in stressed and unstressed positions. In Deori, the durational difference of vowels in stressed and unstressed positions does not lead to loss of vowel quality. Hence, the findings suggest that unstressed vowels in Deori do not lose the vowel quality, both phonologically and phonetically.

3.6.6 Summary of phonetic correlates of stress in Deori

The experiment reported above shows duration as the robust cue for prominence in Deori. Stressed vowels are consistently longer compared to their unstressed counterparts. Duration is suggestive of prominence in Deori, whereas pitch and intensity values are not indicative of prominence in Deori. Although vowel duration in stressed and unstressed syllables differs significantly, the vowel quality of stressed and unstressed vowels remains unchanged.

3.7 Conclusion

In this chapter, the word-internal structure and word-level stress pattern in Deori have been discussed. It has been found that Deori words are mostly open syllables. The phonotactic restrictions show that a subset of consonants occurs in the coda position, whereas there is no such restriction on the occurrence of consonants in the onset position, except for the velar nasal [ŋ]. Consonant clusters are marked in Deori. Vowel epenthesis resyllabifies the syllable structure CVC.CV to CV.CV.CV which ensures that codas are marked in Deori. Thus the coda consonant in Deori is not considered moraic or heavy and it does not contribute to syllable weight. Lack of vowel length distinction also leads us to disregard the moracity of the CVV syllable type. The inventory of vowel segments in the first and second syllables of disyllabic words is not restrictive. There is no restriction on the co-occurrence of vowels in stressed and unstressed syllables, except for the [-high +ATR] vowels [e] and [o] which occurs when followed by [+high +ATR] vowels /i/ and /u/. This is an instance of vowel harmony and it will be discussed more elaborately in Chapter 5. The contrastive vowels /i, u, ɛ, ɑ, ɔ/ and the two allophones [e] and [o] in Deori occur in the stressed and the unstressed syllable without any change of vowel quality which ensures that Deori shows no evidence of sesquisyllables.

Deori exhibits an iambic stress pattern with final prominence. Duration is not contrastive in Deori; however, it plays a decisive role in distinguishing a stressed syllable from an unstressed syllable. The lengthening of the final vowel leads to the formation of a bimoraic foot minimum. Deori is a quantity insensitive language that lacks syllable weight distinction. The unevenness of the metrical foot at the surface is fulfilled by lengthening of the final vowel. In trisyllabic words the final stressless syllable at the right edge is unparsed. Stress in Deori is realized with an increase in duration but not intensity and f_0. The stressed vowel is relatively longer than the unstressed vowel across speakers irrespective of the vowel quality. However, the durational difference does not affect the quality of the vowels in the unstressed syllable. In Deori, every structural syllable, either stressed or unstressed, has a full vowel. The important findings in this chapter are - the absence of sesquisyllables and the manifestation of iambic stress in Deori. Deori exhibits purely disyllabic iambs thereby showing no evidence of sesquisyllables in any particular way.

Results show that stress in Deori does not interact with intensity and f_0. Duration is the primary acoustic correlate for stress in Deori. Cross-linguistically, f_0 is the acoustic correlate for both stress and tone. While f_0 is not a prominent acoustic cue for stress in Deori, f_0 is considered as the prominent acoustic cue in distinguishing lexically homophonous words in Deori (Mahanta *et.al* 2017). However, the f_0 distinction is gradually declining in tonal words resulting in a gradual tonal loss in Deori. Mahanta *et. al*. (2017) have conjectured that Deori is on the verge of tonal loss and the emergence of metrical prominence may have eventually led to the shift from tone to a stress accent language. Vowel duration in tonal words is not distinctive in Deori; however, in non-tonal words lengthening of the final vowel is robust indicating prominence.

In this chapter, we have shown that sesquisyllables which are ubiquitous in many Tibeto-Burman are not there in Deori and if it was present at any stage, it has been replaced by an iambic system. In the next chapter, we will discuss tone in Deori, another phonological property shared by many, if not all, Tibeto-Burman languages.

Chapter 4 - Production and Perception of Tones in Deori

4.1 Introduction

All languages employ pitch variation but languages differ in the ways pitch is employed and the types of functions they serve. Languages which employ pitch to distinguish the meaning of lexically homophonous words are known as tone languages. It is noted that "a language is a tone language if the pitch of the word can change the meaning of the word – not just its nuances, but its core meaning" (Yip, 2002, p.1). Deori too employs pitch variation in distinguishing homophonous words; however, the degree of pitch variation is gradually declining leading to tonal loss (Mahanta *et al.* 2017). It has been conjectured that Deori must have had tonal contrasts historically but synchronically the tonal contrast is unclear and this has been argued to be an outcome of language-contact with a non-tonal language, Assamese (Mahanta *et al.* 2017). The results reported by Mahanta *et al.* (2017) are based on the speech of older generation speakers. Considering the observation in Mahanta *et al.* (2017), this chapter examines tonal distinctions maintained by younger generation speakers through a production experiment. The findings of the production test experiment are further compared with the results of older generation speakers reported by Mahanta *et al.* (2017). Following the production experiment, a perception experiment is also conducted which incorporates both younger and older generation speakers to examine the status of tone in Deori. The production and the perception test investigate the impact of language experience on production and perception of lexical tones in Deori.

The organization of the chapter is as follows. In section 4.2 an overview of tone has been presented; in section 4.3 tone in Tibeto-Burman languages has been discussed; in section 4.4 an overview of tones in Deori is discussed; in section 4.5 the process of tonoexodus is discussed; in section 4.6 production experiment results of younger generation speakers have been reported and further comparison of the younger generation and older generation speakers has been presented; section 4.7 discusses the perception test results of both younger and older generation speakers and the chapter ends with a brief summing up conclusion in section 4.8.

4.2 Overview of tone

A tone language differs from a non-tonal language in terms of its pitch variation which results in distinguishing the meaning of a lexical item. Hyman defines a tone language as "a language with tone is one in which an indication of pitch enters into the lexical realization of at least some morphemes" (2001, p. 1368). Africa, East, and South-East Asia and the Pacific, and the Americas are some of the areas in the world which is home to many tonal languages in the world (Yip, 2002). Yip states that tone is a "phonological category that distinguishes two words or utterances, and is thus only a term relevant for language, and only for languages in which pitch plays some sort of linguistic role" (2002, p. 5).

Tone languages either exhibit level tones or contour tones. African languages exhibit level tones[45] and languages in East Asia (Chinese dialects, Thai, Vietnamese, etc.) exhibit contour tones as well as level tones. While in level tone the pitch raises or lowers to a certain level, in contour tone, pitch changes from high to low or from low to high (Yip, 2002). Tone languages vary in the number of tonal contrasts they maintain. While Yoruba maintains three-way tonal contrasts, Mambila maintains five-way tonal contrasts (Gussenhoven, 2004). Languages with two tonal contrasts, usually exhibit two level tones, i.e. high and low, rather than contour tones. (Yip, 2002). The syllable [yau] in Cantonese can be said in six different pitches which has six different meanings:

(24) [yau] in Cantonese

high level	'worry'
high rising	'paint (noun)'
mid level	'thin'
low level	'again'
very low level	'oil'
low rising	'have' (Yip, 2002).

The domain that constitutes the tone-bearing unit (henceforth TBU), whether it is the vowel, the mora, the entire syllable, or just the rhyme - has been much discussed in the literature. Pike (1948) considers syllable as the TBU. Goldsmith (1990) asserts that "the vowel being the tone bearing unit is a fact about tonal systems" (p. 11). Chao (1965) states that the domain of tone is the voiced part of the syllable, 'thus it is assumed to include an onset if it is voiced' (p.20).

Fundamental frequency (f_0) is the acoustic cue of tone. Differences in tone are perceived as a difference in pitch of the voice which is caused because of the variation in the rate of vocal cord vibration. The frequency of the vibration of the vocal cords or the rate of the vibration of the

[45] However, some African languages also exhibit contour tones, e.g. Luo, a Nilotic languages.

vocal cords is measured in Hertz (Hz). The measurement is such that each cycle of the vibration of the vocal fold is counted as one Hz.

After presenting a general review of tone, the next section discusses tone in Tibeto-Burman languages with particular reference to Northeast India.

4.3 Tones in Tibeto Burman languages of North East India.

Languages belonging to the Tibeto-Burman language family show the distinctive feature of tone (though not always). It has been observed that Tibeto-Burman tone typology widely differs from each other in terms of structure. It has been well-attested in the literature that Tibeto-Burman languages account for many tonal variations. "Tibeto-Burman languages range from having many tonal contrasts to none and from displaying emerging tonal contrasts to disappearing ones" (Evans, 2008, p. 2). Tibeto-Burman languages in Northeast India such as Boro, Dimasa, and Tiwa have fixed acoustic properties. Bodo has falling and rising tone (Sarmah, 2004; Burling, 1959), Dimasa has high rising, mid-level, and low falling tones (Sarmah and Wiltshire, 2010), and Tiwa and Rabha have falling, rising, and mid-tones (Joseph and Burling, 2001; Sarmah, 2009). Bodo-Garo languages primarily show tone assignment on only one syllable (Joseph and Burling, 2001; Sarmah, 2004). Although Tibeto-Burman languages exhibit tone distinctions, tonal analysis of these languages is often considered difficult (Evans, 2009; Post and Burling, 2017). Evans (2009), Teo (2014), and Post (2015) state that the reason for the difficulty in analyzing tones in Tibeto-Burman languages is that Tibeto-Burman languages have polysyllabic words which make the elicitation of the tone bearing syllables difficult. Further, "tone in these languages is often associated with prosodic factors such as rhythm and intonation adding additional layers of complexity to the analysis" (Post and Burling, 2017, p. 220).

A large number of tonal languages are concentrated in Northeast India. The number of tonal distinctions manifested in these languages may range from two to five-way tonal contrasts. For example, while Bodo has only two lexical tones (Joseph and Burling, 2001; Sarmah, 2004, 2009), Mizo and Angami have four tones (Fanai, 1989; Sarmah, 2009; Meyase, 2014) and Tenyidie has a five-tone system (Burling, 1960; Meyase, 2014). Although Northeast India is home to many tonal languages, non-tonal languages are also found in this region. While Bodo exhibits tone, its close genealogical neighbors Garo and Atong spoken in close proximity to the toneless Khasian dialects do not manifest tone (Post and Burling, 2017).

4.4 Tones in Deori

The tonal specification in Deori has been a reason of doubt among various scholars at various points of time (Brown, 1895; Jacquesson, 2005) and has been considered as a moribund feature (Jacquesson, 2005).

Brown (1895) states that lexical items in Deori are distinguished either by tone or by nasalization (apart from other segmentally different minimal pairs). While Goswami (1994) states that Deori exhibits a three-way tonal contrast, Jacquesson (2005) states that there is a two-way tonal contrast in Deori - high and low. Jacquesson (2005) further states that 'high' tone is the unmarked and 'low' tone is the marked tone in Deori. However, Jacquesson states that tonal contrasts are not salient in everyday communication of the native speakers of Deori and are considered 'moribund'. "Tone in Deori was present at a certain point of time but it is difficult to locate the stage chronologically" (Jacquesson, 2005, p. 98). Mahanta *et al.* (2017) have shown that Deori does not manifest a fixed tonal characteristic as compared to the other genetically related Tibeto-Burman languages like Bodo, Dimasa, and Tiwa. The findings reported by Mahanta *et al.* (2017) have been summarized below. The diagrams show the tonally distinctive lexical items in Deori (for details see Mahanta *et al.* 2017).

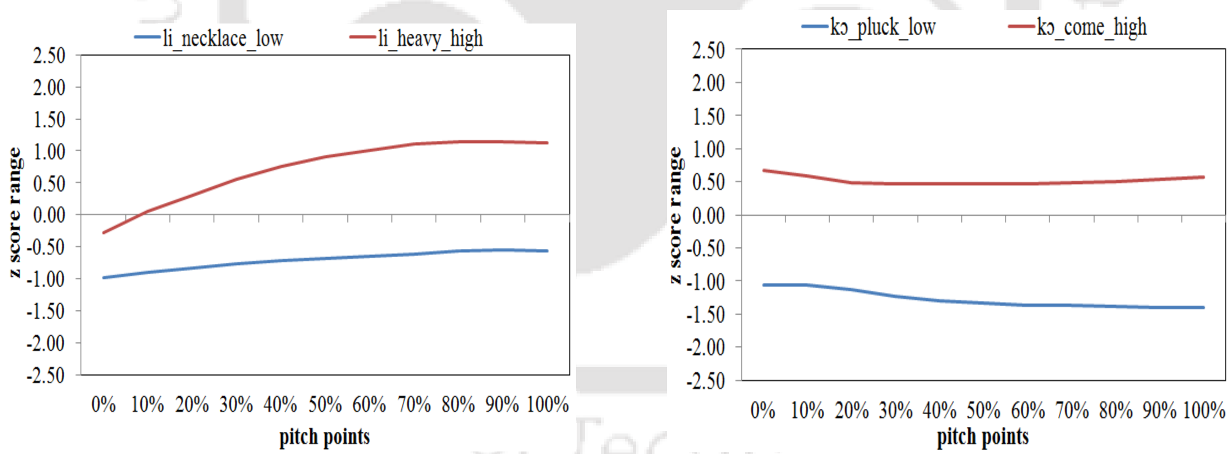


Figure 4.1: Average normalized pitch contours showing tonal contrasts between /li/ "necklace_low tone" and /li/ "heavy_high tone" in the left panel and /kɔ/ "pluck_low tone" and /kɔ/ "come_high tone" in the right panel.

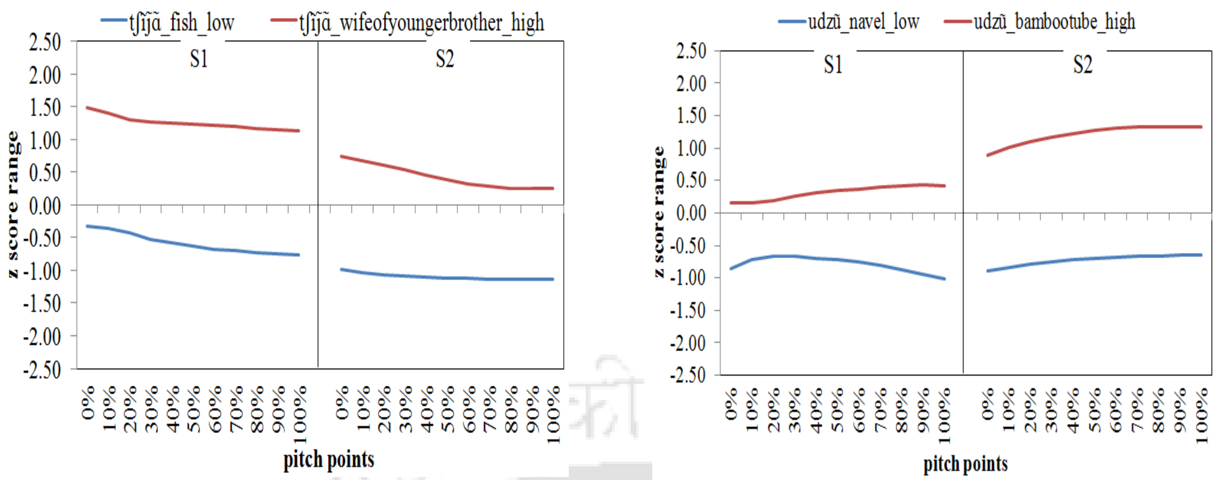


Figure 4.2: Average normalized pitch contours showing tonal contrasts between /tʃĩjɑ̃/ "fish_low tone" and /tʃĩjɑ̃/ "wife of younger brother_high tone" in the left panel and /udzũ/ "navel_low tone" and /udzũ/ "bamboo tube_high tone" in the right panel[46]

Figure 4.1 and Figure 4.2 show the average normalized pitch contours of lexically distinguished tonal words produced by five older generation speakers. Five native speakers were recorded for the production experiment and 28 words were analyzed for the experiment (10 monosyllables and 18 disyllables). One way ANOVA results showed significant pitch difference in the homophonous words both in monosyllables ($p<0.05$ [($F(1,98) = 294.8$) $p = .000$] and in disyllables for both the vowels ($p<0.05$) [($F(1,138) = 261.46$) $p = .000$] (vowel 1), ($p<0.05$) [($F(1,138) = 353.34$) $p = .000$] (vowel 2). Results show that tonal distinctions are maintained in the homophonous words. However, unlike other Tibeto-Burman languages, (Bodo, Dimasa, and Tiwa) the tonal contours in Deori are not static across all the tonally distinctive lexical items and tone is spread across the word in which lexical distinctions are preserved. The domain of tone bearing unit in Deori is the phonological word rather than the syllable in the traditional sense (e.g. Bodo, Dimasa, and Tiwa)[47]. It has been reported that tonoexodus is "reflected in the disyllable being the site of the tone target where the tone bearing unit (henceforth TBU) is the

[46] In the diagrams, S1 represents vowel of the first syllable and S2 represents vowel of the second syllable

[47] The tone bearing unit (TBU) in Deori is the phonological word as Deori tones do not seem to be assigned to each and every syllable. The statistical analysis reported in Mahanta *et al.* (2017) highlights that the results did not suggest whether it was the rightmost or the leftmost edge of the word to which the lexical tone is aligned thereby considering that tone is distinctive in the entire word in Deori, unlike other Tibeto-Burman languages in its vicinity.

entire disyllable” unlike other Bodo-Garo languages in its vicinity (Mahanta *et al.* 2017, p. 75). Tonal contour variations in all the lexically homophonous words in Deori are considered as an effect of language contact with Assamese, a non-tonal language. It has been further reported that although tonal distinctions are maintained in the language, there are very few homophonous words with tonal contrasts. Furthermore, it has been conjectured that “tonal mergers seemed to have occurred as a result of the loss of the mid-tone, the presence of which had been reported in the literature on tone in Deori” (Mahanta *et al.* 2017, p. 55). With this background on the presence of tones in Deori, we proceed to discuss the process of tonoexodus in the next section.

4.5 Tonoexodus

While tonogenesis is well-attested in the literature on tone, tone loss, or tonoexodus is comparatively less explored (Ratliff, 2015). Factors leading to tone loss are many. Mention may be made of the context of reinterpretation (Shih, 1985; Schadeberg, 2009), proximity to toneless syllables, and reanalysis of a prominent tone as an accent (Ratliff, 2015). Moreover, it is well-attested in the literature that contact plays a vital role in tone loss. Contact induced tonal loss has been reported in languages such as Swahili (Schadeberg, 2009) and Northwest Mandarin Chinese variety spoken in Wutun, Qinghai Province, China (Janhunen *et al.* 2008). A generational account of tone is examined in studies such as Chen and Wiltshire (2003), Utsugi (2009), Zhang (2014 b), Yang and Yang (2018), Yang *et.al*. (2019), etc. which focuses tonal variation across generations, in the context of language contact. Additionally, tonal change among younger speakers has been reported in Mien, a Hmong-Mien tone language, where tonal distinctions are reduced from six to five, owing to language contact with Standard Thai (Thongkum, 1997). Bradley (2015) and Yeh and Lin (2015) state that studies on tone change in endangered languages, though limited, report a reduction in the number of tonal categories and loss of tone sandhi process owing to language contact. Hai-lu Hakka, a Taiwanese dialect is reported to have undergone tonal change demonstrated mainly by younger speakers because of language contact (Yeh and Lin, 2015). Yang *et al.* (2019) report tonal variations in Yangliu Lalo (Central Ngwi), a minor community in China because of language contact with Southwestern Mandarin. It is reported that the high rising-falling high tone in Yangliu Lalo is “lowering and flattening” among younger generation speakers, mostly females, because of infrequent use of Lalo (Yang *et al.*, 2019, p. 2). Tone loss also happens because of radical tone mergers.

Hildebrandt (2003) states that "tone may be a marked feature in the minority language" (p. 15) and in due course of time is simplified or lost. Radical tone merger is shown in the Central Vietnamese dialect of Nghe An (Pham, 2005).

After presenting a brief account on tone in Tibeto-Burman languages and the process of tonoexodus, the next section discusses the production experiment of tone in Deori with special reference to younger generation speakers. Furthermore, the results of younger generation speakers are compared with older generation speakers as reported by Mahanta *et al.* (2017) to understand the status of tonal distinctions maintained by different generations.

4.6 Production experiment

In this section, the methodology and results of the production test are discussed. At first, we will discuss the materials selected for the production experiment and the recording procedure, followed by a discussion on the statistical analysis and results.

4.6.1 Materials

For the production experiment, 10 monosyllabic words and 16 disyllabic words were chosen. The word list was prepared after multiple interactions with native speakers. As vowel nasalization is also a factor in distinguishing homophonous words in Deori, this experiment ruled out words with nasal-oral contrasts. Monosyllabic words were of CV syllable type and disyllabic words were of CVCV and VCV syllable types as shown in Table 4.1. For monosyllabic words, there was a total of 150 samples (10 words*5 speakers*3 iterations) and for disyllabic words, there were 240 samples (16 words*5 speakers*3 iterations).

Deori	Gloss	Deori	Gloss
li	'necklace'	li	'heavy'
tu	'oil'	tu	'deep'
tʃu	'pig'	tʃu	'speech'
tʃi	'blood'	tʃi	'to make'
kɔ	'go'	kɔ	'pluck'
ɑkũ	'ear'	ɑkũ	'upland'
tʃĩj̃ɑ̃	'fish'	tʃĩj̃ɑ̃	'wife of younger brother'
udzũ	'navel'	udzũ	'bamboo tube'
tiɹi	'banana'	tiɹi	'hang from a tree'
bɑɹi	'garden'	bɑɹi	'carry on back'
kiɹi	'poor'	kiɹi	'to furnish with heddles'
tʃitũ	'rope'	tʃitũ	'old'
nĩnĩ	'hold'	nĩnĩ	'rescue from water'

Table 4.1: The dataset displaying the list of monosyllabic and disyllabic words considered for the production experiment

4.6.2 Speakers

Five native speakers (male - SP1, SP2, SP3, SP4, and SP5) participated in the production experiment. The speakers were between 18-30 years of age at the time of data collection. The speakers were from Naam Deori and Upor Deori village, Jorhat district of Upper Assam. All the speakers were competent bilingual. Apart from Deori, they were equally fluent in Assamese. The speakers reported that they had no history of hearing or speaking disability.

4.6.3 Recording

The recordings took place in quiet environments either in the participants' house or in nearby school premises. The target word bearing the tonal contrast was embedded in a fixed sentence frame "I X said" *a X nina itʃabɛm* where X is the target word. The use of the frame ensured that intonational interference in the target word was uniform and hence predictable. Tone was not marked in the orthography presented to the participants. A method of using pictures of the target word was integrated into our experimental design to have one to one correspondence with the actual meaning in an appropriate context. Before the task, the procedure was explained to the participants. Each word with the carrier sentence along with the relevant picture was randomized and was presented to the participants on the computer screen and they were instructed to read each word four times in the predetermined sentence frame. However, the first three of the four repetitions of each target word were used for analysis; the last repetition was discarded to avoid intonational boundary effect. The recording was done using a Shure SM-10 head-mounted microphone connected to a Tascam DR 100 MK II solid-state recorder. The recordings were digitized at a sampling frequency of 44.1 kHz and 32-bit resolution.

4.6.4 Fundamental frequency (f_0) extraction

After the recording, the sound files were transferred to a portable PC using a USB cable for segmentation and annotation. The segmentation and annotation of the target words were done manually using Praat (version 5.3.04_win32) (Boersma and Weenink, 2017). Since the TBU is the entire phonological word in Deori (Mahanta *et al*., 2017), the pitch property of each tone is expected to spread across the phonological word. Therefore to analyze the pitch property of each target word, the f_0 of the vowel of the first syllable (henceforth S1) and f_0 of the vowel of the second syllable 2 (henceforth S2) were taken into consideration. A Praat script was used to calculate the pitch values of the target words. The pitch values were calculated from the onset of the syllable to the offset of the syllable at 11 successive points at 10% interval of time (i.e, "start pitch 0%", "10%", "20%", "30%"…. to "end pitch 100%). Using the same script, duration, and intensity values were also measured. The non-normalized f_0 values at 11% interval of time were transformed to normalized f_0 values using the z score normalization method (Disner, 1980; Rose, 1987) to avoid speaker variations. The formula used for z score normalization is as follows:

$$z = (f_0 i - x)/SD$$

Here $f_0 i$ is the pitch value of an individual point of the target word calculated at the onset of the syllable, i.e start pitch 0%, x is the average value of $f_0 i$ across all pitch values and SD is the standard deviation of all the pitch values. Following the z score normalization method, the pitch values of each token of the target word uttered by each speaker (measured in Hz) were transformed to z score normalized values. After the pitch values were normalized, the average of z score values of each target word across speakers across iterations was plotted in an excel sheet as a line graph for visual examination of tonal contrasts in Deori. In the analysis of tonal contrasts, we assume that the pitch contours with positive values above the baseline, i.e., 0.00 represent high tone and the pitch contours with negative values below the baseline, i.e., 0.00 represent low tone.

4.6.5 Statistical Analysis

To determine the significant difference between the tonal categories, a Univariate Analysis of Variance (ANOVA) was performed. For the statistical analysis, average pitch values at 11 successive points from the onset (start pitch 0%) of the syllable to the offset (endpoint 100%) across the total length of each TBU across the speaker was measured. Apart from the f_0 values, the duration and the intensity values were also used for the statistical analysis. While f_0, duration, and intensity values of the pitch contour were the dependent variable, tonal categories were the fixed factor. Furthermore, a speaker-wise analysis was done to confirm the general observation concerning the variation in pitch patterns across tones. As such another ANOVA test was performed to determine the degree of pitch regularity or stability across utterances of particular words. The same method was used for both monosyllabic and disyllabic stems.

4.6.6 Results

In this section, results of monosyllabic and disyllabic words are discussed. At first, monosyllabic words are discussed followed by a discussion on disyllabic words. The average pitch contours for each word across the speaker are presented first for better visual observation which is followed by speaker wise pitch contours for each word. The results show considerable speaker variations mostly in monosyllabic words. Tone reversal is observed in monosyllabic words and tonal distinctions are not maintained by all speakers. In case of disyllabic words, a gradual tonal loss is observed.

4.6.6.1 Monosyllables

The normalized pitch values were averaged across all the three repetitions across speakers and were written down on a spreadsheet and plotted for graphical representation to observe the distinct pitch contour.

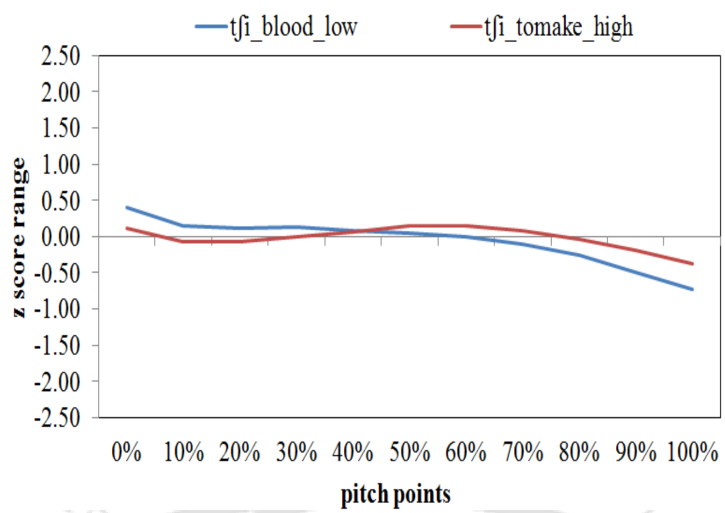


Figure 4.3: Average normalized pitch contours showing no tonal contrasts between /tʃi/ "blood_low tone" and /tʃi/ "to make_high tone"

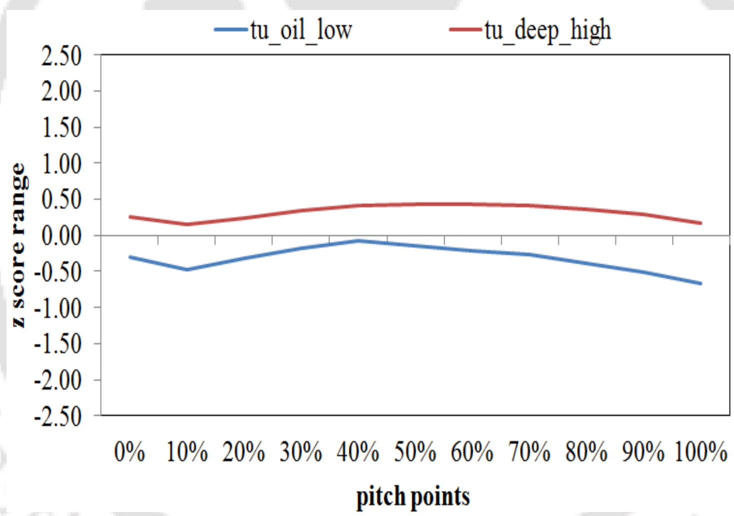


Figure 4.4: Average normalized pitch contours showing tonal contrasts between /tu/ "oil_low tone" and /tu/ "deep_high tone"

The graphical representation of pitch contours of monosyllabic words shows that there are no tonal contrasts between tʃi "blood_low tone" and tʃi "to make_high tone" as represented in Figure 4.3 whereas Figure 4.4 shows tonal contrast between tu "oil_low tone" and tu "deep_high tone". Figure 4.5 shows tonal contrast between *li* "necklace_low tone" and *li* "heavy_high tone" and Figure 4.6 shows tonal contrasts maintained between *tʃu* "pig_low tone" and *tʃu* "speech_high tone".

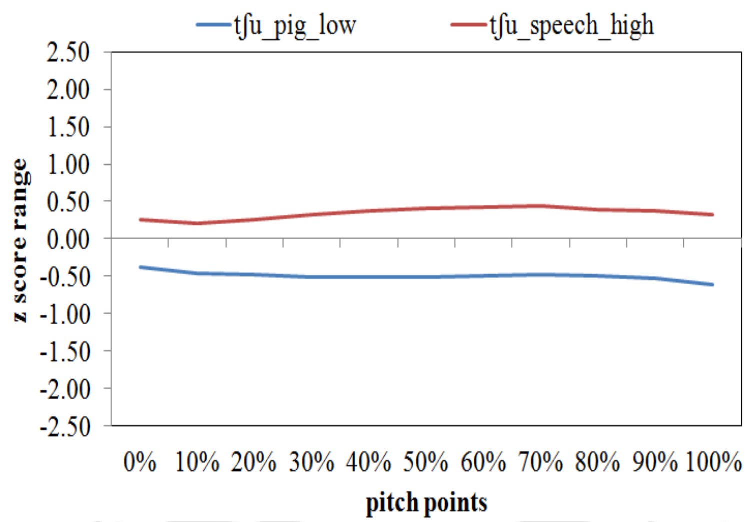


Figure 4.5: Average normalized pitch contours showing tonal distinctions between /tʃu/ "pig_low tone" and /tʃu/ "speech_high tone"

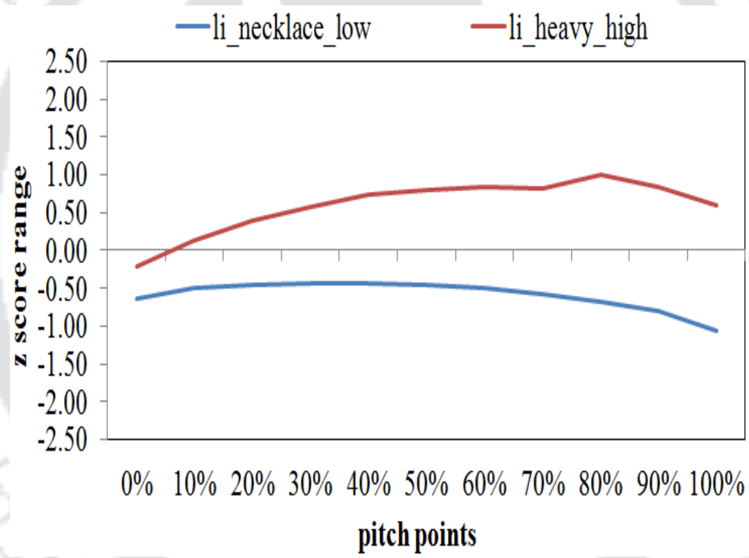


Figure 4.6: Average normalized pitch contours showing tonal distinctions between /li/ "necklace_low tone" and /li/ "heavy_high tone"

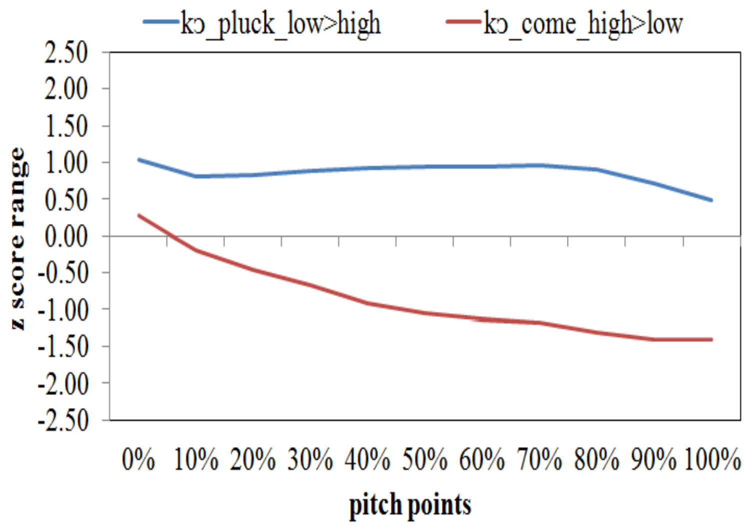


Figure 4.7: Average normalized pitch contours showing tonal reversals between /kɔ/ "pluck_low>high" and /kɔ/ "come_high>low"

Tone reversal is observed in *kɔ* "pluck/come" (Figure 4.7) wherein the low tone is realized as high tone (L>H) and high tone is realized as low tone (H>L).

An ANOVA test was conducted to determine whether the monosyllabic words were significantly distinct from each other considering the averaged pitch point values (at 11% interval of time) across all words across speakers. The results show significant effect of f_0 on tone types for words like *li* "heavy/necklace" ($p<0.05$ [($F(1,20) = 126.21$) $p = .000$]); *tu* "oil/deep" ($p<0.05$ [($F(1,20) = 512.81$) $p = .000$]); *tʃu* "pig/speech" ($p<0.05$ [($F(1,20) = 556.3$] $p = .000$]) and *kɔ* "come/pluck" ($p<0.05$ [($F(1,20) = 91.57$) $p = .000$]). Although tone reversal is evident in *kɔ* "come/pluck", statistical results show significant difference of tone as there is no overlap of the pitch contours. However, *tʃi* "blood/to make" did not show any significant effect of tone as there is overlap of the two pitch contours ($p>0.05$ [($F(1,20) = 302.32$) $p = .011$]). The results further show that duration ($p>0.05$ [($F(1,20) = .429$) $p = .513$]) and intensity ($p>0.05$ [($F(1,20) = .184$) $p = .669$]) across monosyllabic word types are not statistically significant. The statistical result thus shows that tone had no significant effect on duration and intensity.

Shown in Table 4.2 are the comparative results of monosyllabic words of older generation speakers as reported by Mahanta *et al.* (2017) and younger generation speakers as observed in this study which will help us understand the variation in tone realization in both the generations.

Older generation (Mahanta *et al.* (2017)				Younger generation			
Word	Tone	F and *p* value	Result	Word	Tone	F and *p* value	Result
tʃi	low*high	F	[(1,20)=212.0 2]	tʃi	low*high	F	[(1,20)=302.32]
		p value	.000			*p* value	.011
tu	low*high	F	[(1,20)=171.11]	tu	low*high	F	[(1,20)=512.81]
		p value	.000			*p* value	.000
tʃu	low*high	F	[(1,20)=203]	tʃu	low*high	F	[(1,20)=556.3]
		p value	.000			*p* value	.000
kɔ	low*high	F	[(1,20)=511]	kɔ	low*high	F	([1,20)=91.57]
		p value	.000			*p* value	.000
li	low*high	F	[(1,20)=121.44)]	li	low*high	F	[(1,20)=126.21]
		p value	.000			*p* value	.000

Table 4.2: Results showing tonal distinctions in monosyllables maintained by the older generation and younger generation speakers

Table 4.2 shows that while significant tonal distinctions are maintained by older generation speakers in all monosyllabic words with a significant *p value* ($p<0.005$), significant tonal distinctions among younger generation speakers are found only in lexical words *tu* ($p<0.05$ [(F(1,20) = 512.81) *p* = .000]), *tʃu* ($p<0.05$ [(F(1,20) = 556.3] *p* = .000]), *kɔ* ($p<0.05$ [(F(1,20) = 91.57) *p* = .000]), and *li* ($p<0.05$ [(F(1,20) = 126.21) *p* =.000]). The younger generation speakers maintain no tonal distinctions between *tʃi* low and high tone ($p<0.05$ [(F(1,20) = 302.32) *p* = .011]), unlike older generation speakers. Although statistical results show significant tonal contrasts between *kɔ* low and high tone, it is to be noted that tone reversal is observed in *kɔ* as shown in Figure 4.7. Thus, the results highlight that compared to the older generation there is gradual tonal loss among younger generation speakers. Further, speaker variations were observed among younger generation speakers in realizing the tonal distinctions which are discussed in the next section.

4.6.6.1.1 Speaker wise tonal analysis- Monosyllables

After examining the averaged pitch contours across speakers, a speaker wise analysis was done to understand the tonal variation of each speaker. Average pitch contours show tonal distinctions in monosyllabic words, except *tʃi* (Figure 4.3). However, speaker variations are observed across all monosyllabic words and tonal distinctions are not maintained by all speakers. For speaker wise analysis, the z score normalized pitch points were averaged across the three iterations of each target word for each speaker separately. The average values for each speaker were then plotted for a graphical examination of f_0 syllable alignment. Speaker wise graphical representation of the tonal words is presented below. The figures in the left panel show the low tone words and the figures in the right panel show the high tone words. The graphical representation of the normalized pitch contours of the homophonous words confirms speaker variations in the target words.

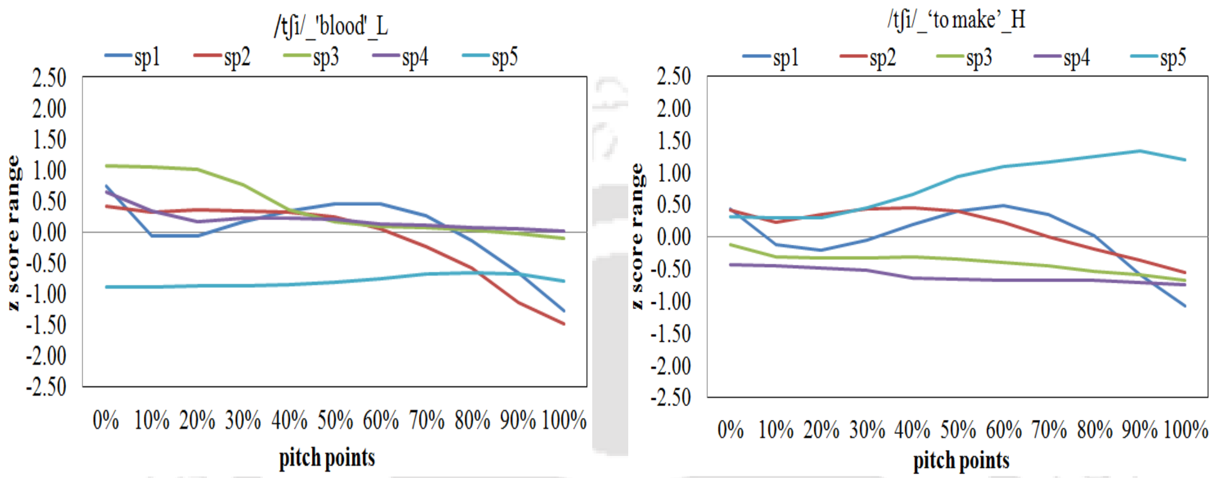


Figure 4.8: Speaker wise normalized pitch contours of /tʃi/. The left panel shows the low tone word /tʃi/ "blood" and the right panel shows the high tone word /tʃi/ "to make"

Figure 4.8 shows the pitch contours of *tʃi* "blood/to make". The tonal distinction between *tʃi* low and high tone is maintained only by SP5 (indicated by the blue line). SP1 and SP2 completely merge the two tones and SP3 and SP4 reverse the two tonal categories.

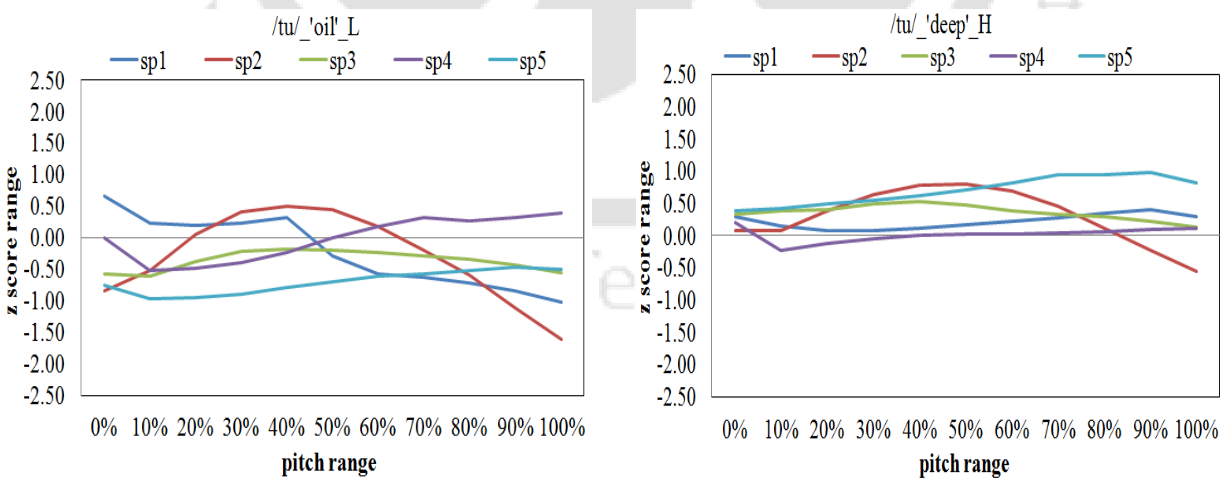


Figure 4.9: Speaker wise normalized pitch contours of /tu/. The left panel shows the low tone word /tu/ "oil" and the right panel shows the high tone word /tu/ "deep"

Figure 4.9 shows the pitch contours of *tu* in which tonal distinctions are maintained by SP3 and SP5 (indicated by green and light blue line respectively). SP1, SP2, and SP4 completely merge the two tonal categories (indicated by dark blue, purple, and red line respectively).

Figure 4.10: Speaker wise normalized pitch contours of /tʃu/. The left panel shows the low tone word /tʃu/ "pig" and the right panel shows the high tone word /tʃu/ "speech"

Figure 4.10 represents the pitch contours of *tʃu* in which tonal distinctions are maintained by SP2, SP3, SP4, and SP5. However, SP1 reverses the two tones with a higher (average) f_0 value for low tone contour 172.11 Hz and lower (average) f_0 value for high tone 119.33 Hz.

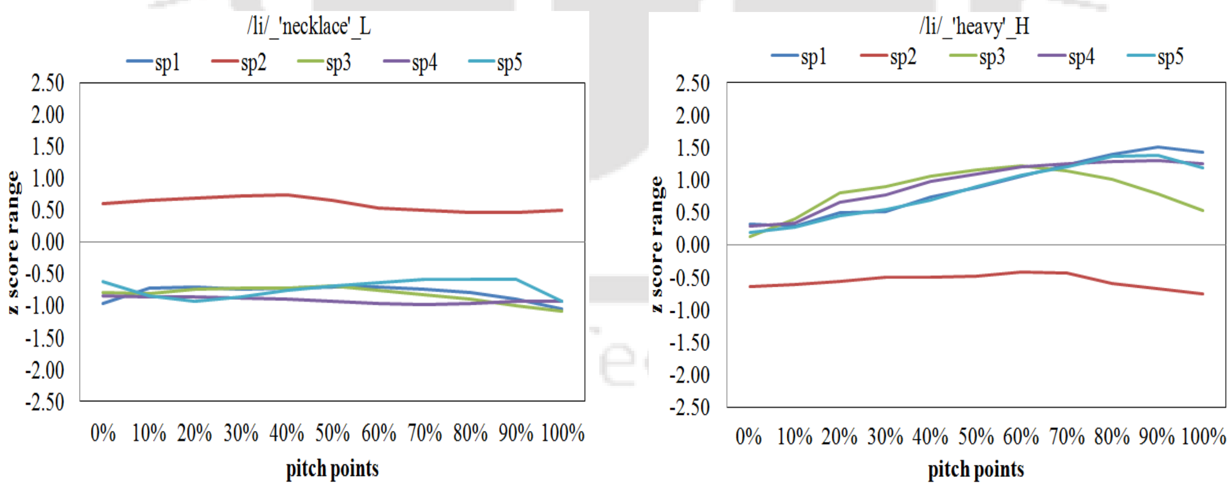


Figure 4.11: Speaker wise normalized pitch contours of /li/. The left panel shows the low tone word /li/ "necklace" and the right panel shows the high tone word /li/ "heavy"

Figure 4.11 represents the pitch contours of *li* where all speakers maintain tonal distinctions, except SP 2 (indicated by the red line) who reverses the two tones with a higher (average) f_0

value for low tone contour 167.73 Hz and lower (average) f_0 value for high tone contour 129.85 Hz.

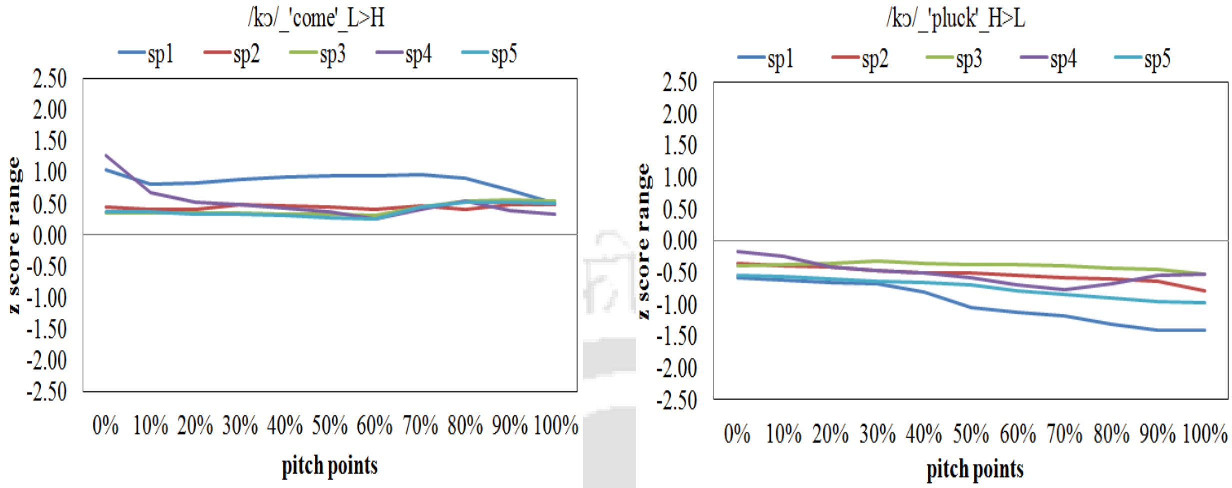


Figure 4.12: Speaker wise normalized pitch contours of /kɔ/. The left panel shows the low tone word /kɔ/ "come" which has reversed to high tone and the right panel shows the high tone word /kɔ/ "pluck" which has reversed to low tone.

Figure 4.12 represents the pitch contours of *kɔ* in which there is complete tone reversal with a low tone. The underlying low tone *kɔ* is realized as a high tone with higher (average) f_0 value 165.21 Hz and the underlying high tone *kɔ* is realized as a low tone with lower (average) f_0 value 140.04 Hz.

To examine the significant difference of tone in the lexical words, a one way ANOVA test was performed considering each tonal word uttered by each speaker, with tone as the fixed factor and pitch values (average) at 11% interval of time as the dependent variable. Results in Table 4.3 show that SP 1 and SP 2 do not maintain any tonal distinctions between *tʃi* low and high tone and it has no significant difference as the *p*-value reveals .886 and .712 respectively; SP 3 ($p<0.05$ [($F(1,20) = 211$) $p = .000$]) and SP 4 ($p<0.05$ [($F(1,20) = 113$) $p = .000$]) maintain tonal distinctions but they completely reverse the two tonal categories (H>L, L>H). SP 5 maintains tonal distinctions between *tʃi* low and high tone without any tone reversal ($p<0.05$ [($F(1,20) =$ 317) $p = .000$]). In words like *tu* SP 1 ($p>0.05$ [($F(1,20) = 434$) $p = .503$]), SP 2 ($p>0.05$ [($F(1,20) = 321$) $p = .412$]), and SP 4 ($p>0.05$ [($F(1,20) = 289$) $p = .797$]) maintain no significant tonal distinctions. Only SP 3 and SP 5 maintain tonal distinctions with *p*-value .002 and .001 respectively.

Word	F and *p* value	Speakers				
		SP1	SP2	SP3	SP4	SP5
tʃi low*high tone	F	[(1,20)=144]	[(1,20)=481]	[(1,20)=211]	[(1,20)=113]	(1,20)=317]
	p value	.886	.712	.000	.000	.000
tu low*high tone	F	[(1,20)=434]	[(1,20)=321]	[(1,20)=172]	[(1,20)=289]	[(1,20)=377]
	p value	.503	.412	.002	.797	.001
tʃu low*high tone	F	[(1,20)=111]	[(1,20)=156]	[(1,20)=117]	[(1,20)=321]	[(1,20)=432]
	p value	.000	.000	.000	.000	.000
li low*high tone	F	[(1,20)=211]	[(1,20)=321]	[(1,20)=231]	[(1,20)=244]	[(1,20)=266]
	p value	.000	.000	.000	.000	.000
kɔ low*high tone	F	[(1,20)=101]	[(1,20)=626]	[(1,20)=344]	[(1,20)=661]	[(1,20)=172]
	p value	.000	.000	.000	.000	.000

Table 4.3: Production test results of monosyllables

Tonal distinctions between *tʃu* low and high tone are maintained by all speakers. SP 1 reverses the two-tone categories of *tʃu* low and high tone, but the statistical result shows a significant difference of tone as there is no tonal overlap of the pitch contours (Figure 4.10). Tonal contrasts between *li* low and high tone are maintained by all speakers which are statistically significant SP1 (p<0.05 [(F(1,20) = 211) *p* = .000]), SP2 (p<0.05 [(F(1,20) = 321) *p* = .000]), SP3 (p<0.05 [(F(1,20) = 231) *p* = .000]), SP4 (p<0.05 [(F(1,20) = 244) *p* = .000]), SP5 (p<0.05 [(F(1,20) = 266) *p* = .000]), however, SP 2 reverses the two tones without any tonal overlap (Figure 4.11). As for the lexical word *kɔ*, all speakers reverse the two-tone categories, but the result shows a significant distinction of tone as there is no overlap of the pitch contours.

The results highlight that tone in Deori appears to be changing, as some speakers no longer distinguish the lexical tones in their production. SP 1 merges the tonal categories in *tʃi* and reverses *tʃu*, i.e., produces high tone as low tone and low tone as high tone (H>L; L>H). SP 2 merges the tonal categories in words *tʃi*, *tu*, *tʃu*, and reverses *li*. SP 3 reverses the tonal categories of *tʃi* and merges the tonal categories in *tʃu*. SP 4 reverses *tʃi* low and high tone and merges the tonal categories in *tu* and *tʃu* and SP 5 merges the tonal categories in *tʃu*. The merging of two-tone categories indicates that tonal distinctions in these words are gradually lost. Tone reversal highlights that speakers are confused regarding the underlying tonal distinctions of the lexical items. The gradual tonal loss can be attributed to the frequency and context of language use among younger generation speakers owing to language contact. We now proceed to discuss the results of disyllabic words in the next section.

4.6.6.2 Disyllable

Similar to the monosyllabic words, in disyllabic words, the average pitch contours across speakers are examined first followed by speaker wise analysis of the lexical words. The figures below show the average normalized pitch contours of tonal domains of disyllabic words across speakers.

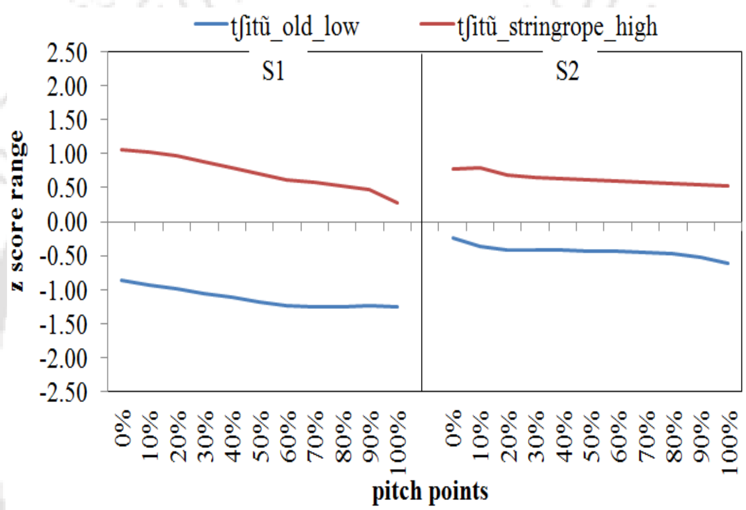


Figure 4.13: Average normalized pitch contours showing tonal distinctions between /tʃitũ/ "old_low tone" and /tʃitũ/ "string rope_high tone"

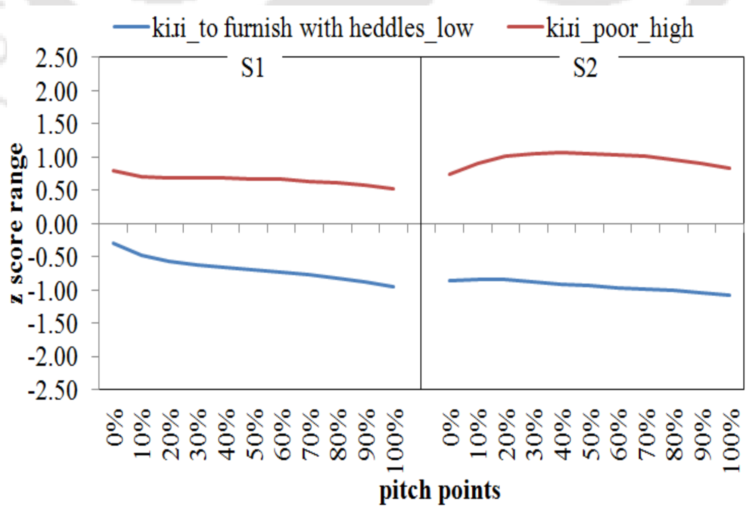


Figure 4.14: Average normalized pitch contours showing tonal distinctions between /kiɹi/ "to furnish with heddles_low tone" and /kiɹi/ "poor_high tone"

In disyllabic words, tonal distinctions are maintained in two words *tʃitũ* "old/string rope" and *kiɹi* "to furnish with heddles/poor" as can be seen in Figure 4.13 and Figure 4.14 respectively.

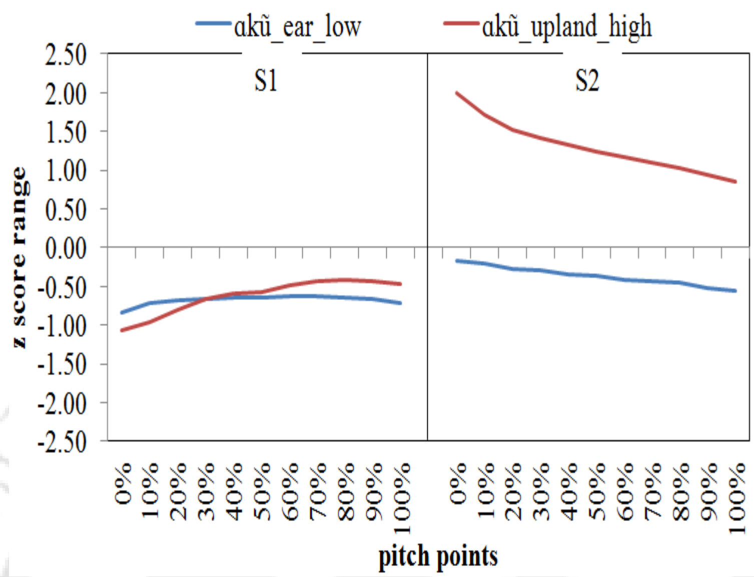


Figure 4.15: Average normalized pitch contours showing tonal distinctions between /ɑkũ/ "ear_low tone" and /ɑkũ/ "upland_high tone"

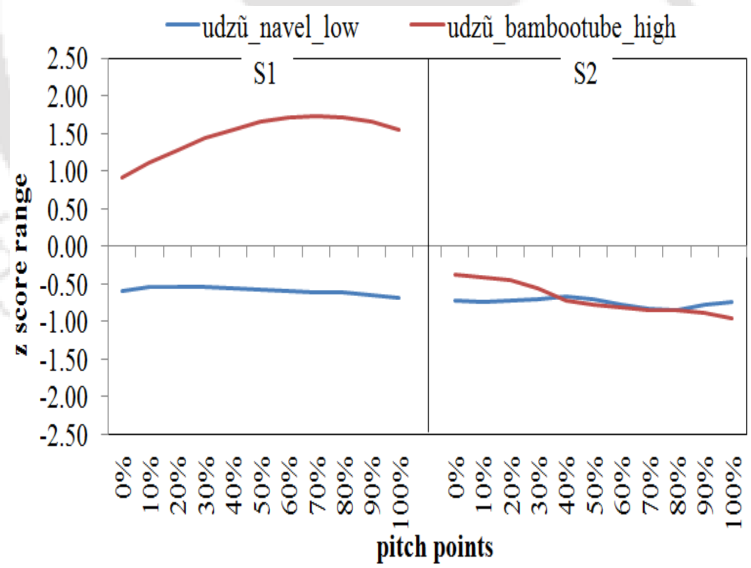


Figure 4.16: Average normalized pitch contours showing tonal distinctions between /udzũ/ "navel_low tone" and /udzũ/ "bamboo tube_high tone"

In words such as *akũ* "ear/upland" (Figure 4.15) and *udzũ* "navel/bamboo tube" (Figure 4.16), tonal contrasts are maintained in either of the syllables, unlike older speakers.

Apart from the lexical words *tʃitũ* and *baɹi* where tonal distinctions are maintained and *udzũ akũ* where tonal distinctions are maintained in either of the syllables, there are some lexical words where tonal distinctions are not maintained as can be seen in the diagrams below.

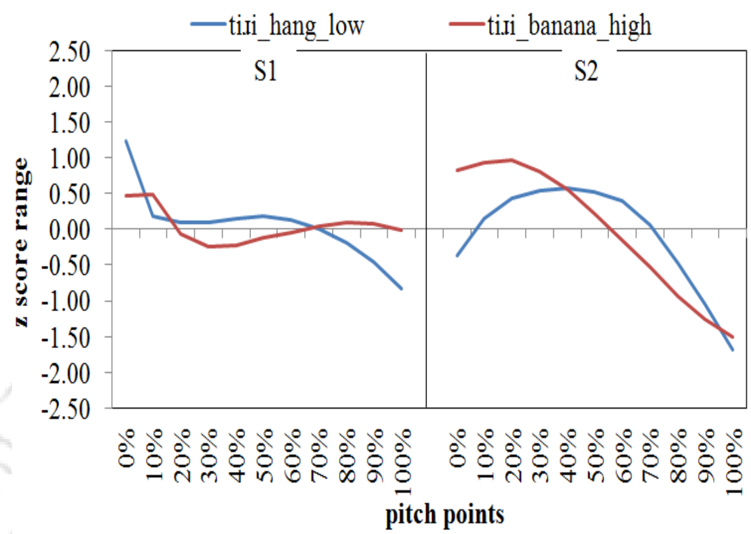


Figure 4.17: Average normalized pitch contours showing no tonal distinctions between /tiɹi/ “hang_low tone” and /tiɹi/ “banana_high tone”

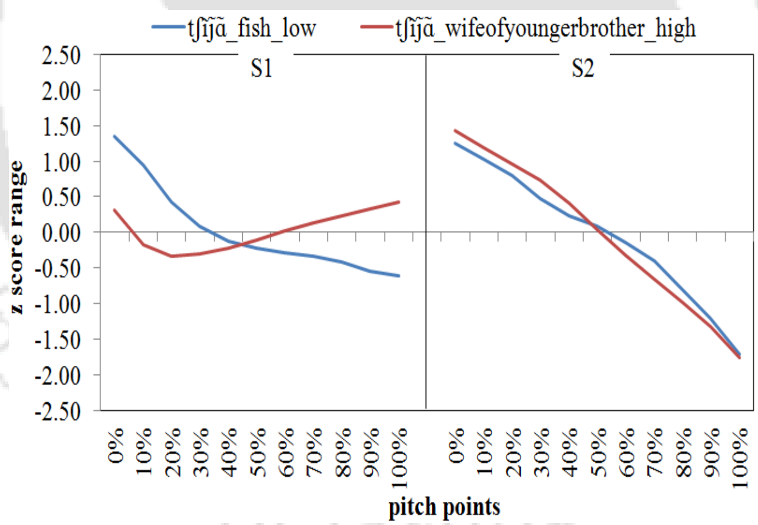


Figure 4.18: Average normalized pitch contours showing no tonal distinctions between /tʃĩjã/ “fish_low tone” and /tʃĩjã/ “wife of younger brother_high tone”

As can be seen in Figure 4.17 and Figure 4.18 no tonal distinctions are maintained in words such as *tiɹi* “hang/banana”, *tʃĩjã* “fish/wife of a younger brother” respectively. Similarly, in *baɹi* “garden/carry on back” (Figure 4.19) and *nĩnĩ* “drink/hold” (Figure 4.20) no tonal distinctions are maintained, unlike older generation speakers as can be seen in the following diagrams.

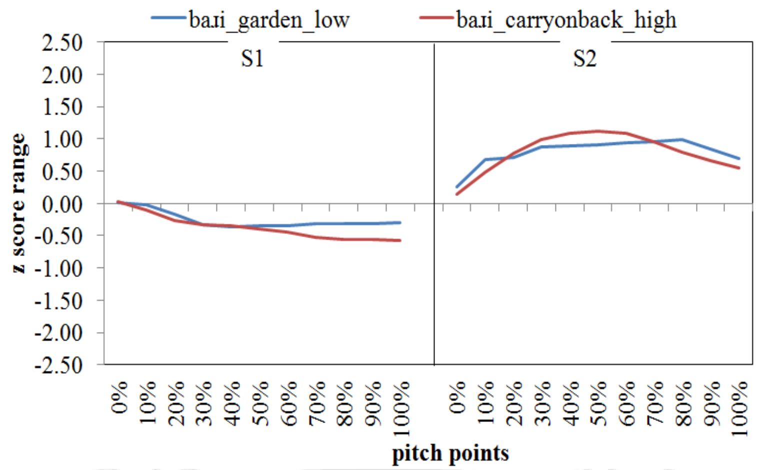


Figure 4.19: Average normalized pitch contours showing no tonal distinctions between /baɹi/ "garden_low tone" and /baɹi/ "carry on back_high tone"

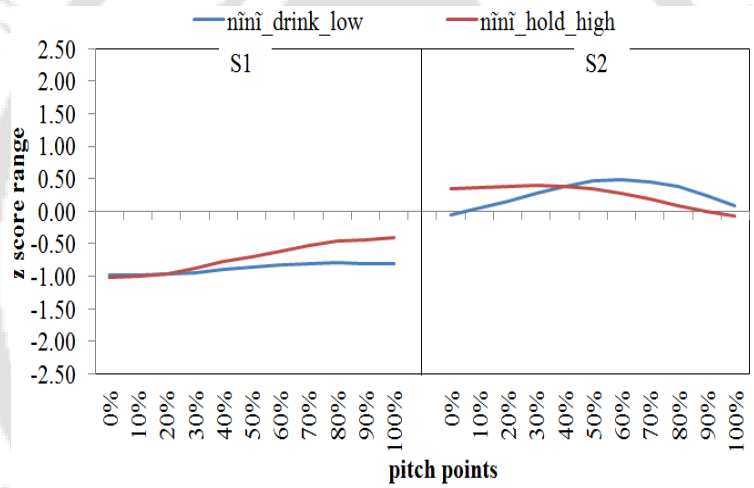


Figure 4.20: Average normalized pitch contours showing no tonal distinctions between /nĩnĩ/ "drink_low tone" and /nĩnĩ/ "hold_high tone"

After the visual examination of the pitch contours, a one way ANOVA test was done considering the averaged pitch point values (at 11% interval of time) across speakers for individual words to examine significant tonal distinctions in the lexical words. The results show significant tonal distinctions in both the syllables in words *tʃitũ* (p<0.05 [(F (1, 20) =149.58) *p* =.000]) (vowel 1), (p<0.05 [(F(1, 20) = 122.64) *p* =.000]) (vowel 2) and *kiɹi* (p<0.05 [(F (1, 20) =280.96) *p* =.000]) (vowel 1), (p<0.05 [(F(1, 20) = 176.13) *p* =.000]) (vowel 2) in both the syllables. In *akũ*, tone is significantly different only in the final syllable (p<0.05 [(F (1, 20) =172.29) *p* =.000]) (vowel 2) and not in the initial syllable (p<0.05 [(F (1, 20) =122.33) *p* =.612]) (vowel 1) and in *udzũ* significant difference of tone is found only in the initial syllable (p<0.05 [(F (1, 20) =217.27) *p*

=.000]) (vowel 1) and not in the final syllable (p<0.05 [(F (1, 20) = 234.86) *p* =.031]) (vowel 2). No significant tonal distinctions are observed in words like *nĩnĩ* (p<0.05 [(F (1, 20) = 114.61) *p* =.011]) (vowel 1) and (p<0.05 [(F (1, 20) = 243.61) *p* =.010]) (vowel 2), *baɹi* (p<0.05 [(F (1, 20) = 67.06) *p* =.030]) (vowel 1) and (p<0.05 [(F (1, 20) = 340.03) *p* =.070]) (vowel 2), *tʃĩj̃ã* (p<0.05 [(F (1, 20) = 248.18) *p* =.037]) (vowel 1) and (p<0.05 [(F (1, 20) = 144.61) *p* =.715]) (vowel 2), and *tiɹi* (p<0.05 [(F (1, 20) = 161.14) *p* =.779]) (vowel 1) and (p<0.05 [(F (1, 20) = 226.09) *p* =.010]) (vowel 2). Duration and intensity values were also examined to determine significant effect of duration and intensity on tone (if any). The results show that duration and intensity had no significant effect on tone in disyllabic stems, similar to the monosyllabic stems. An ANOVA test for duration test reveals a *p*-value of .075 (S1_low) and .101 (S1_high); .012 (S2_low) and .112 (S2_high) and for intensity a *p*-value of .461 (S1_low) and .021 (S2_high); .091 (S2_low) and .056 (S2_high).

Similar to the monosyllables, Table 4.4 and Table 4.5 show the results of disyllabic words of both older and younger generation speakers. Table 4.4 shows the results of the vowels in the initial syllable and Table 4.5 shows the results of the vowel in the final syllable.

Vowel 1							
Older generation (Mahanta *et al.* (2017)				Younger generation			
Word	Tone	F and *p* value	Result	Word	Tone	F and *p* value	Result
tʃitũ	low*high	F	[(1, 20) =101.12]	tʃitũ	low*high	F	[(1, 20) =149.58]
		p value	.000			*p* value	.000
kiɹi	low*high	F	[(1, 20) =446.1]	kiɹi	low*high	F	[(1, 20) =280.96]
		p value	.000			*p* value	.000
ɑkũ	low*high	F	[(1, 20) =309]	ɑkũ	low*high	F	[(1, 20) =122.33]
		p value	.000			*p* value	.612
udzũ	low*high	F	[(1, 20) =104.21]	udzũ	low*high	F	[(1, 20) =217.27]
		p value	.000			*p* value	.000
tiɹi	low*high	F	[(1, 20) = 224.21]	tiɹi	low*high	F	[(1, 20) = 161.14]
		p value	.000			*p* value	.779
tʃĩj̃ã	low*high	F	[(1, 20) = 220]	tʃĩj̃ã	low*high	F	[(1, 20) = 248.18]
		p value	.000			*p* value	.037
bɑɹi	low*high	F	[(1, 20) = 332.33]	bɑɹi	low*high	F	[(1, 20) = 67.06]
		p value	.000			*p* value	.030
nĩnĩ	low*high	F	[(1, 20) = 229]	nĩnĩ	low*high	F	[(1, 20) = 114.61]
		p value	.000			*p* value	.011

Table 4.4: Results showing tonal distinctions in disyllables (Vowel 1) maintained by the older generation and younger generation speakers

Vowel 2							
Older generation (Mahanta *et al.* (2017)				Younger generation			
Word	Tone	F and *p* value	Result	Word	Tone	F and *p* value	Result
tʃitũ	low*high	F	[(1,20)=433.55]	tʃitũ	low*high	F	[(1, 20)=122.64]
		p value	.000			*p* value	.000
kiɹi	low*high	F	[(1, 20)=243.63]	kiɹi	low*high	F	[(1, 20)=176.13]
		p value	.000			*p* value	.000
ɑkũ	low*high	F	[(1, 20)=199.61]	ɑkũ	low*high	F	[(1, 20)=172.29]
		p value	.000			*p* value	.000
udzũ	low*high	F	[(1, 20)=332.53]	udzũ	low*high	F	[(1, 20) = 234.86]
		p value	.001			*p* value	.031
tiɹi	low*high	F	[(1, 20)=177]	tiɹi	low*high	F	[(1, 20) = 226.09]
		p value	.000			*p* value	.010
tʃĩj̃ã	low*high	F	[(1, 20)=189]	tʃĩj̃ã	low*high	F	[(1, 20) = 144.61]
		p value	.000			*p* value	.715
baɹi	low*high	F	[(1, 20)=301.3]	baɹi	low*high	F	[(1, 20) = 340.03]
		p value	.000			*p* value	.070
nĩnĩ	low*high	F	[(1, 20)=151.43]	nĩnĩ	low*high	F	[(1, 20) = 243.61]
		p value	.000			*p* value	.010

Table 4.5: Results showing tonal distinctions in disyllables (Vowel 2) maintained by the older generation and younger generation speakers

The results in Table 4.4 and Table 4.5 show that tonal distinctions in *tʃitũ* and *kiɹi* are maintained in both the syllables by older generation speakers [(F (1, 20) =101.12) *p* =.000]) (vowel 1) [(F(1, 20) = 433.55) *p* =.000]) (vowel 2) and younger generation speakers [(F (1, 20) =149.58) *p* =.000]) (vowel 1) [(F(1, 20) = 122.64) *p* =.000]) (vowel 2) and are significantly different. However, while words such as *akũ* [(F (1, 20) =309) *p* =.000]) (vowel 1) [(F (1, 20) =199.61) *p* =.000]) (vowel 2) and *udzũ* [(F (1, 20) =104.21) *p* =.000]) (vowel 1) [(F (1, 20) = 332.53) *p* =.001]) (vowel 2) show tonal contrasts among older generation speakers in both the syllables, younger generation speakers maintain tone distinctions in *akũ* and *udzũ* in either of the syllable. In *akũ* tone is significantly different in the final syllable [(F (1, 20) =172.29) *p* =.000]) (vowel 1) and not in the initial syllable [(F (1, 20) =122.33) *p* =.612]) (vowel 2) and in *udzũ*, tone is significantly different in the initial syllable [(F (1, 20) =217.27) *p* =.000]) and not in the final syllable [(F (1, 20) = 234.86) *p* =.031]). In disyllabic words *tʃĩj̃ã*, *tiɹi*, *baɹi*, and *nĩnĩ*, no tonal distinctions are maintained by younger generation speakers, unlike older generation speakers. The results show that tonal contrasts are gradually reducing among younger generation speakers compared to older generation speakers.

4.6.6.2.1 Speaker wise tonal analysis - Disyllables

Similar to monosyllabic words, speaker wise analysis of the tonal words was conducted to examine speaker wise variation in disyllabic stems. The figures below show considerable f_0 variations and tone overlap in disyllabic words.

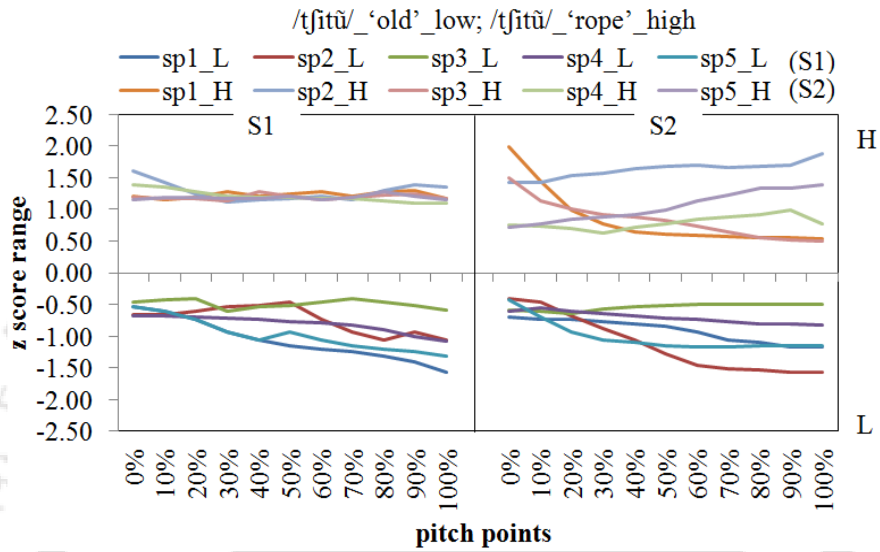


Figure 4.21: Speaker wise normalized pitch contours showing tonal distinctions between /tʃitũ/ "old_low tone" and /tʃitũ/ "rope_high tone".

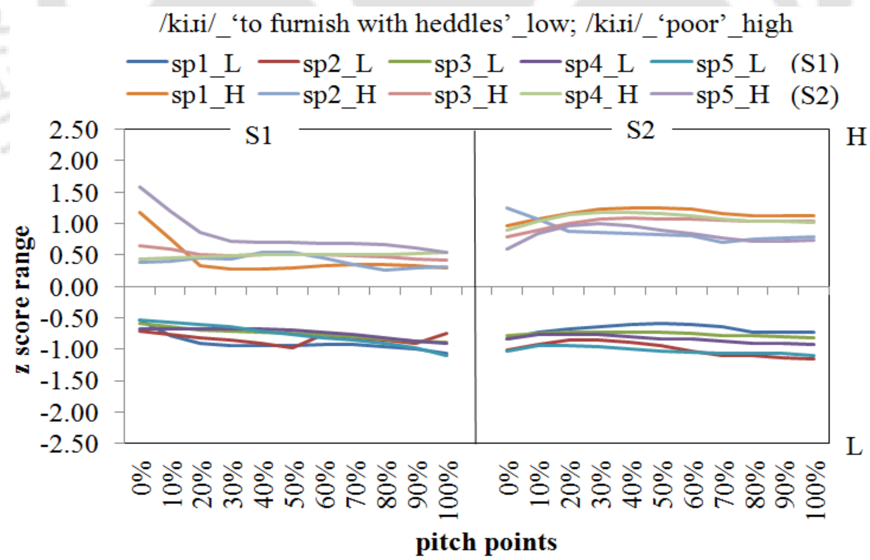


Figure 4.22: Speaker wise normalized pitch contours showing tonal distinctions between /kiɹi/ "to furnish with heddles_low tone" and /kiɹi/ "poor_high tone".

Tonal distinctions in disyllabic words are maintained only in *tʃitũ* and *kiɹi* by each speaker as can be seen in Figure 4.21 and Figure 4.22 respectively.

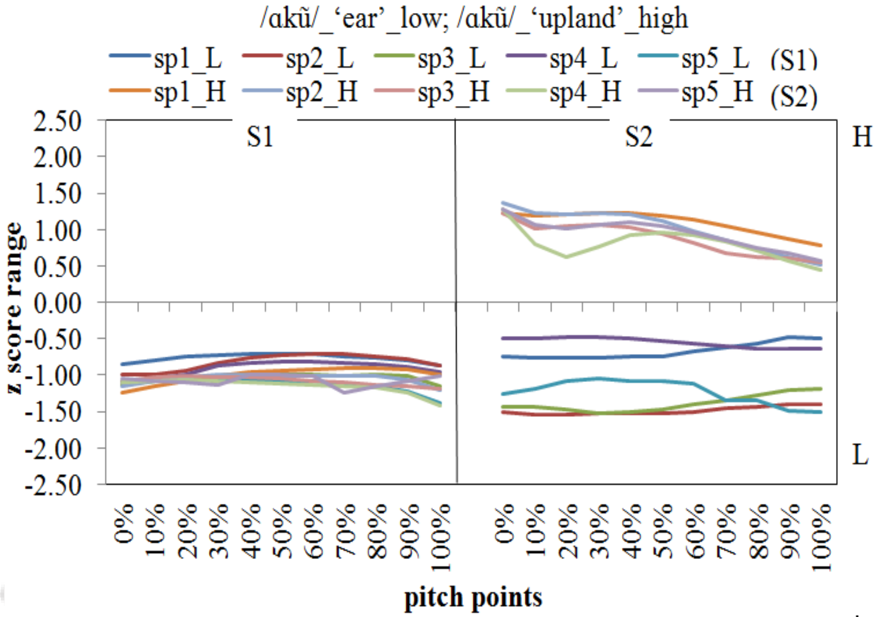


Figure 4.23: Speaker wise normalized pitch contours showing tonal distinctions (only in the final syllable) between /ɑkũ/ "ear_low tone" and /ɑkũ/ "upland_high tone".

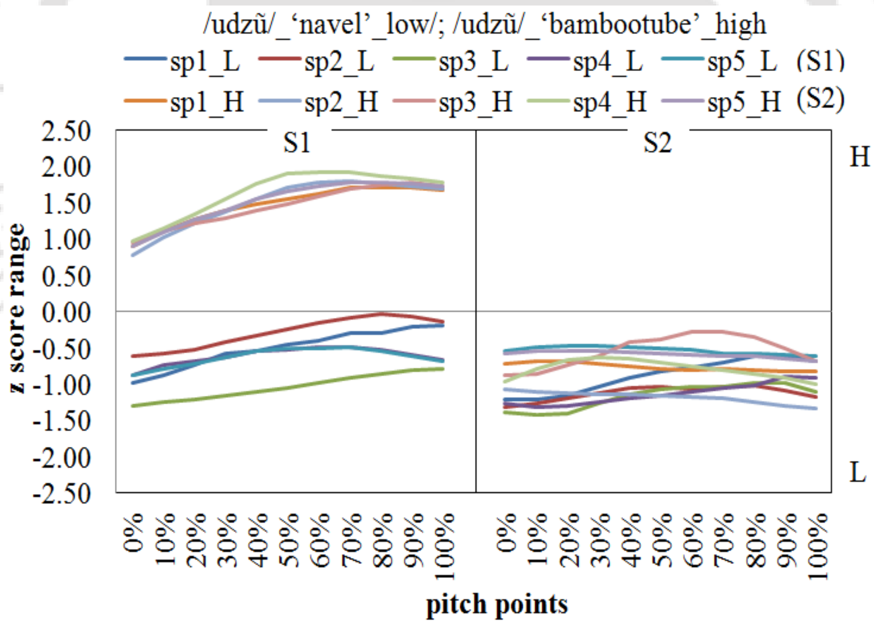


Figure 4.24: Speaker wise normalized pitch contours showing tonal distinctions (only in the initial syllable) between /udzũ/ "navel_low tone" /udzũ/ "bambootube_high tone".

Tonal contrasts in *akũ* (Figure 4.23) and *udzũ* (Figure 4.24) are maintained in either of the syllables, unlike older speakers. In *akũ* there is tone overlap in the initial syllable and in *udzũ* there is tone overlap in the final syllable.

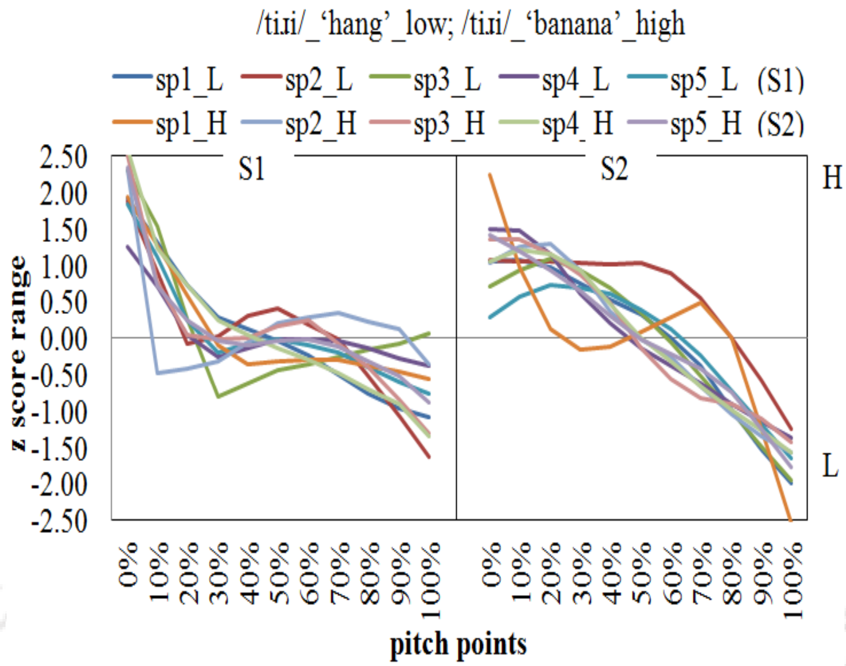


Figure 4.25: Speaker wise normalized pitch contours showing no tonal distinctions between /ti.ɹi/ “hang_low tone” and /ti.ɹi/ “banana_high tone”.

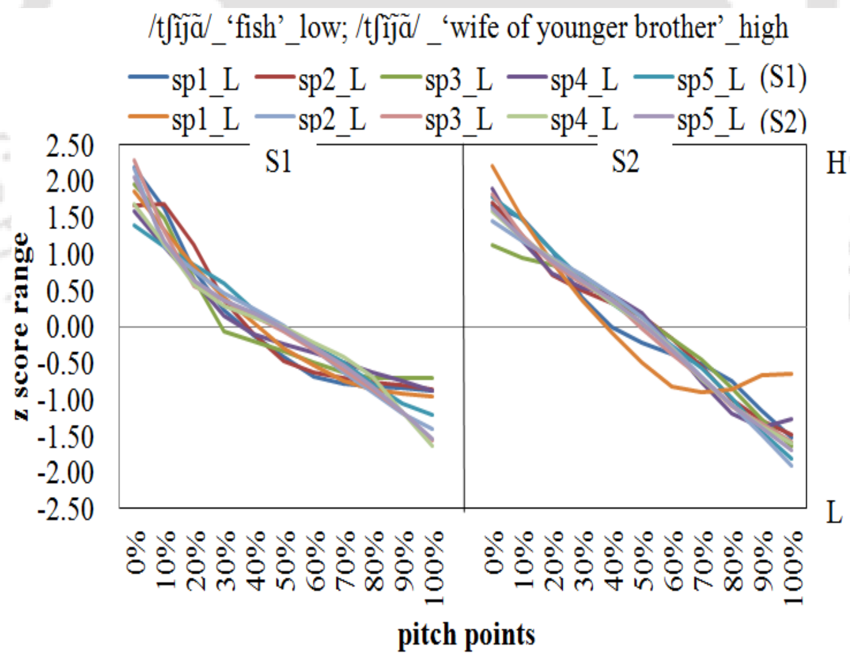


Figure 4.26: Speaker wise normalized pitch contours showing no tonal distinctions between /tʃĩj̃ɑ̃/ “fish_low tone” and /tʃĩj̃ɑ̃/ “wife of younger brother_high tone”.

Figure 4.25 and Figure 4.26 show a falling f_0 contour without any tonal distinctions between *ti.ɹi* low and high tone and *tʃĩj̃ɑ̃* low and high tone respectively.

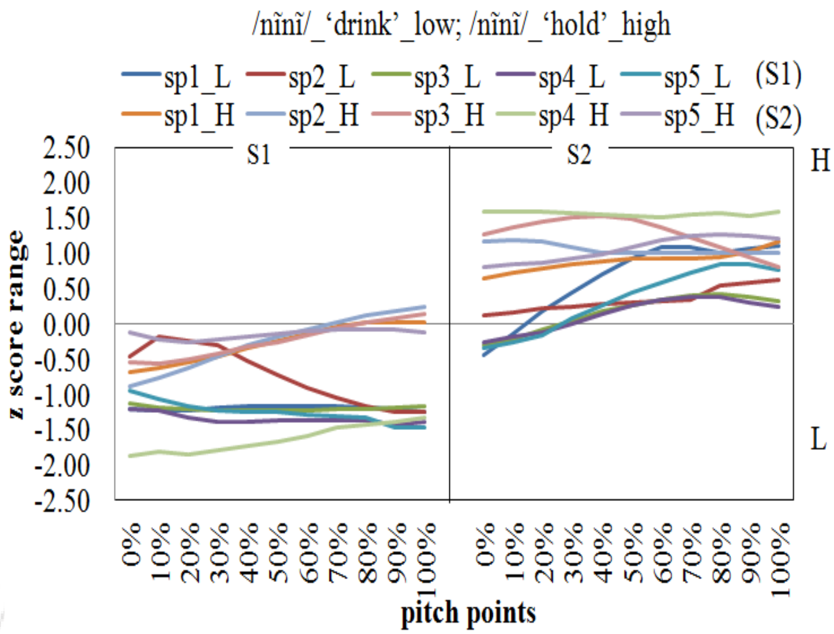


Figure 4.27: Speaker wise normalized pitch contours showing no tonal distinctions between /nĩnĩ/ “drink_low tone” and /nĩnĩ/ “hold_high tone”.

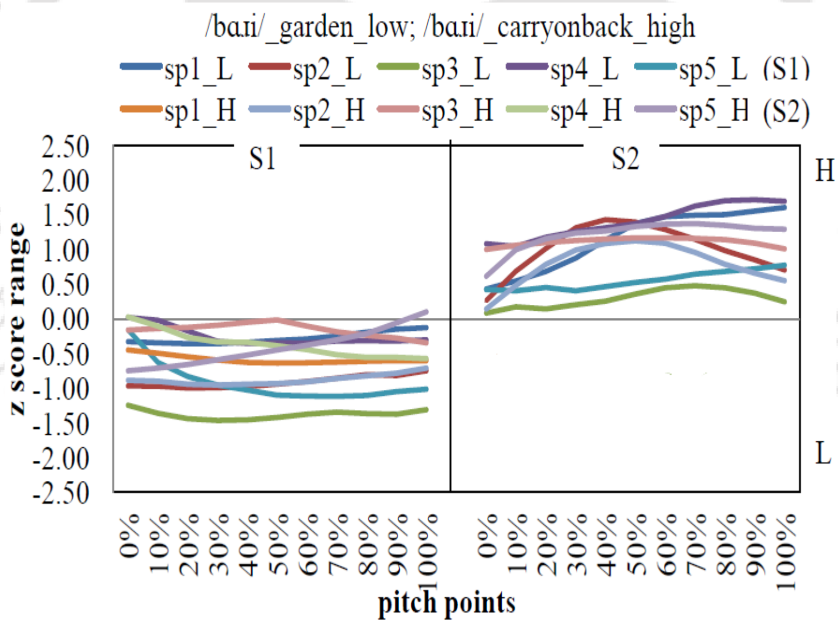


Figure 4.28: Speaker wise normalized pitch contours showing no tonal distinctions between /bɑɹi/ “drink_low tone” and /bɑɹi/ “hold_high tone”.

Lexical words *nĩnĩ* and *baɹi* are not tonally distinct as can be seen in Figure 4.27 and Figure 4.28 respectively. While in monosyllables, speaker variation is robust; in disyllables, no speaker variation is observed. Unlike monosyllables, in disyllabic words, there is f_0 variation and tone overlap. Similar to monosyllables, an ANOVA test was conducted to discern the significant difference of tone in disyllabic words. ANOVA test results are presented in Table 4.6 and Table 4.7. Table 4.6 shows the results of the vowels in the initial syllable and Table 4.7 shows the results of the vowels in the final syllable.

Word	F and *p* value	**Vowel 1**				
		Speakers				
		SP1	SP2	SP3	SP4	SP5
tʃitũ low*high tone	F	[(1,20)=59]	[(1,20)=44]	[(1,20)=121]	[(1,20)=93]	[(1,20)=111]
	p value	.000	.000	.000	.000	.000
kiɹi low*high tone	F	[(1,20)=110]	[(1,20)=221]	[(1,20)=323]	[(1,20)=117]	[(1,20)=377]
	p value	.000	.000	.000	.000	.000
udzũ low*high tone	F	[(1,20)=121]	[(1,20)=44]	[(1,20)=201]	[(1,20)=172]	[(1,20)=233]
	p value	.000	.000	.000	.000	.000
akũ low*high tone	F	[(1,20)=663]	[(1,20)=131]	[(1,20)=117]	[(1,20)=200]	[(1,20)=501]
	p value	.021	.011	.011	.331	.021
tiɹi low*high tone	F	[(1, 20) =154]	[(1,20)=291]	[(1, 20)=419]	[(1,20)=111]	[(1, 20)=140]
	p value	.059	.093	.028	.033	.028
tʃĩjã low*high tone	F	[(1, 20) =201]	[(1, 20)=115]	[(1,20) =173]	[(1,20)=109]	[(1, 20)=330]
	p value	.037	.081	.015	0.22	.042
baɹi low*high tone	F	[(1, 20) =601]	[(1,20)=59]	[(1, 20)=311]	[(1,20)=120]	[(1,20)=298]
	p value	.029	.321	.081	.030	.022
nĩnĩ low*high tone	F	[(1, 20) =119]	[(1, 20)=110]	[(1, 20)=200]	[(1,20)=139]	[(1, 20)=400]
	p value	.021	0.51	.110	.019	.011

Table 4.6: Production test results of disyllabic words (Vowel 1)

Word	F and *p* value	**Vowel 2**				
		Speakers				
		SP1	SP2	SP3	SP4	SP5
tʃitũ low*high tone	F	[(1, 20)=334]	[(1,20)=166]	[(1,20)=112]	[(1,20)=266]	[(1,20)=61]
	p value	.000	.000	.000	.000	.000
kiɹi low*high tone	F	[(1, 20)=163]	[(1, 20)=321]	[(1,20)= 441]	[(1,20)=218]	[(1,20)=290]
	p value	.000	.000	.000	.000	.000
udzũ low*high tone	F	[(1, 20) =100]	[(1, 20)=309]	[(1,20)=419]	[(1,20)=210]	[(1, 20) =431]
	p value	011	.023	.011	.512	.031
akũ low*high tone	F	[(1, 20) =177]	[(1, 20)=155]	[(1,20)=190]	[(1,20)=119]	[(1, 20) =453]
	p value	.000	.000	.000	.000	.000
tiɹi low*high tone	F	[(1, 20)=191]	[(1,20)=772)	[(1,20)=111]	[(1,20)=276]	[(1, 20)=121]
	p value	.012	.018	.033	.013	.092
tʃĩjã low*high tone	F	[(1, 20)=186]	[(1, 20)=131]	[(1,20)=501]	[(1,20)=442]	[(1, 20)=191]
	p value	.043	.052	.170	.010	.721
baɹi low*high tone	F	[(1, 20)=334]	[(1,20)=461]	[(1, 20)=339]	[(1,20) =671]	[(1, 20)=291]
	p value	.018	.141	.021	.070	.033
nĩnĩ low*high tone	F	[(1, 20)=143]	[(1,20)=332]	[(1,20)=262]	[(1,20)=399]	[(1, 20)=166]
	p value	.016	.322	.022	.020	.020

Table 4.7: Production test results of disyllabic words (Vowel 2)

The results in Table 4.6 and Table 4.7 show that tone is significantly different in words *tʃitũ* and *kiɹi* throughout all pitch points in both the syllables and is maintained by all speakers. The speaker wise significant distinctions of tone in *tʃitũ* are as follows: SP1 (p<0.05 [(F (1, 20) =59) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 334) p = .000] (syllable 2), SP2 (p<0.05 [(F (1, 20) =44) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 166) p = .000] (syllable 2), SP3 (p<0.05 [(F (1, 20) =121.11) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 112) p = .000] (syllable 2), SP4 (p<0.05 [(F (1, 20) =93) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 266) p = .000] (syllable 2), SP5 p<0.05 [(F (1, 20) =111) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 61) p = .000] (syllable 2). The speaker wise significant distinctions of tone in *kiɹi* are as follows: SP1(p<0.05 [(F (1, 4) =110) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 163) p = .000] (syllable 2), SP2 (p<0.05 [(F (1, 4) =221) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 321) p = .000] (syllable 2), SP3 (p<0.05 [(F

(1, 4) =323) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 441) p = .000] (syllable 2), SP4 (p<0.05 [(F (1, 4) =117.2) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 218) p = .000] (syllable 2), SP5 (p<0.05 [(F (1, 4) =377) p = .000] (syllable 1) (p<0.05 [(F(1, 20) = 290) p = .000] (syllable 2). In *udzũ* tone is distinct only in the first syllable and not in the second syllable: SP1 (p<0.05 [(F (1, 20) =121) p = .000] (syllable 1) (p<0.05 [(F (1, 20) =100) p = .011] (syllable 2), SP2 (p<0.05 [(F (1, 20) =441) p = .000] (syllable 1) (p<0.05 [(F (1, 20) =309) p = .023] (syllable 2), SP3 (p<0.05 [(F (1, 20) =201) p = .000] (syllable 1) (p<0.05 [(F (1, 20) =419) p = .011] (syllable 2), SP4 (p<0.05 [(F (1, 20) =172) p = .000] (syllable 1) (p<0.05 [(F (1, 20) =210) p = .512] (syllable 2), SP5 (p<0.05 [(F (1, 20) =233) p = .000] (syllable 1) (p<0.05 [(F (1, 20) = 431) p = .031] (syllable 2). Unlike *udzũ*, tone in *akũ* "ear/upland" is significantly different in the second syllable and not in the initial syllable: Sp1 (p<0.05 [(F (1, 20) =663) p = .021] (syllable 1) (p<0.05 [(F (1, 20) =177) p = .000] (syllable 2), SP2 (p<0.05 [(F (1, 20) =131) p = .011] (syllable 1) (p<0.05 [(F (1, 20) =155) p = .000] (syllable 2), SP3 (p<0.05 [(F (1, 20) =117) p = .011] (syllable 1) (p<0.05 [(F (1, 20) =190) p = .000] (syllable 2), SP4 (p<0.05 [(F (1, 20) =200) p = .331] (syllable 1) (p<0.05 [(F (1, 20) =119) p = .000] (syllable 2), SP5 (p<0.05 [(F (1, 20) =501) p = .021] (syllable 1) (p<0.05 [(F (1, 20) =453) p = .000] (syllable 2). The results further show that in words like *nĩnĩ* "drink/hold", *tĩɹĩ* "banana/hang", *tʃĩ̃jã* "fish/wife of the younger brother", *baɹi* "garden/carry on back" no significant tonal distinctions are maintained. Unlike monosyllables, in disyllables no tone reversal is observed.

4.6.7 Summary of tone production

The production experiment highlights considerable speaker variations mainly in monosyllables. The results show a trend of underlying tone reversal H>L; L>H in monosyllabic words. All the words examined were not tonally distinct for each speaker. Not all speakers maintain tonal distinctions. In disyllabic words, although no tone reversal is observed, there is considerable variation in the pitch contours and tonal overlap. The words that have significant tonal distinctions among older generation speakers have either a) undergone complete tone reversal among younger generation speakers as in *kɔ*, or b) have tonal distinctions in either of the syllable as in *udzũ* and *akũ* or c) maintain no tonal distinctions as in *tʃĩ̃jã*, *tiɹi*, *nĩnĩ*, and *baɹi*.

In general, considerable variations in fundamental frequency (f_0) of the tonally specified words among younger generation speakers eventually leads to the process of contact-induced tonal diffusion in the language. The reduction in the number of tonal distinctions and tonal variations can be attributed to long term bilingual contact with Assamese, a non-tonal language. The frequency of language use by younger speakers also predicts the rate of changes in the tonal pattern. Although Acharyya and Mahanta (2019) have mentioned that intergenerational language transmission is not completely hindered in Deori, there is no denying that older generation speakers use Deori more frequently than younger generation speakers. As already mentioned in section 4.6.6.1.1, it can be assumed that the frequency and context of language use can be considered to be a factor leading to gradual tone loss and tonal variations among younger generation speakers.

Furthermore, while duration plays a significant role in differentiating a stressed syllable from an unstressed syllable in Deori (as discussed in Chapter 3), duration is not significantly different when a word has a distinctive tone. It is the f_0 which is the acoustic cue for tonal distinctions in Deori. Results show no significant effect of duration on tone. It is to be noted that words that have no tonal distinctions such as *tʃĩj̃ã*, *tiɹi*, *baɹi*, and *nĩnĩ* also do not exhibit significant durational difference. However, following Mahanta *et al.* (2017) it can be conjectured that these words might emerge as stress-bearing words and eventually might give rise to a stress-accent system in Deori. Having discussed the production experiment, we now proceed to discuss the perception of tone in Deori to examine how lexical tones are perceived in Deori.

4.7 Tone perception

The findings of the production experiment on Deori tone suggest gradual tonal loss and tonal variations among younger generation speakers compared to older generation speakers. After the production experiment, a perception test was conducted to confirm the findings and to investigate speakers' ability to identify tonal categories which will help us understand the status of tone in Deori. For the perception experiment, both older and younger generation speakers were taken into consideration to examine the impact of language experience on pitch perception between generations.

In studies on tone perception either discrimination task is taken into consideration as in Mok *et al.* (2013), or identification task as in Brunelle and Jannedy (2007), or both identification and discrimination tasks as in Peng *et al.* (2010). While in an identification task a stimuli is played one after another and the participant has to identify the tonal categories of the stimuli, in the discrimination task, two stimuli are played together and the participant has to distinguish whether the two stimuli belong to the same category or different category. Gandour (1978) states that for listeners of tone languages pitch height or contour difference is sufficient to distinguish lexical items. While contrasts involving consonantal feature, especially related to the perception of stop consonants, are perceived mostly in a categorical manner (Liberman *et al*., 1961), vowel feature contrasts are not perceived categorically (Abramson, 1976; Fry *et al*., 1962; Stevens *et al*., 1969). The concept of 'categorical perception' was developed by Liberman *et al.* (1957). "When stimuli are perceived categorically, equivalent acoustic differences between two tokens are treated differently, depending on whether the two tokens are heard as members of the same category or as members of different categories. Two members of one category are less discriminable than are two tokens from two different categories with an equivalent acoustic difference between them. The idea is that, through experience with a given language, listeners learn the location of specific category boundaries along various acoustic continua. By increasing discrimination accuracy across these boundaries and/or reducing it within boundaries, listeners improve their ability to hear two acoustically similar but not identical members of one category as the same and, conversely, improve their ability to hear two acoustically similar members of distinct categories as different" (Francis *et al*., 2003, p. 1029). There have been conflicting results concerning the categorical nature of tone perception across languages (Wang and Peng, 2012). While in Mandarin Chinese tone is perceived categorically (Wang, 1976), in Thai tone is not perceived categorically (Abramson, 1979). Francis *et al*. (2003) state that in Cantonese, contour tones are perceived categorically and level tones are not. In this study, we have conducted an identification test to examine speakers' ability to identify tonal categories. Tone identification is a distinct perceptual experiment wherein the speaker has to identify the tonal categories of the stimuli, i.e, whether the stimuli are low tone stimuli or high tone stimuli.

4.7.1 Methodology

For the perception experiment, following monosyllabic words (CV syllable type) with underlying tonal distinctions were chosen (Table 4.8).

Low tone	Gloss	High tone	Gloss
li	‘necklace’	li	‘heavy’
tʃi	‘blood’	tʃi	‘to make’
kɔ	‘pluck’	kɔ	‘come’
tʃĩj̃ã	‘fish’	tʃĩj̃ã	‘wife of younger brother’
kiɹi	to furnish with heddles	kiɹi	‘poor’

Table 4.8: The wordlist considered for the perceptual experiment

The stimuli were chosen in such a way that their underlying tonal distinctions are maintained by both older and younger generation speakers as in *li* and *tʃĩj̃ã*. Further, stimuli *tʃi*, *kɔ*, and *kiɹi* were chosen to examine whether tonal variations that were observed in the production of these words among young speakers also surface in the perception test. The perception test was designed using natural speech data and the stimuli were recorded from two older generation speakers aged between 50 and 55 years. The stimuli for the perception test were recorded from older generation speakers because older speakers were more accurate in maintaining tonal distinctions compared to younger speakers. The recording procedure of the stimuli for the perception test is similar to that of the production experiment as such it will not be discussed here to avoid redundancy. In the production test, it has been observed that f_0 is the acoustic cue in distinguishing contrastive pairs among both the generation and other factors such as duration and intensity were identical for the contrastive pairs. The sound files that were recorded for the perception experiment were identical in duration and intensity and had a distinct f_0 distinction.

4.7.2 Speakers

Ten native speakers (5 belonging to older and 5 belonging to the younger generation) participated in the perception experiment. The participants were all male and they were in the age group of 18-30 years (younger generation: SP6, SP7, SP8, SP9, SP10) and 45-60 years (older generation; SP11, SP12, SP13, SP14, Sp15). The speakers that participated in the perception test reported that they had no history of hearing or speaking disorders.

4.7.3 Procedure

In the identification task, the sound files were played one by one and the speakers were asked to identify the correct tonal categories. The sound files with the minimal pairs played to the participants were in a sentence frame “I X said” *a X nina itʃabɛm*. The target stimuli were embedded with two options – the real meaning and the contrastive meaning. All the stimuli were randomized. The participants were allowed to listen to one particular sound three times. Each speaker listened to a total of 30 tokens (10 words*3 repetitions). The stimuli were played from a computer connected with a headphone. The participants were instructed to listen to the stimuli and select any of the two options displayed on the computer screen that they perceive as representing the exact meaning.[48]

4.7.4 Results

In this section, the results of the perception test will be discussed. The results show that participants, more particularly younger participants, have difficulty in perceiving the tonal categories.

4.7.4.1 Identification test

The identification test results show speakers' difficulty in identifying the tonal categories. At first, the responses of monosyllabic words will be discussed followed by a discussion on the responses of disyllabic words.

Perception of *li* "necklace_low tone/heavy_high tone"

The identification test results show that stimuli *li* is perceived correctly by all speakers across generations, except SP 7 (younger generation). SP 7 identified the low tone stimuli *li* "necklace" as high tone *li* "heavy" 80% of the times and high tone stimuli *li* "heavy" as low tone *li* "necklace" 60% of the times as can be seen in the figures below.

[48] As pointed out by the examiner on using nonce words in the perception experiment, we believe nonce words cannot be taken into consideration because Deori does not have an abundance of lexically contrastive tonal pairs. Our only way to understand the existence of remnant tonal distinctions was to use the contrastive pairs. We had doubts whether nonce pairs would be recognized at all, since in the existing pairs itself we had variable results (tone reversal, varying *f0* pattern, tone overlap).

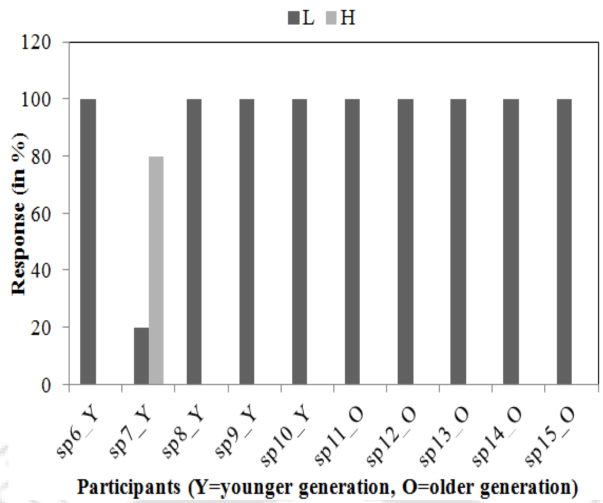


Figure 4.29: Younger and older generation speakers' perception of /li/ low tone stimuli

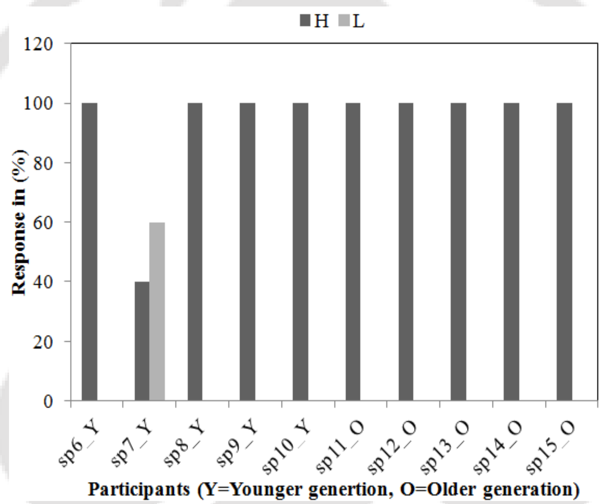


Figure 4.30: Younger and older generation speakers' perception of /li/ high tone stimuli

While in production test two way tonal contrasts in *li* was maintained by both the generation, in perception test SP 7 had perceptual difficulty in perceiving the exact tonal category.

Perception of *tʃi* 'blood_low tone/to make_high tone'

Figure 4.31 shows that among younger generation speakers, SP 6, SP 7, and SP 8 perceived the low tone stimuli (*tʃi*_blood) as high tone (*tʃí*_to make) 60%, 80%, and 80% of the times respectively, whereas SP 9 and SP 10 completely reversed the low tone (*tʃi*_blood) as high tone (*tʃí*_to make). The responses of SP 9 and SP 10 show that low tone stimuli *tʃi*_blood is identified as *tʃí*_to make. On the contrary, older generation speakers rightly identified the low tone stimuli and associated the right meaning to the respective tonal category.

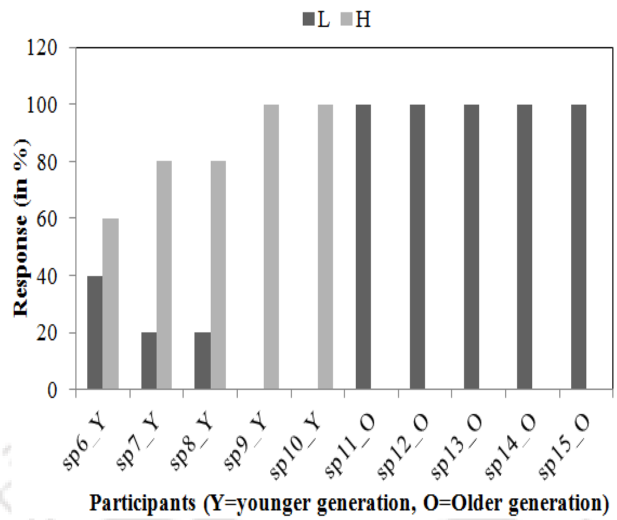


Figure 4.31: Younger and older generation speakers' perception of /tʃi/ low tone stimuli

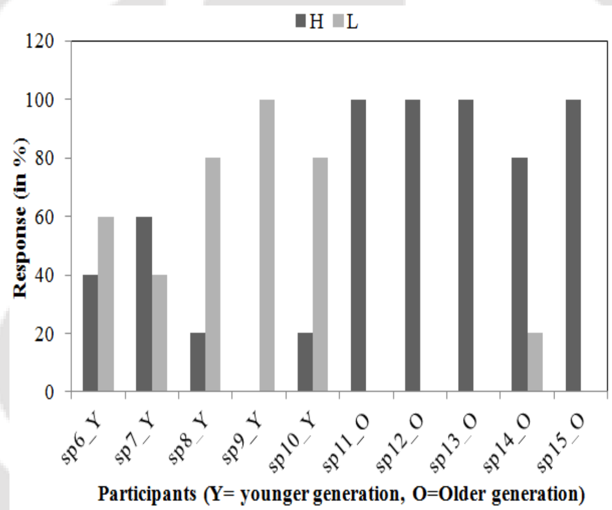


Figure 4.32: Younger and older generation speakers' perception of /tʃi/ high tone stimuli

Figure 4.32 shows the response of high tone stimuli. Similar to low tone stimuli, in the high tone stimuli SP 6, SP 7, SP 8, and SP 10 had perceptual difficulty in identifying the tonal categories and SP 9 completely reversed the two tonal categories, i.e identified the high tone as low tone. Among older generation speakers, SP 11, SP 12, SP 13, and SP 15 identified the right meaning of the high tone stimuli *tʃi* as "to make" without any perceptual difficulty, whereas SP 14 have perceptual difficulty and identified the high tone stimuli as the low tone stimuli 20% of the times.

Perception of *kɔ* 'come_low tone/pluck_high tone'

The response for *kɔ* 'come/pluck' shows that younger speakers could not identify the two tonal categories correctly. They identified the low tone as high tone and high tone as low tone. This is consistent with their inability to produce the two tonal categories distinctively. However, older generation speakers could rightly identify the two tonal categories which show that older generation speakers have preserved the underlying tonal distinctions of the lexical item *kɔ* 'come/pluck'.

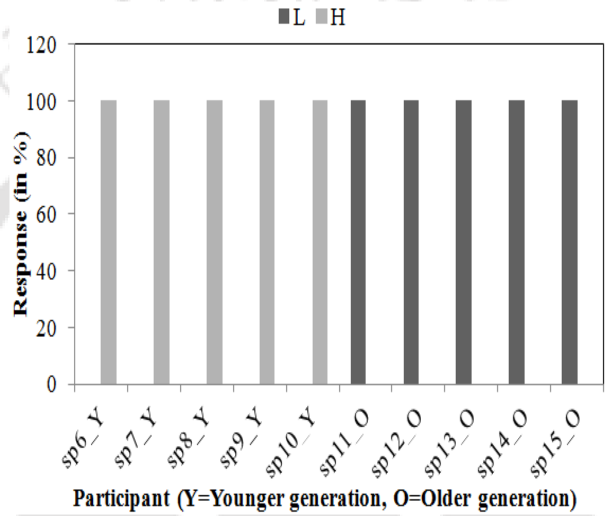


Figure 4.33: Younger and older generation speakers' perception of /kɔ/ low tone stimuli

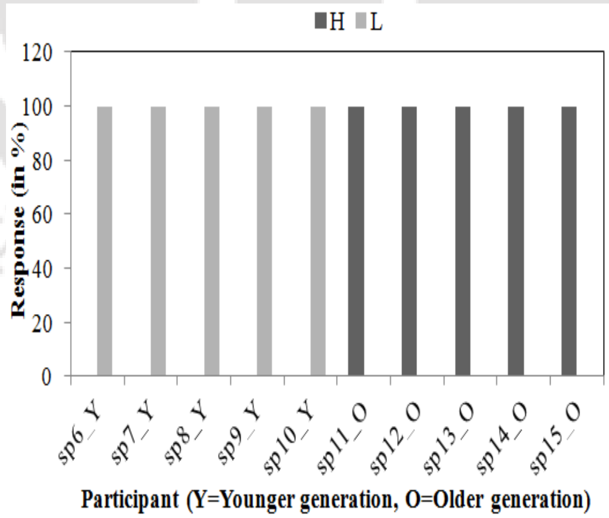


Figure 4.34: Younger and older generation speakers' perception of /kɔ/ high tone stimuli

Perception of *kiɹi* ‘to furnish with heddles_low tone/poor_high tone’

Production test results show that both the generation maintains tonal distinctions in *kiɹi*, however, perception test results show that among younger generation participants, SP 8 and SP 10 had difficulty in perceiving the tonal categories of *kiɹi* and identifies the low tone stimuli as high tone stimuli 40% and 60% of the times respectively and high tone stimuli as low tone stimuli 60% and 50% of the times.

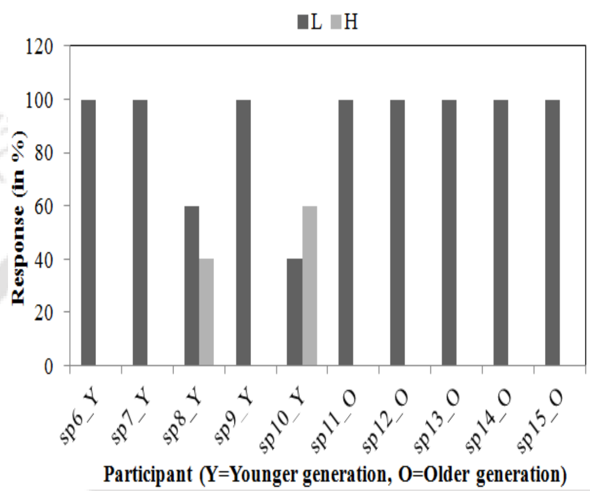


Figure 4.35: Younger and older generation speakers’ perception of /kiɹi/ low tone stimuli

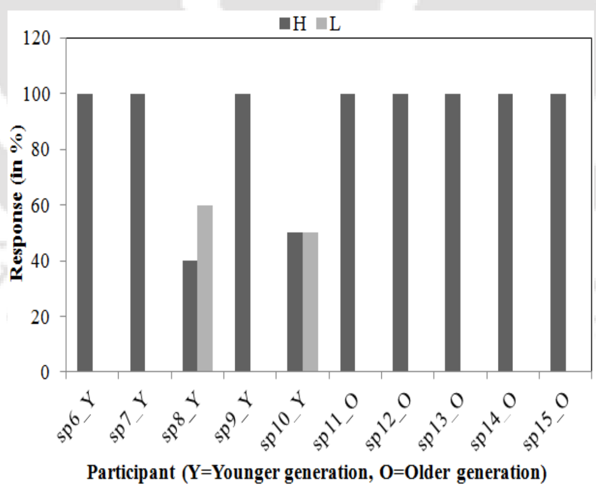


Figure 4.36: Younger and older generation speakers’ perception of /kiɹi/ high tone stimuli

Tone reversal which was evident only in monosyllabic words in the production experiment (as reported in § 4.6.6.1), is also evident in disyllabic words in perception experiment. Older generation speakers had no difficulty in identifying the exact meaning of *kiɹi*.

Perception of *tʃĩʝã* "fish_low tone/ wife of younger brother_high tone"

Production test results show that tonal contrasts in *tʃĩʝã* is maintained by older generation speakers (Mahanta *et al*, 2017), but not maintained by younger generation speakers. Perception test results show that there is tone reversal in *tʃĩʝã*, unlike production test. Younger generation speakers had perceptual difficulty and identified the high tone stimuli as low tone and vice-versa. On the other hand, older generation speakers had no perceptual difficulty in identifying the tonal category of *tʃĩʝã*.

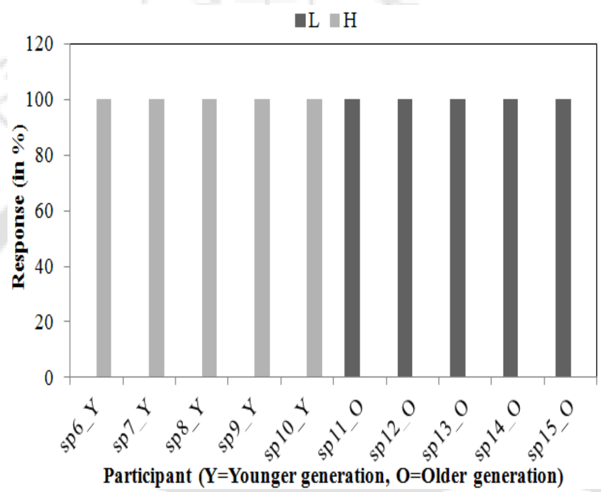


Figure 4.37: Younger and older generation speakers' perception of /tʃĩʝã/ low tone stimuli

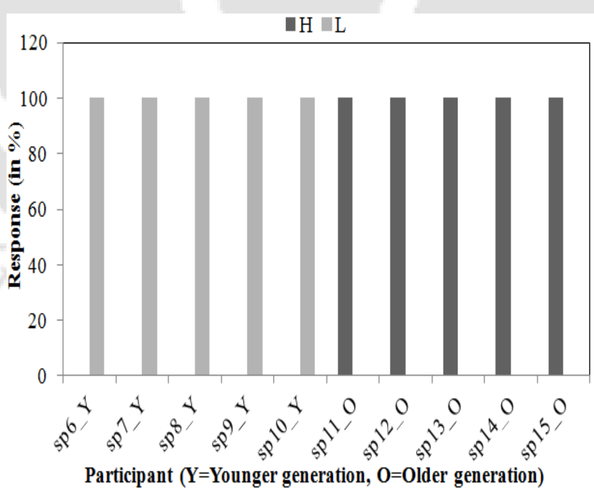


Figure 4.38: Younger and older generation speakers' perception of /tʃĩʝã/ high tone stimuli

In Figure 4.37, it can be seen that older generation speakers perceived the low tone stimuli as low tone whereas younger generation speakers perceived the low tone stimuli as high tone and vice-versa. Similarly, in Figure 4.38, while older generation speakers could rightly perceive the exact tonal category of the stimuli, younger generation speakers had difficulty in identifying the tonal categories. They identified the high tone stimuli as low tone and vice-versa.

4.7.5 Summary of tone perception

The identification test results show perceptual difficulty in identifying the tonal categories by younger generation speakers compared to older generation speakers. In the identification task, the participants tend to associate low tone stimuli with that of a high tone stimuli and vice-versa (though not across all responses) which conforms to the production test result. For instance: the high tone word *kɔ* "come" is identified as *kɔ* "pluck" which is a low tone and vice-versa. Identification test results show that there is perceptual difficulty observed across the words examined for the study. Among older generation speakers, only SP 14 had perceptual difficulty in identifying the tonal category of the stimuli *tʃi*. In the perception experiment, tone reversal is observed both in monosyllabic and disyllabic words, unlike the production test. The production and perceptual difficulty among younger generation speakers can be considered as a result of language experience. As has been already discussed, young speakers use less Deori compared to older generation speakers, and hence, the rate of tonal variations and perceptual difficulty is more evident among young speakers. Although the tone discrimination task has not been conducted, it would be interesting to know participants' ability to distinguish a tonal category as belonging to the same category or different category. This is an area of investigation we intend to explore in the future.

4.8 Conclusion

Production test results show a trend of underlying tone reversal H>L; L>H and a gradual tone loss among younger generation speakers. The findings show enormous tonal variations among younger generation speakers and statistically, all the words examined are not tonally distinct. An inconsistent f_0 pattern was observed among younger generation speakers for all the words. A look at the statistical analysis confirms the general observation concerning the great variation in pitch patterns across individual words and also across the speakers. In the case of monosyllabic words, the result shows tone reversal. For disyllabic words, the f_0 values of the majority of individual words merge, and also there is a noticeable f_0 variation for individual words. The high degree of speaker variations observed in the result sheds light on segmental sound change in progress in Deori. The result unveils a process of tonoexodus in Deori.

The results of the identification task show that older generation speakers could respond more accurately in identifying the stimuli than the younger generation speakers. The perception test result correlates with the idea that there is perceptual difficulty in identifying the distinct tonal categories among younger generation speakers which further conforms to the production test result. In perception test, tone reversal is observed both in monosyllabic and disyllabic words, unlike the production experiment.

The reduction in the number of tonal distinctions and tonal variation among the speakers can be attributed to long term bilingual contact with Assamese, a non-tonal language. The loss of tonal categories is more gradient among younger generation speakers. In the process of contact with the atonal language, these speakers are in a process of reducing their number of tones. The asymmetric tonal contours of the homophonous words show that there is a gradual tonal loss in Deori. The result also indicates that language experience has an impact on the production and perception of tones in Deori. As reported in Acharyya and Mahanta (2019) intergenerational language transmission is not completely hindered in Deori. The younger generation grows up learning Deori as their first language, but at the same time, they are competent bilinguals. At this point, it can be assumed that persistent bilingualism among younger generation speakers has eventually led to their inability to produce and perceive tonal distinctions. However, all the words have not undergone tonal reduction. Some lexical words still maintain tonal contrasts which support the idea that phonological changes in a language do not affect the whole lexicon at the same time. It is a gradual process and we hypothesize that it is a transitional stage before the whole lexicon undergoes a complete transformation.

The results show duration and intensity as a non-significant cue to distinguish tonal categories. It is the fundamental frequency (f_0) which determines the lexical contrast of the homophonous words (at least in the words where tonal distinctions are maintained). Duration is significantly different between both the syllables in stressed words but is not statistically significant in tonal words. Following Mahanta *et al.* (2017) it can be assumed that the inherently prominent tonal words may become an anchor for metrical structure facilitating the transition from tone to stress in Deori. Certain phonetic variables may also play a role in influencing particular pitch properties of certain words across tones and speakers. Vowel quality and laryngeal properties may influence slightly different pitch heights within a particular tone. Another possible factor affecting tone merging is word frequency as some words are more prone to sound change than others. This is an area of investigation we intend to explore in the future, but as of now, we consider the rise of metrical prominence as the more distinguishing factor leading to tonal variations in Deori.

In this chapter, we have discussed the tonal properties of Deori and we have identified Deori to be a language undergoing incomplete tonoexodus. In the next chapter, we will discuss phonological processes such as vowel harmony in Deori.

Chapter 5 - Vowel Harmony in Deori

5.1 Introduction

Vowel harmony is defined as a phenomenon in which adjacent vowels within a phonological or morphological domain agree with each other concerning one or more articulatory features (Archangeli and Pulleyblank, 1989; Krämer, 2003). Vowel harmony is a widespread pattern that is attested in many languages. It has been noted that "in the prototypical case of vowel harmony, all vowels within some domain (usually the word) must agree in the presence or absence of some property, for example, frontness, roundness, or ATRness" (Piggott and van der Hulst, 1997, p. 87). In other words, vowel harmony can be defined as a set of methodical co-occurrence restrictions.

In this chapter, the vowel harmony pattern in Deori will be discussed. Deori displays [ATR] vowel harmony in which a vowel in a word agrees with the adjacent [±ATR] feature. [±ATR] harmony which requires agreement in the position of the tongue root is found in languages such as Wolof, Akan, Granada Spanish, Yoruba, and other languages (Archangeli and Pulleyblank, 1989; Casali, 2003). As discussed in Chapter 2, Deori exhibits 5 distinctive oral vowels /ɑ, ɛ, i, ɔ, u/ and the feature specification of the vowels are as follows:

	Front	Back	
high	i	u	+ATR
mid	ɛ	ɔ	-ATR
low		ɑ	-ATR

Table 5.1: Distinctive feature representation of oral vowels in Deori

Apart from the five contrastive vowels, there are two allophones in Deori. The [+ATR] mid vowels [e] and [o] are the allophonic variation of [-ATR] mid vowels /ɛ/ and /ɔ/ in Deori as can be seen in Figure 5.1.

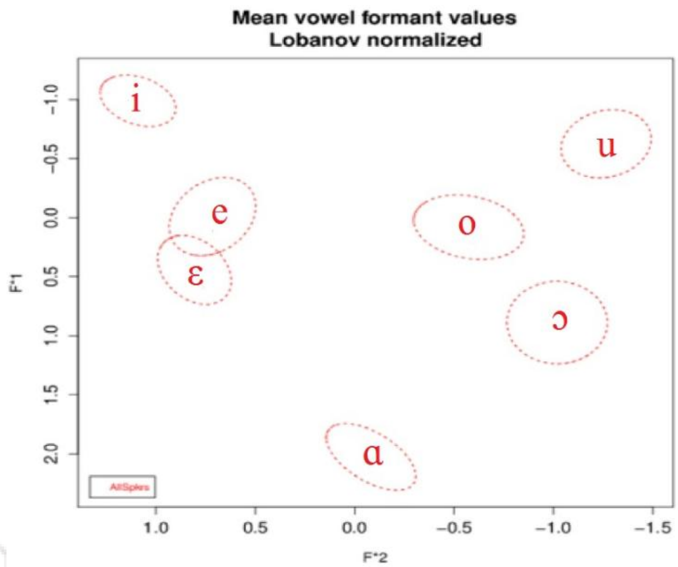


Figure 5.1: Deori vowels

[+ATR] vowels [e] and [o] occur when followed by [+high +ATR] vowel /i/ and /u/ and not otherwise and their occurrence is predictable from the phonological contexts. [+ATR] vowels [e] and [o] occur in the surface inventory of Deori as an output of vowel harmony. Exceptional occurrences of [e] and [o] in absence of the following triggering vowel [+high +ATR] /i/ and /u/ is seen in English loanwords such as *gate* → /*get*/ "gate", *cake* → /*kek*/ "cake" etc. Since the occurrence of [e] and [o] in the loanword phonology of Deori is sparsely attested, it is not pursued further in this chapter. While discussing the vowel harmony pattern in Deori, *triggering*, *target* and *opaque* vowels in Deori will be discussed. A *triggering* vowel generates a change in a preceding or a following vowel. A *target* vowel participates in vowel harmony and undergoes change, and an *opaque* vowel blocks the spreading of the harmonic feature from propagating further. Another important goal of this chapter is to show the *directionality* of vowel harmony in Deori.

Deori manifests regressive [ATR] harmony, a pattern akin to that of the Assamese vowel harmony pattern (for more details in Assamese [ATR] harmony see Mahanta 2007), which appears to have developed under the influence of language contact with Assamese[49]. The Assamese vowel harmony pattern (as reported in Mahanta 2007) is discussed within the framework of Optimality Theory (henceforth OT, Prince and Smolensky, 1993/2004). Thus, the

[49] However, there are many more additional constraints in Assamese that are not required to account for Deori vowel harmony pattern. In this chapter, our main aim is to show Deori vowel harmony pattern and the similarities that it shares with Assamese.

analysis of Deori vowel harmony is also situated within the output-oriented framework of Optimality Theory to show that the vowel harmony pattern in Deori and Assamese share many similarities descriptively and this can be expressed in theoretically similar ways. It will be shown that the interaction of markedness and faithfulness constraints that captures the vowel harmony pattern in Assamese (as reported in Mahanta, 2007) is also active in Deori, which highlights shared linguistic features between the dominant language, i.e., Assamese and the recipient language, i.e. Deori, due to language contact. "At the heart of Optimality Theory lies the idea that language, and every grammar, is a system of conflicting forces. These 'forces' are embodied by CONSTRAINTS, such as *markedness* and *faithfulness* constraints, each of which makes a requirement about some aspect of grammatical output forms" (Kager, 1999, p. 4). Canonically, the Markedness (M) constraints in OT regulate contrasts, and Faithfulness (F) constraints preserve them. It is the interaction of these two constraints which yields a well-formed output in a language.

The organization of the chapter is as follows: section 5.2 presents a detailed outline of [ATR] harmony as discussed in the existing literature and the sub-sections, the directionality of vowel harmony and opaque segments in vowel harmony is discussed. Section 5.3 provides adequate descriptive information about the vowel harmony facts of Deori. Section 5.4 discusses vowel harmony within the theoretical framework of OT which is followed by a conclusion in section 5.5.

5.2 ATR Harmony

[ATR] based vowel harmony is documented for many African languages (cf. Archangeli and Pulleyblank, 1994; Casali, 2003, 2008; Clements, 2000; Starwalt, 2008). The greatest concentration of languages having ATR harmony is the Nilotic languages of East Africa, Niger-Congo language branches of Gur, Kwa, Adamawa Eastern, Mande and Benue-Congo, and Afro-Asiatic family, mainly Somali (Casali, 2003, 2008). Languages with [ATR] harmony either exhibit 10 vowels or have seven or nine vowels (Casali, 2003; Starwalt, 2008; Obikudo, 2008). In languages with the 10-vowel system, the distinction for ATR is maintained equally for all sets of vowels at all vowel heights; in languages, with 9 vowel system the low vowel /ɑ/ lacks a harmony counterpart; and in languages with the 7-vowel system either they lack mid [+ATR] vowels /e/ and /o/ or [+high -ATR] vowels /ɪ/ and /ʊ/. In languages with 7-vowel system, [ATR] interaction is confined mostly to the four mid vowels, or the high vowels contrasting in [±ATR]. Languages having 10-vowel system exhibiting [ATR] harmony are Twi, a dialect of the Akan language (Berry, 1957) and Bongo, a Central Sudanic (Nilo-Saharan) language of South Sudan (Kilpatrick, 1985); languages with 9 vowel system exhibiting [ATR] harmony are Akan, a language of Ghana (Clements, 1981; Van der Hulst and Smith, 1986); languages with 7-vowel system exhibiting [ATR] harmony with no contrasts among the mid vowels are Kinande (Mutaka, 1995) and with no distinction of the high vowels is Yoruba (Awobuluyi, 1967; Bamgbose, 1967; Archangeli and Pulleyblank, 1989). Assamese, an Indo-Aryan language, exhibits 8 surface vowels /i, u, ʊ, e, o, ɛ, ɔ, ɑ/. The low vowel /ɑ/ in the Assamese lacks a harmony counterpart and the mid vowels [e] and [o] occur only under the circumstances of vowel harmony and in some exceptional circumstances (Mahanta, 2007).

Several impressionistic (Pike, 1967; Stewart, 1967) and instrumental (Ladefoged, 1968; Painter, 1973; Lindau, 1976, 1979, 1987) studies have established that the harmonic feature in most West and East African languages involves a more advanced position of the tongue root in vowels of one set (now known as [+ATR] set) than the other. Stewart (1971), Lindau (1978), and Hall and Creider (1998) state that [+ATR] vowels are pronounced with the root of the tongue advanced or with an expanded pharynx and [-ATR] vowels are pronounced without any such feature. "As the advancement of the tongue root tends to raise the tongue body, one of the strongest phonetic indicators of ATR is probably the change in the first formant frequency F1, the primary acoustic correlate of tongue height" (Casali, 2008, p. 506). Hence, there is an acoustic difference between [+ATR] vowels e.g. /i/, /u/, /e/ and /o/, and their corresponding [-ATR] vowels e.g. /ɪ/, /ʊ/, /ɛ/ and /ɔ/. Furthermore, it has been well-attested in the literature that while [ATR] harmony languages [+ATR] vowels /i/, /u/ and [-ATR] vowels /ɛ/, /ɔ/, and /ɑ/ are unmarked vowels, high [-ATR] vowels /ɪ/, /ʊ/ and non-high [+ATR] vowels /e/, /o/ are marked vowels.

5.2.1 Directionality

Baković (2000, 2001, 2003) has stated that the directionality in a vowel harmony language is predictable from the morphological structure of the language and has rejected stipulating directionality (similar discussion is also available in Krämer 2001 and Krämer 2003). He further states that directionality is "root-outward", i.e., the spreading should proceed from root to affixes. Baković (2000) and Krämer (2003) have shown that directionality is unidirectional only in root-outward systems, i.e. root to prefix, and is bidirectional in dominant-recessive systems, i.e., root to suffix and prefix. However, Baković's proposition of the direction of spreading as "root-outward" does not incorporate languages such as Karajá (Riberio, 2002), Assamese and Pulaar (Mahanta, 2007) which involve harmony from suffixes to stems (right-to-left), but not from prefixes to stems (left-to-right). Mahanta (2007) has shown that in languages such as Assamese, Karajá, and Pulaar, directionality is not root-outward, yet it exhibits a unidirectional vowel harmony pattern, unlike Baković (2000) and Krämer (2003). It has been noted that "the unidirectionality in harmony languages is not an outcome of a root-outward system, but rather an instance of precedence relation, wherein a marked sequence of vowel features is prohibited" (Mahanta, 2007, p. 3).

5.2.2 Opaque segments

Vowel harmony is based on the fact that one vowel can affect another vowel even across a consonant (Öhman, 1966; Recasens, 1987; Fowler, 1981; Magen, 1997; Beddor *et al.*, 2002; Modarresi *et al.*, 2004; Benus, 2005; Benus and Gafos, 2007). However, instances of opacity are recorded in vowel harmony languages in which both vowels and consonants are opaque to vowel harmony and systematically block the harmonic feature from propagating further.

The low vowel /ɑ/ is a non-participatory vowel mainly in languages with 9 and 7 vowel systems resulting in an unpaired vowel and is opaque to vowel harmony (Archangeli and Pulleybank, 2003; Casali, 2003, 2008). The opacity of the [+low -ATR] vowel /ɑ/ stops the spreading of the harmonic feature from propagating further in many vowel harmony languages. The explanation for the non-participation of the low vowel /ɑ/ is two-fold. First, Stewart (1971) and Hall and Creider (1998) suggest that since the vowel quality differences in the mid-central region of the vowel space are difficult to perceive, the low vowel /ɑ/ does not have a [+ATR] counterpart in many languages; secondly, Morton (2012) notes that " in the words of Stewart (1971) and Archangeli and Pulleyblank (1994) there is articulatory difficulty in advancing the tongue root when the tongue body is low to produce a low [+ATR] vowel" (p. 71). Non-participation of /ɑ/ in the harmony system is attested mostly in West African languages e.g. Wolof, Fula, Diola Fogni as reported in Hall *et al.* (1980). Non-participation of /ɑ/ in the harmony system is also attested in Assamese (Mahanta, 2007), for example[50]: *mɔdahi*

[50] The Assamese examples referred in this chapter are taken from Mahanta (2007).

“drunkard”, *pɛtari* “covered cane basket”. In the examples, the intervening low vowel /ɑ/ blocks the harmonic spreading, hence the [-ATR] vowels /ɔ/ and /ɛ/ are unaffected by the following [+ATR] vowels /i/ and /u/.

Apart from vowels blocking vowel harmony, consonants blocking vowel harmony is also attested in languages such as Madurese (Trigo, 1991), Shona (Uffman, 2006), Assamese (Mahanta, 2007) wherein an intervening consonant surface as a blocker which impedes the harmonic spreading. In Madurese, the voiceless obstruents and the nasals block harmony, e.g. *kʱɤman* “weapon” (Trigo, 1991); in Shona, in loan word phonology, vowel harmony spreads across labial and coronal consonants but not across sonorants, e.g. *kiripi* “clip”, *aitemu* “item”, *kirabhu* “club”, *chifi* “chief” (Uffman, 2006); and in Assamese, vowel harmony spreads across all intervening consonants except nasal consonants, e.g. *mɔni* ‘pearl’, *khɔmir* “leavening agent”, *sɛkɔni* “strainer” (Mahanta, 2007).

Nasal vowels blocking vowel harmony is attested in languages such as Ijesa and Ekiti (Przezdziecki, 2005) and Karajá (Ribeiro, 2002). In Ijesa and Ekiti, while pronouns with [+ATR] oral vowels alternate (for example: *órígi* ‘s/he saw a tree’, *arígi* ‘we saw a tree’), pronouns with [-ATR] or nasal vowels do not alternate (for example: *ɔ́rílá* ‘s/he saw okra’, *arílá* ‘we saw okra’). In Karajá nasal vowels /ã/, /õ/, and /ɛ̃/ are opaque to vowel harmony prohibiting the regressive spreading of the [ATR] feature, e.g. *rɛmɛ̃re* ‘I caught (it)’, *rɛhãɖere* ‘I hit (it)’.

With this general background on [ATR] harmony and the role of the intervening segments, we now proceed to discuss the vowel harmony pattern in Deori. At first, we will discuss the descriptive facts of vowel harmony in Deori in section 5.3, followed by theoretical implications of vowel harmony pattern in Deori in section 5.4.

5.3 Descriptive facts

In this section, co-occurrence restrictions of vowels in disyllabic and trisyllabic words will be discussed. Section 5.3.1 discusses the distributional restrictions on vowels in different positions of a disyllabic word in the underived domain. Section 5.3.2 discusses vowel co-occurrence restrictions in trisyllabic words in the underived domain. Section 5.3.3 summarizes the discussion on the distributional restrictions on vowels in the underived domain. Section 5.3.4 discusses vowel co-occurrence restrictions in the derived domain and Section 5.3.5 summarizes the discussion on the distributional restrictions on vowels in a derived domain. Section 5.3.6

discusses the consonants and vowels blocking vowel harmony in Deori and section 5.3.7 summarizes the discussion. The data incorporated in the analysis of vowel harmony in Deori is based on primary data collection as mentioned in section 1.5 Chapter 1. Data were recorded in a quiet environment in Bordeori village, Narayanpur, Lakhimpur district, and Naam Deori and Upor Deori village, Jorhat district of Assam. The speakers were between 40-55 years of age at the time of data collection. All the speakers were bilingual; they were equally fluent in Assamese apart from Deori. The word list (Appendix 6 - 8) was thus implemented among the speakers four times each among a set of ten native speakers (5 male and 5 female) and was asked to utter at a moderate pace. From the four recorded tokens of each word, three of the samples were selected for analysis. The samples were collected using a Shure SM-10 head-mounted microphone connected to a Tascam DR 100 MK II recorder and digitized at a sampling frequency of 44.1 kHz and 32-bit resolution.

5.3.1 Co-occurrence restrictions of vowels in disyllabic words in the underived domain.

Co-occurrence restrictions of the high and the mid vowels in disyllabic words in Deori are discussed below. At first, the monomorphemic disyllabic roots are discussed followed by monomorphemic trisyllabic roots.

5.3.1.1 High vowels /i/ and /u/

High vowels /i/ and /u/ are the triggering vowels in Deori. The occurrence restrictions of the high vowels /i/ and /u/ show that they do not co-occur with all vowels both in V_1 (initial vowel) and V_2 (final vowel) positions. The possible sequences of occurrence of the high vowels in V_1 and V_2 positions are exemplified in (25), (26), and (27) and the impossible sequence is exemplified in (28).

(25) Sequences of [+high +ATR] vowels /i/ and /u/.

[+high +ATR] vowels co-occur with each other and themselves in all positions of a word.

V_1	V_2
[+high]	[+high]
[+ATR]	[+ATR]
i,u	i,u

i-initial/ i-final	Gloss	i-initial/u-final	Gloss
kiɹi	'thread'	tʃĩtũ	'rope/old'
tiɹi	'banana'	tʃinũ	'brother in law'
siɹi	'night'	pitʃu	'meat'
simĩ	'needle'	tidzu	'jackfruit'

u-initial/u-final	Gloss	u-intial/i-final	Gloss
udzũ	'navel/bamboo tube'	tuɹi	'thatch'
buɹu	'stomach	budzi	'sister-in-law'
dubu	'snake'		
mũsu	'cow		

(26) Sequences of [+high+ ATR] vowels with mid vowels

The [-ATR] mid vowels /ɛ/ and /ɔ/ occur to the right of the [+high +ATR] vowels /i/ and /u/ whereas [+ATR] mid vowels [e] and [o] occur to the left.

(a)	V_1	V_2	(b)	V_1	V_2
	[+ATR]	[-ATR]		[+ATR]	[+ATR]
	[+high]	[-high, -low]		[-high, -low]	[+ATR]
	i,u	ɛ,ɔ		e,o	i,u

i-initial/ ɛ-final	Gloss	ɛ-initial/i-final
siɹɛ	'world'	not attested
gimɛ̃	'respectable person'	

i-initial/ɔ-final		ɔ-initial/i-final
ditɔ̃	'neck'	not attested
bibɔ̃	'granary'	
mĩĩɔ̃	'dish'	
pidzɔ	'raw'	

u-initial/ɛ-final		ɛ-initial/u-final
sudzɛ̃	'rice beer'	not attested
duɹɛ	'donkey'	
gumɛ̃	'part of fish trap'	
lubɛ	'pole for driving boat'	

u-initial/ɔ-final		ɔ-initial/u-final	
gubɔ̃	'head'	not attested	
buɹɔ	'where'		
duɹɔ	'bird'		

i-initial/e-final		e-initial/i-final	Gloss
not attested		-	-

i-initial/o-final		o-initial/i-final	Gloss
not attested		sosi	'middle'
		mosi	'person'
		nodzi	'plough'

u-initial/e-final		e-initial/u-final	
not attested		beku	'beans'
		tʃegu	'bow'
		ekũ	'smoke'
		tʃeku	'soul'

u-initial/o-final		o-initial/u-final	
not attested		opũ	'arm'
		joɹu	'bride'
		kotũ	'ear-ring'
		jotu	'slave'

Monomorphemic underived disyllabic words with /e…i/ sequence is not attested in Deori. The absence of /e…i/ sequence in underived disyllabic words is considered as an accidental gap, the evidence coming from the existence of /e…i/ in the derived part of the lexicon (See § 5.3.4.1).

(27) Sequences of high vowels /i/ and /u/ in combination with /ɑ/

The [+low -ATR] vowel /ɑ/ has no harmonic counterpart and it occurs with the [+high +ATR] vowels /i/ and /u/ both initially and finally.

(a)	V_1	V_2	(b) V_1	V_2
	[+ATR]	[-ATR]	[-ATR]	[+ATR]
	[+high]	[+low, -high]	[+low, -high]	[+high]
	i, u	ɑ	ɑ	i, u

i-intial /ɑ-final

gisɑ	'comb'
tʃĩȷ̃ɑ̃	'fish/wife of younger brother'
giɹɑ	'old'

ɑ -intial/i-final

ɑsi	'mountain'
ɑdzi	'son-in-law'

u-initial/ɑ-final

dukɑ	'bird'
mũkɑ	'husband'
ugɑ	'cry'

ɑ-initial/u-final

tɑdũ	'spoon'
tʃɑgu	'road'
ɑkũ	'ear/upland'

(28) Impossible sequences of [+high, +ATR] vowels with mid vowels

(a) *[51] V_1	V_2	(b) * V_1	V_2
[-ATR]	[+ATR]	[+ATR]	[-ATR]
[-high, low]	[+high]	[+high]	[-high]
ɛ,ɔ	i,u	i,u	e,o

From the above distribution of the vowel sequences, it is evident that mid vowels always appear with their [+ATR] specification before /i, u/, therefore the vowel sequences */ɛ…i/ and */ɔ…i/ do not exist. Similarly, the patterns */ɛ…u/ and */ɔ…u/ are also not possible occurrences in Deori. From the distribution of the [+high +ATR] vowels [e] and [o], following generalizations can be formulated:

(29) Generalizations regarding /i,u/

(i) In V_1 position, [+high +ATR] /i/ and /u/ co-occur with everything except /e, o/

(ii) In V_2 position, [+high +ATR] /i/ and /u/ co-occur with everything except /ɛ, ɔ/.

The generalizations exemplify that the [+high +ATR] vowels /i/ and /u/ are permissible both to the left and to the right of the mid vowels, and also co-occur with themselves. However, mid vowels /ɛ/ and /ɔ/ are only licensed to occur to the right of the [+high +ATR] vowels /i/ and /u/

[51] Here the asterisk mark refers to the non-occurrence of the particular vowel sequence.

and not vice-versa. Words with the vowel sequences /e…u/, /o…i/ and /o…u/ show that [e] and [o] occur to the left of [+high +ATR] vowel. The occurrence of /e…i/ vowel sequence will be evident in the derived section (§ 5.3.4.1) since the underived domain does not exhibit /e…i/ vowel sequence.

5.3.1.2 The mid vowels /ɛ, ɔ, e, o/

This section mainly focuses on highlighting the combinatory possibilities of the mid vowels. Mid vowels with feature specification [-high -ATR] occur with each other but not with [+high +ATR] vowels /i and u/ and [-high + ATR] vowels [e, o]. The distribution in (30) illustrates the possible sequence of mid-vowels and the distribution in (31)-(32) illustrates the impossible sequence of mid vowels.

(30) Possible sequences of mid vowels

[-ATR -high] vowels / ɛ and ɔ/ co-occur with each other on either side of a word.

(a) V_1	V_2
[-ATR]	[-ATR]
[-low, -high]	[-low, -high]
ɛ, ɔ	ɛ, ɔ

ɛ-initial/ɛ-final

tʃɛpɛ 'cold'
kɛpɛ 'cotton'

ɛ-initial/ɔ-final

sɛlɔ 'home-made cigarette'
gɛkɔ 'lizard'

ɔ-initial/ɛ-final

bɔsɛ 'towel'
tɔpɛ̃ 'blanket'

ɔ-initial /ɔ-final

pɔpɔ 'tree'
mɔ̃kɔ̃ 'rice'

(31) Impossible sequences of mid-vowels

(a) *V_1	*V_2	(b) *V_1	*V_2
[-ATR]	[+ATR]	[+ATR]	[-ATR]
[-high, -low]	[-high,-low]	[-high, -low]	[-high, -low]
ɛ,ɔ	e,o	e,o	ɛ,ɔ

(32) Impossible sequences of mid vowels and high vowels

(a) *V_1	V_2	(b) *V_1	V_2
[+ATR]	[+ATR]	[-ATR]	[+ATR]
[+high]	[-high, -low]	[-high, -low]	[+high]
i,u	e,o	ɛ,ɔ	i,u

From the distribution of vowels in (30) (31) and (32), it is evident that mid vowels co-occur only with vowels which have [±ATR] values. The mid vowels always agree with the [±ATR] specification of the vowel on the right and not vice-versa. While /ɛ/ occurs in all positions of a word, /e/ occurs in initial positions as shown in (33) and (34) respectively.

(33) The distribution of /ɛ/ in all positions of a word.

ɛ-initial	Gloss	ɛ - final	Gloss
gɛpɑ	'basket'	tʃɛpɛ	'cold'
mɛ̃bɑ	'fat'	kɛpɛ	'cotton'

(34) The distribution of [e] is restricted to the initial position

e-initial	Gloss	final
ekũ	'smoke'	not attested
tʃegu	'bow'	

The vowel [e] emerges only when there is a following high vowel. [e] in a word, either initially or medially is conditioned by the presence of a following high vowel /i/ and /u/. [e] does not surface without a succeeding high vowel. The occurrence of [e] in Deori is conditioned by the [+ATR] feature, i.e., [e] can only occur when it precedes a high vowel. The phonotactic restrictions prohibit the occurrence of [e] and [o] in a word unless followed by a high vowel; however, no such restrictions are imposed on the occurrence of /ɛ/ and /ɔ/. Thus, based on the co-occurrence restrictions of the mid vowels, the following generalizations can be formulated:

(35) Generalizations regarding [e]

(i) [e] occurs when there is a following [+high, +ATR]

(ii) /ɛ/ occurs elsewhere.

These facts substantiate that [e] is present only in the surface inventory of Deori. Similarly, (36) (37) and (38) below show the distributional restriction of /ɔ/ and [o] which is not different from the distribution of /ɛ/ and [e].

(36) The distribution of /ɔ/

ɔ-initial	Gloss	ɔ-final	Gloss
bɔsɛ	'towel'	pitʃɔ	'forehead'
tɔpɛ̃	'blanket'	disɔ	'pot'

(37) Initial and final /ɔ/

ɦɔjɔ	'true'
pɔpɔ	'tree'

(38) The distribution of [o]

o-initial	Gloss	final
opũ	'arm'	not attested
joɹu	'bride'	
kotũ	'ear-ring'	

The examples (36)-(38) highlight that the occurrence of /ɔ/ and [o] in Deori is determined by following high vowels /i/ and /u/. The occurrence of [o] in the stem phonology of Deori is conditioned by the presence of a succeeding high vowel. Distributionally, /ɔ/ has fewer restrictions than [o]. From this section, it is clear that [e] and [o] emerge only when /i/ and /u/ occur in succeeding syllables and are allophonic variants of /ɛ/ and /ɔ/. The occurrence of /e…i/ will be discussed in section 5.3.4.1. Though /ɛ/ and /ɔ/ co-occur with each other in both V_1 and V_2 positions, they never co-occur with [e] and [o].

5.3.1.3 The low vowel /ɑ/

Low vowel /ɑ/ occurs with both [-ATR] vowels /ɛ/, /ɔ/ and also with high vowels /i/, /u/. Low vowel /ɑ/ has the feature value [-ATR] and so can combine with the other [-ATR] vowels as exemplified in (39)-(42).

(39) The distribution of /ɑ/

(a) V_1	V_2	(b) V_1	V_2
[-ATR]	[+ATR]	[+ATR]	[-ATR]
[+low]	[+high]	[+high]	[+low]
ɑ-initial/ i-final		i-initial/ɑ-final	
ɑsi	'mountain'	tʃĩj̃ɑ̃	'fish/wife of younger brother'
ɑdzi	'son-in-law'	tʃikɑ	'heart'
		pisɑ	'son'

ɑ-initial/u-final		u-initial/ɑ-final	
ɑkũ	'ear/upland'	dukɑ	'bird'
ɑgũ	'knee'	tʃutʃɑ	'dried fish'
tʃɑgu	'road'	gusɑ	'chin'

(40)

(a) V_1	V_2	(b) V_1	V_2
[-ATR]	[-ATR]	[-ATR]	[-ATR]
[+low]	[-low, -high]	[-low, -high]	[+low]
ɑ	ɛ,ɔ	ɛ,ɔ	ɑ
ɑ -initial/ ɛ-final		ɛ-initial/ ɑ-final	
sɑdzɛ	'hay'	gɛpɑ	'basket'
tʃɑlɛ	'dative marker'	mɛ̃bɑ	'fat'
ɑdzɛ	'urine'		

(41)

ɑ-initial/ ɔ-final		ɔ-initial/ ɑ-final	
ɑtʃɔ̃	'house'	jɔmɑ̃	'fish trap'
gɑ̃ĩɔ̃	'pot/throat'	mɔ̃sɑ	'child'

(42)

V_1	V_2
[-ATR]	[-ATR]
[+low]	[+low]
ɑ	ɑ
ɑ-initial	Gloss
ɑtɑ̃	'arrow'
ɑjɑ	'wife of son'

In Deori, as can be seen above, low vowel /ɑ/ co-occurs with all vowels and its occurrence is not conditioned by the [±ATR] feature unlike the mid vowels /ɛ/, /ɔ/ and [e] and [o]. Hence, it can be convincingly said that low vowel /ɑ/ occurs in the underlying inventory of Deori. So far it is evident that Deori vowel harmony spreads right-to-left, from a [+ATR] vowel to an adjacent vowel. Next, we discuss the monomorphemic trisyllabic/quadrisyllabic words followed by derived words.

5.3.2 Trisyllables/Quadrisyllables

As previously stated in Chapter 1, monomorphemic trisyllables and quadrisyllables are less common in Deori. Trisyllables and quadrisyllables are mostly derived words in Deori. However, there are a few words in the Deori lexicon which has no evidence of derivation when compared to the cognate sets of the Bodo-Garo languages in its vicinity (Bodo, Garo, Tiwa, Dimasa, Rabha, etc) (Jacquesson, 2005). Hence in this section, we discuss those trisyllabic words which are considered to be monomorphemic in the existing literature.

(43) Occurrences of [e] and [o] in trisyllables.

seɹegi	'bamboo instrument used in working the thread.'
sipɛɹɛ	'door'
boɹogi	'roof of the house'
lepeduɹ/lepeduɹu	'goat'

In the examples above, it can be seen that in *seɹegi* the [+ATR] mid vowel agrees with the [+high +ATR] vowel to the right, whereas in *sipɛrɛ* the [-ATR] mid vowel does not agree with the [+high +ATR] vowel to the left. In *lepeduɹ*/*lepeduɹu* and *boɹogi* the [+ATR] mid vowels agree with the [+high +ATR] /u/ and /i/ respectively and even the vowel at the extreme left also agrees with the [±ATR] feature. The vowel sequences /e…e...i/, /o...o...i/, and /e...e...u/ in (43) appears to be an instance of vowel copying rather than vowel harmony, wherein the vowels at the left edge agrees with the adjacent vowel, however, we do not pursue this further since sufficient data is not available to substantiate our assumption[52]. Trisyllables/quadrisyllables are considered good test words to test the directionality of vowel harmony. However, in Deori lexicon,

[52] We would like to see the extent of harmony vis-a-vis vowel copying when we can have a sufficiently large Deori lexicon. For the time being we recognize that there may be two processes.

trisyllables/quadrisyllables are sparsely distributed and hence are not sufficient to test the directionality of vowel harmony in the language. The monomorphemic disyllabic words discussed so far show that the spreading of the [ATR] feature in Deori is regressive. The directionality of vowel harmony in Deori will be clearer when derived words will be taken into consideration.

5.3.3. Summary of vowel harmony in underived domain

From the analysis, it is evident that in Deori, all vowels in a word agree with [±ATR] specifications, akin to that of Assamese. The mid vowels [e] and [o] surface in the stem phonology of Deori, as an output of vowel harmony triggered by the following [+ATR] vowels /i/ and /u/. The mid vowels [e] and [o] are the allophonic variants of [-high -ATR] vowels /ɛ/ and /ɔ/. The [+high +ATR] vowels /i/, /u/ and [+low -ATR] vowel /ɑ/ never alternate, whereas, mid vowels /ɛ/ and /ɔ/ alternate with [e] and [o] respectively when followed by [+high +ATR] vowels /i/ and /u/. The occurrence of /e…i/ vowel sequence in Deori will be evident in the derived domain which will be discussed in the subsequent section.

Deori shows a lot of similarities with the Assamese vowel harmony pattern[53]. In Assamese too, the high vowels /i/ and /u/ trigger vowel harmony on the vowels to its left (for example[54]: *beli* "sun", *k^heti* "farming", *soku* "eye", *potu* "clever") and not to its right (for example: *dizɛn* "proper name", *igɔl* "eagle", *xitɔl* "cool"). The high vowels /i/ and /u/ co-occur with each other and themselves in all positions of a word (for example: *iti* "end", *ritu* "season", *buku* "chest"). The [-ATR] mid vowels /ɛ/ and /ɔ/ can occur with each other (for example: *tɛrɔ* "thirteen", *pɔxɛk* "week") and with themselves (for example: *ɔxɔm* "Assam", *gɔrɔm* "hot", *bɛlɛg* "different", *xɛmɛk* "damp") but not with [+ATR] mid vowels [e] and [o]. The low vowel /ɑ/ occurs with both [-ATR] vowels /ɛ/, /ɔ/ both in V_1 and V_2 positions (for example: *palɛŋ* "spinach", *tɛma* "container", *asɔl* "real", *mɔta* "male") and also with [+ATR] vowels /i/, /u/ both in V_1 and V_2 positions (for example: *ali* "sand", *ita* "brick", *atur* "distressed", *uka* "bare").

As has been already pointed out, it is only a following [+high +ATR] vowel which triggers a change in the preceding vowels. Since the Deori lexicon mostly consists of monosyllabic and disyllabic words, the directionality so far evident in the disyllabic word domain is regressive. [-

[53] However, Deori does not exhibit [+high -ATR] vowel /ʊ/ in the inventory, unlike Assamese.
[54] The Assamese examples are taken from Mahanta (2007)

ATR] vowel can occur to the right of [+ATR] vowel but it cannot occur to the left of [+ATR] vowel. Long test words with /o…i…ɔ/ or /e…u…ɛ/ would have been suitable to verify directionality of vowel harmony as regressive in Deori, however, such vowel sequences are not attested in Deori.

From the descriptive analysis of the combinatorial restrictions following generalizations can be formulated:

(44) Agreement in terms of the feature [+ATR]

(i) In the presence of following [+high +ATR] vowels, mid vowels appear with their [+ATR] specifications.

(ii) In the presence of a [-ATR] vowel, the mid vowels appear with their [-ATR] specifications.

After a detailed examination of the underived words, derived words are now examined in the following section. Derived words will lead to a more prominent directionality pattern in Deori. It will be shown that the following [+high +ATR] vowel consistently imposes changes on the preceding [-ATR] vowels.

5.3.4 Co-occurrence restrictions of vowels in derived domain

This section mainly highlights how the suffixal vowel induce vowel harmony in Deori by triggering a change in the [-ATR] specification of the vowels of the preceding syllables. Similar to the underived words it is also expected that [-high +ATR] vowels [e] and [o] are realized in the context of a following [+high +ATR] vowel in the derived domain. The root vowel undergoes vowel harmony change and agrees with the feature agreement of the suffixal vowel. In this section, vowel harmony in verbs will be discussed. Verbal roots are both monosyllabic and disyllabic in Deori and they inflect for tense and not for person. This section will show longer derived word sequences that will validate the directionality of vowel harmony in Deori.

5.3.4.1 Vowel harmony in verbs

In Deori, suffixes such as -*bɛm* and -*ɹɔm* are used to denote past tense/perfect aspect and the use of these suffixes are determined by the transitivity of the verb (Jacquesson, 2005; Wood, 2008). The suffix -*ɹɔm* is attached to intransitive verbs and -*bɛm* is attached to transitive verbs. Furthermore, the suffixes -*bɛm* and -*ɹɔm* changes to -*mɛm* and -*nɔm* respectively depending on the nasality of the preceding vowel. Wood (2008) states that it is difficult to say whether these two suffixes refer to a past distinction or some kind of perfective aspect. At first, we discuss the monosyllabic verb roots followed by the disyllabic verb roots. Root verb consists of the following vowels /i/, /u/, /ɛ/, /ɔ/, /ɑ/. There are no monosyllabic roots with [-high +ATR] vowel [e] and [o]. The verbal roots containing each of the five contrastive vowels are mentioned below.

(45) Verbal conjugations in monosyllabic roots

Root vowel	/ɑ/	/ɔ/	/u/	/ɛ/	/i/
	ɦɑ 'eat'	kɔ 'pluck'	ku 'fall'	kɛ 'go'	dzi 'buy'
Simple Present	ɦɑ.i	ko.i	ku.i	ke.i	dzi.i
Imperative	ɦɑ.bɛ	kɔ.bɛ	ku.ɹɔ	kɛ.ɹɔ	dzi.bɛ
Past	ɦɑ.bɛ.m[55]	kɔ.bɛ.m	ku.ɹɔ.m	kɛ.ɹɔ.m	dzi.bɛ.m
Future	ɦɑ.n[56]	kɔ.n	ku.n	kɛ.n	dzi.n
Future Perfect	ɦɑ.ku.n	ko.ku.n	ku.ku.n	ke.ku.n	dzi.ku.n
Present Progressive	ɦɑ.ɹi	ko.ɹi	ku.ɹi	ke.ɹi	dzi.ɹi
Past Perfect	ɦɑ.ɹu.m.dɛ[57]	ko.ɹu.m.dɛ	ku.ɹu.m.dɛ	ke.ɹu.m.dɛ	dzi.ɹu.m.dɛ

In the verb paradigms above, the [+high +ATR] vowel /i/ always trigger a change in the preceding [-ATR] vowels /ɛ/ and /ɔ/ as in *ke-ɹi* and *ko-ɹi* but not in the following [-ATR] vowels /ɛ/ and /ɔ/ as in *dzi-bɛ* and *ku-bɛ*. The /e…i/ sequence which is not attested in the underived domain is present in the derived domain as in *ke-ɹi* "go.PRES PROG", *ko-ɹi* "pluck. PRES PROG" etc. Some additional examples with /e…i/ sequence are, for example, *le-ɹi* 'give.PRES PROG', *se-ɹi* 'spread. PRES PROG', *je-ɹi* 'bite. PRES PROG' etc. These examples show that [-high +ATR] vowel [e] occurs when followed by [+high +ATR] vowels /i/ and /u/. Verbs in Deori inflect in the order of Root+Aspect(Perfective/Progressive)+Tense. The verbal inflections of Deori are presented in (46) to provide a clearer picture of their occurrences.

[55] /m/ is Perfective Predicative marker.
[56] /n/ is Imperfect Predicative marker.
[57] Following Jacquesson (2005), we consider /dɛ/ as an enclitic (Jacquesson 2005).

(46) Morphological Markers in verbal conjugations in Deori

Tense/Aspect Markers	
Simple Present	/-i/
Past	/-m/
Future	/-n/
Present Progressive	/-ɹi/ /-nĩ/
Past Perfect	/-ɹu/ /-nũ/
Future Perfect	/-ku/
Imperative	/-bɛ/ /-mɛ̃/, /-ɹɔ/ /-nɔ̃/

Similar to the monosyllabic roots, words in the disyllabic roots also agree with the [±ATR] feature as presented in (47) below:

(47) Verbal conjugations in disyllabic roots

A similar pattern is also observed in the disyllabic verbal roots. The verb roots consist of the vowels /i/, /u/, /ɛ/, /ɔ/ and /ɑ/ and outputs with [e] and [o] occur after inflection.

Root vowel	/ɑ/	/ɔ/	/u/	/ɛ/	/i/
	nĩj̃ɑ̃ 'cook'	ɔdzɔ 'play'	gĩj̃ũ 'swim'	ɦidzɛ̃ 'see'	itɔ 'look'
Simple Present	nĩj̃ɑ̃.ĩ	odzo.i	gĩj̃ũ.ĩ	ɦidzẽ.ĩ	ito.i
Imperative	nĩj̃ɑ̃.mɛ̃	ɔdzɔ.bɛ	gĩj̃ũ.mɛ̃	ɦidzɛ̃.mɛ̃	itɔ.bɛ
Past	nĩj̃ɑ̃.mɛ̃.m	ɔdzɔ.bɛ.m	gĩj̃ũ.mɛ̃.m	ɦidzɛ̃.mɛ̃.m	itɔ.bɛ.m
Future	nĩj̃ɑ̃.n	ɔdzɔ.n	gĩj̃ũ.n	ɦidzɛ̃.n	itɔ.n
Future Perfect	nĩj̃ɑ̃.ku.n	odzo.ku.n	gĩj̃ũ.ku.n	ɦidzẽ.ku.n	itɔ.ku.n
Past Progressive	nĩj̃ɑ̃.nĩ	odzo.ɹi	gĩj̃ũ.nĩ	ɦidzɛ̃.nĩ	ito.ɹi
Past Perfect	nĩj̃ɑ̃.nũ.m.dɛ	odzo.ɹu.m.dɛ	gĩj̃ũ.nũ.m.dɛ	ɦidzɛ̃.nũ.m.dɛ	itɔ.ɹu.m.dɛ

From the above examples in (47), it is evident that the [+high +ATR] vowel in the suffix induces vowel harmony by triggering a change in the [-ATR] specification of the vowels of the preceding root vowels, but not vice-versa. The verbal root *ɔdzɔ* changes to *odzoi* in the simple present form when the present tense marker /i/ gets affixed to it. Similarly, the verbal root *ɦidzɛ̃* changes to *ɦidzẽ.i* in the simple present form but we do not get **ɦidzẽ.nĩ* because in this case the intervening nasal consonant and the nasal vowel are blocking the harmonic feature from propagating further.

Vowel harmony blocking by intervening nasal consonants will be discussed in detail in section 5.3.6. It is to be noted that the occurrence of the consonant -*ɹ* and -*n* in the verbal suffix -*ɹi* and -*ni* and -*b* and -*m* in the verbal suffix -*bɛm* and -*mɛm* is determined by the preceding [+nasal] vowel. If the preceding vowel is nasalized, the following suffixal consonant surfaces as /n/ as in *ɦidzɛ̃.ni*, and if the preceding suffixal vowel is oral than the following suffixal consonant surfaces as [ɹ] as in *odzo.ɹi*. Similarly, the past progressive marker *numdɛ* is used when the preceding vowel is nasal and *ɹumdɛ* is used when the preceding vowel is oral. More discussion on the suffixal alternation based on the [nasal] feature of the preceding vowel will ensue in the next chapter.

Apart from the verbal inflection discussed above, some verbal roots are inflected with more than one suffix to denote a complete action. These verbal inflections show the occurrence of /o…e...i/ and /o…e…u/ which shows that the vowels to the extreme left also agree with the [±ATR] feature.

(48) Sequences of /o…e...i/, /e…o…i/

Root	Gloss	Inflected form
bɔ.tɛ[58].ɹi	'kill.action. PROG'	boteɹi
jɔ.tɛ.ɹi	'cut.action.PROG'	joteɹi
bɔ.tɛ.dzu[59]	'beat.action.reciprocate'	botedzu
jɔ.tɛ.dzu	'cut.action.reciprocate'	jotedzu

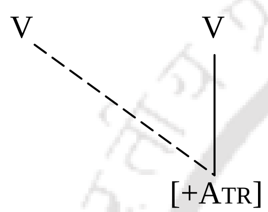
In (48), the vowel on the root form and the vowel of the suffix *tɛ* agrees with the following [+ATR] high vowel /i/ and /u/ respectively. Similar to the underived domain, in derived domain too there are no words with vowel sequence /o…i…ɔ/ and /e…u…ɛ/ which would have been good test words to determine the directionality of the spreading. However, based on the available vowel sequences we conclude that [+high + ATR] vowel /i/ and /u/ can always trigger harmony on all preceding [-ATR] vowels thereby instantiating the fact that Deori exhibits regressive [ATR] harmony.

[58] *tɛ* suffix denotes a complete action and it mainly affixes with verbs which means 'kill'
[59] *dzu* means reciprocate action.

5.3.5 Summary of vowel harmony in derived domain

From the discussion so far it is evident that Deori exhibits regressive ATR harmony within the stem and from affixes to stem, similar to the Assamese vowel harmony pattern. In a derived domain, it is the suffix vowel that triggers harmony on the stem vowel, but not vice-versa. Regressive vowel harmony in Deori is represented schematically in (49) which shows the regressive propagation of the feature value [+ATR] to vowels that would otherwise surface as [-ATR]. Suffixes or root-internal vowels with [+ATR] specification can trigger regressive vowel harmony in Deori. The variable outcome is schematized below:

(49)



A [+high +ATR] vowel in the right always determines the feature of the vowels to the left, i.e. vowels following a [+ATR] vowel specification is unaffected, whereas vowels preceding [+ATR] vowel is affected. Vowel harmony in Deori is strictly phonological similar to Assamese, unlike Baković (2000, 2001, 2003) who proposes that ATR harmony in a language is dependent on its morphological structure. Identical to Assamese vowel harmony pattern, /o…i/ and /e…i/ sets are unmarked sequences in Deori, whereas */ɛ…i/ and */ɔ…i/ sequences are marked sequences in Deori.

5.3.6 Consonants and vowels blocking harmony

The discussion so far has highlighted the co-occurrence restrictions of vowels both in the derived and the underived domain. In this section, the opacity of vowels and consonants in Deori will be discussed. It has been observed that [+ATR] vowel [e] and [o] occur when it is followed by a triggering [+high +ATR] vowel /i/ and /u/. However, there are some restrictions on the occurrence of [e] and [o] even when followed by high vowels /i/ and /u/. This is due to the occurrence of an intervening low vowel /ɑ/ and the nasal consonants /m/ and /n/. The opaque segments of Deori that block the regressive spreading of the [+ATR] feature, is discussed in the next section.

5.3.6.1 Intervening low vowel /ɑ/

The [+low -ATR] vowel /ɑ/ blocking harmony is cross-linguistically common and in this context, Deori vowel harmony is not exceptional. In example (50) and (51), it can be seen that an intervening low vowel /ɑ/ prohibits the spreading of the harmonic feature from propagating further and the [-ATR] vowels /ɛ/ and /ɔ/ remain unaltered both in the underived and the derived domain.

(50) Underived domain[60]

mɛ̃dzɑti	'violet color'
sɔkɑtu	'cane'

(51) Derived domain

Word	Gloss	Inflected form
jɔ.gɑ[61].ɹi	'dig.upwards.PRED[62]'	jɔgɑɹi
tɛ.gɑ.ɹi	'store.upwards.PRED'	tɛgɑɹi
bɛ.gɑ.ɹi	'tremple.upwards.PRED'	bɛgɑɹi
jɔ.pɑ.ɹi	'cut.CAU[63]. PRED'	jɔpɑɹi
nidzɛ̃.mɑ̃.dzu	'know.particle.reciprocativeaction'	nidzɛ̃mɑ̃dzu

The words in (50) and (51) show that the vowel sequences */e…ɑ…i/ and */o…ɑ…u/ are not attested in Deori as the intervening low vowel /ɑ/ prevents the [+ATR] value in the right from spreading through. Similarly in Assamese, an intervening low vowel /ɑ/ blocks the harmonic spreading (for example: *mɔdahi* "drunkard", *kɔpahi* "of cotton", *pɛtari* "covered cane basket") (as reported in Mahanta 2007).

5.3.6.2 Nasal consonants blocking vowel harmony

Vowel harmony in Deori is also blocked by the intervening nasal consonants as shown in (52) and (53). Vowel harmony in Deori spreads from [+nasal, +high, +ATR] vowel as in *opũ* "arm", *kotũ* "ear-ring', however, in example (52) it is the adjacent nasal consonant which prevents the harmonic spreading from [+nasal, +high, +ATR] vowel. The harmony is blocked when the nasal consonant is immediately preceding the triggering vowel both in the underived and the derived domain.

---

60 Words with intervening /ɑ/ are less common in underived domain
61 The suffix 'gɑ' refers to an action meaning "upwards"
62 Predicative suffix
63 Causative suffix.

(52) Nasal consonants blocking harmony in the underived domain

kɔnũ	'year'
gupɔnĩ	'lid'
gɑɹɔmĩ	'soot'

(53) Nasal consonants blocking harmony in the derived domain.

nɔ̃.nĩ[64]	'do. PROG[65]'
ɦidzɛ̃.nĩ	'see.PROG'

While nasal consonants block harmony when it is immediately preceding the triggering vowel, it does not block harmony when it is not adjacent to the triggering [+ATR] vowel as in (54).

(54) No blocking in the presence of a nasal distally

ɑmõdzi	'dirty'
kemõdzi	'cotton'
tʃemẽtʃi	'ant'

Example in (54) shows that nasal consonant not adjacent to the triggering vowel does not block vowel harmony. The examples further show nasalized mid vowels [ẽ] and [õ] also occur in Deori, though minimally attested in the language. In *amõdzi* and *tʃemẽtʃi* it can be seen that the feature [nasal] does not spread rightwards from the vowels [õ] and [ẽ]. This is so because affricates /dz/ and /tʃ/ are opaque to nasal harmony in Deori which halts the spreading of nasalization. This will be discussed elaborately in Chapter 6. The sequence of nasal consonant blocking harmony in Deori is [-ATR] vowel /ɛ/ or /ɔ/, nasal /n/ or /m/ and [-ATR] vowel /i/ or /u/. The harmony blocking by the nasal consonant in Deori is also similar to the Assamese vowel harmony pattern. In Assamese, nasal consonants block the harmonic spreading (for example: *sɛkɔni* "strainer", *kʰɔmir* "leavening agent"), however, a nasal somewhere else in the word does not function as a blocker (for example: *porinoti* "consequence", *ponoru* "onion").

Nasals blocking vowel harmony is well attested in the literature. Trigo (1991) shows that in Madurese, a [+ATR] specification spreads from a voiced obstruent but not from a voiceless obstruent and nasal. In Ijesa and Ekiti (Przezdziecki, 2005) pronouns with [+ATR] oral vowels alternate, while those with [-ATR] or nasal vowels do not. In Shona loan words, Uffman (2006)

[64] As stated previously in section 5.3.4.1, the occurrence of the suffix /ni/ /nɑ/ in (53) is determined by the preceding nasal vowel.
[65] Progressive marker.

has shown that in epenthetic vowel assimilation sonority of the intervening consonants plays a distinctive role. Vowel harmony in Shona only occurs across labial and coronal obstruents, not across sonorants. While in Madurese a direct connection between [-ATR] and nasals has been shown, in other languages such as in Ijesa and Ekiti and Shona a correlation between nasals and [ATR] have been shown. Considering these observations, Mahanta (2007) has mentioned that there are articulatory constraints on nasals and non-low vowels occurring together. Further, Mahanta (2007) posits that the segments that block vowel harmony are high in sonority. More sonorous a segment more capable it is to block harmony, "because they tend to be more faithful" (Mahanta 2007: 188). Here I will briefly paraphrase Mahanta's (2007) proposition on sonority playing a decisive role in blocking vowel harmony. Mahanta cites Walker's (1998) typology of nasal harmony to show the compatibility of segments with nasalization. However, the sonority hierarchy scale as proposed by Walker (1998) does not necessitate that any segment high in sonority is capable of blocking harmony; a segment must also bear featural compatibility to behave as a blocker. By featural compatibility, Mahanta (2007) refers to the featural similarity between consonants and vowels. The dual requirement of sonority, as well as featural compatibility in a segment, is essential to block harmony. "The answer to this lies in the fact that though voiced consonantal segments show the requirements of a [-ATR] feature, their demonstrated ability to block vowel harmony has not been recorded so far" (Mahanta, 2007: 161-162). Mahanta (2007)[66] proposes that consonants blocking vowel harmony in Assamese is driven by 'similarity' principle which necessitates two factors:

(i) Similarity can be measured by a consonant's proximity to vowels in a sonority scale
(ii) It can also be apparent from features that both vowels and consonants could share.

Following Mahanta (2007), we assume that there is some featural compatibility between the nasal consonants and the vowels in Deori for which nasal consonants are opaque segments in the context of vowel harmony.

5.3.7 Summary of consonants and vowels blocking harmony.

From the discussion, it is evident that the spreading of the harmonic feature [+ATR] in Deori is blocked by the [+low] vowel /ɑ/ and the nasal consonants /m/ and /n/ in proximity to the

[66] For more details on nasals blocking vowel harmony refer to Mahanta (2007).

triggering vowels. However, vowel harmony is not blocked when a nasal consonant is further away from the trigger, i.e. if the nasal consonant does not immediately follow /ɔ/ and /ɛ/ and precede a [+ATR] vowel, it does not block harmony. [ATR] harmony in Deori is a local process that can be arrested by a low vowel /ɑ/ and the nasal consonants /m/ and /n/. The blocking of the harmonic spreading by an intervening low vowel /ɑ/ and the nasal consonants /m/ and /n/ is also evident in Assamese. Further, in Assamese the low vowel /ɑ/ changes to [e] and [o] and the high vowel /u/ changes to /ʊ/ in exceptional occurrences, however, such exceptional occurrences do not surface in Deori.

Having discussed the descriptive facts of the vowel harmony pattern in Deori, the next section discusses the constraints which account for the harmony pattern in the language. The main aim of the optimality-theoretic analysis is to highlight the similarities of Deori vowel harmony with that of Assamese vowel harmony and to show that the same set of constraints that regulate the vowel harmony pattern in Assamese is also active in Deori.

5.4 Optimality Theory

The fundamental concept in OT is constraint ranking and constraint violability. The constraints in OT are universal and the different rankings of the universal constraints are language-specific (Prince and Smolensky, 1993; Kager, 1999). OT is a framework wherein the focus is on the interaction of some violable constraints which yields well-formed output. In OT, while the markedness constraint necessitates that output forms meet some criterion of structure well-formedness, faithfulness constraint evaluates the disparity in the input-output form. Within OT, the underlying forms (the input) and the surface forms (the output) are distinguished. CON is the set of universal constraints out of which grammar is constructed. Apart from CON, two other constructs are taken into consideration in OT, namely, GEN (generator) and EVAL (evaluator). The GEN (Generator) generates an infinite set of candidate output forms of a given input. There is a fixed set of constraints which are ranked hierarchically. The function EVAL (evaluator) evaluates the output candidates based on their harmonic values and selects the optimal candidate. The optimal candidate satisfies the higher-ranked constraint over the lower-ranked constraint. The basic architecture of OT grammar as represented by McCarthy (2002) is summarized below:

(55) Basic OT architecture (McCarthy 2002:10)

Input → [Gen] → candidates → [Eval] → output

Conventionally, the ranking of the constraints is marked by solid lines separating constraint columns; however, if the ranking of the constraints is undetermined then the constraints are either separated by dotted lines or no lines at all.

With a theoretical background of OT, the vowel harmony pattern in Deori is discussed within the caveats of OT in the next section.

5.4.1 ATR harmony in Deori: an OT account

The descriptive facts of Deori vowel harmony discussed so far highlights that vowel agreement in Deori necessitates a constraint which requires the marked vowels [e] and [o] to appear to the left of the [+high +ATR] /i/ and /u/ vowels and not otherwise, similar to Assamese. In this section, it will be shown that the markedness and the faithfulness constraint that accounts for the Assamese vowel harmony pattern as reported in Mahanta (2007) is also active in Deori. Following Mahanta (2007), a step by step discussion of the markedness and faithfulness constraints accounting for vowel harmony process and its appropriateness in taking care of Deori vowel harmony is discussed below.

In OT, the markedness and the faithfulness constraint which accounts for the assimilatory process are AGREE[F] and IDENT[F] respectively.

Markedness constraint

(56) AGREE[F]

Adjacent segments have the same value for the feature.

Faithfulness constraint

(57) IDENT[F]

Input-Output segments have the same value for the feature [F]

To result in the assimilatory process the markedness constraint AGREE[F] has to be ranked higher than the faithfulness constraint IDENT[F]. A schematic tableau below shows that the ranking of the markedness constraint over the faithfulness constraint is essential to capture assimilation in OT.

(58) Schematic tableau

I:[-F][+F]	AGREE[F]	IDENT[F]
a. [-F][+F]	*!	
b. ☞ [+F][+F]		*

This hierarchical ranking of the markedness and faithfulness constraint can capture the vowel harmony in Deori which is shown in a schematic tableau in (59) below, considering a real example from Deori. The following tableau shows that optimal output is (b) which satisfies the high ranked markedness constraint AGREE[F] thereby violating the low ranked faithfulness constraint IDENT[F].

(59) Vowel harmony tableau

I: /bɔ/+/ɹi/	AGREE[F]	IDENT[F]
a. [bɔɹi]	*!	
b. ☞ [boɹi]		*

The above tableau shows that the verbal root /bɔ/ agrees with the following high vowel /ɹi/ in the suffix and surfaces as /boɹi/ which satisfies the high ranked constraint AGREE[F]. Tableau (59) further shows that the ranking of Markedness » Faithfulness is necessary to account for the assimilatory process in OT. However, in tableau (58) and (59) there is also a possibility of assimilation to the [-F] feature which would result in [-F][-F] featural composition which involves progressive assimilation. The assimilation to the [-F] feature would generate an ill-formed output such as */bɔɹɪ/ which is not attested in Deori. In Deori, it is only [+high +ATR] feature which triggers vowel harmony regressively on the preceding vowel. Moreover, [+high -ATR] vowels /ɪ/ and /ʊ/ are not attested in Deori[67]. Hence, AGREE[F] is not capable of accounting for the assimilation process in a language where spreading is unidirectional. The limitation of the AGREE[F] constraint to capture vowel harmony process which is strictly unidirectional is postulated by Mahanta (2007) as follows: "The symmetrical nature of AGREE[F] prohibits the right results in strictly directional systems. AGREE is capable of showing the right result only when unbounded iterative assimilation is the predicted form. AGREE fails while evaluating input candidates like [-ATR][+ATR][-ATR], where the desired output is one with regressive harmony and not total agreements of the flanking [-ATR] vowels on both sides" (p. 36). Thus the behavior

[67] However, /ʊ/ is attested in Assamese vowel inventory.

of AGREE is disentangled "from its inherently asymmetric nature to a more specific constraint which identifies the marked sequence of features" (Mahanta, 2007, p. 37) and represented in two sub-constraints which would result in regressive or progressive directionality instead of total assimilation. The sub-constraints as discussed in Mahanta (2007) are presented below:

(60) Sequential markedness constraints

*[+F][-F] - Assign a violation mark to [-F] segments preceded by [+F] segments

*[-F][+F] - Assign a violation mark to [+F] segments preceded by [-F] segments

The sequential markedness constraint *[-F][+F] is suitable to account for the regressive assimilatory process in which the occurrence of the feature [-F] followed by a feature value [+F] is marked in a language such as Assamese as postulated by Mahanta (2007). Since Deori resembles the Assamese vowel harmony pattern the sequential markedness constraint *[-F][+F] can also account for the regressive vowel harmony pattern in Deori. In Deori, there is no word sequence such as [+ATR][+ATR][-ATR] which would have been good test words for the directionality of assimilation. Nevertheless, the marked sequence such as [-ATR][+ATR] and unmarked sequence such as [+ATR][+ATR] and [+ATR][-ATR] in Deori is sufficient to validate the directionality in the language as regressive. Following Mahanta (2007), it is argued that in Deori the assimilatory agreement is the outcome of contextual neutralization and this instance of contextual neutralization is driven by a sequential markedness constraint which prohibits the occurrence of a marked feature [-F] when followed by a [+F] feature, but not vice-versa. The sequence which requires to be prohibited in Deori is *[-ATR][+ATR]. The sequential markedness constraint which drives harmony in Deori is discussed below:

(61) *[-ATR][+ATR]

Assign a violation mark to a [-ATR] vowel followed by a [+ATR] vowel.

The constraint *[-ATR][+ATR] penalizes the occurrence of [-ATR] vowels when followed by [+ATR] vowels. For instance, when a verb root undergoes inflection /bɔ/+/ɹi/ "beat" the output */bɔri/ violates the constraint *[-ATR][+ATR]. On the other hand, the output /bori/ satisfies the constraint *[-ATR][+ATR].

Apart from the markedness constraint which bans a marked [-ATR][+ATR] sequence in Deori, a faithfulness constraint is also required which will penalize any deviation of the surface form (output) from its lexical form (input). Faithfulness constraint evaluates the identity of correspondent elements. The IDENT family of constraints, initially proposed as below in McCarthy and Prince (1995), relate corresponding input and output features of a segment:

(62) IDENT (F)

Let α be a segment in S_1 and β be any correspondent of α in S_2. If α is [γF], then β is [γF]. ("Correspondent segments are identical in feature F").

Taking the IDENT (F) constraint into consideration to account for [-ATR] harmony domains, similar to Assamese, it can be shown that the underlying feature value of the [-ATR] vowels are retained in the absence of harmony-inducing high vowels in Deori. Thus, IDENT [ATR] constraint is taken into account which would preserve the underlying [-ATR] feature in absence of the following [+high +ATR] vowels. Following Mahanta (2007), the IDENT [ATR] constraint which preserves the harmonic value of [-high -ATR] vowels, if not followed by triggering high vowels, is discussed below:

(63) IDENT [ATR]

A segment in the output and its correspondent in the input must have identical specifications for [ATR].

The faithfulness constraint IDENT [ATR] will be ranked lower than the sequential markedness constraint *[-ATR][+ATR] because faithfulness constraint will prevent the alternation of /ɛ/ and /ɔ/ to [e] and [o] as it requires identical input and output form. Therefore, *[-ATR][+ATR] is ranked above IDENT [ATR] which will yield the well-formed output.

In this section, the constraints resulting in the assimilatory process in Deori are discussed. In the next subsections, the operation of the harmony-driven constraint *[-ATR][+ATR] vis-à-vis other constraints enforcing regressive harmony will be discussed in detail with respective tableau.

5.4.2 ATR harmony in presence of mid vowels

This section mainly concentrates on the ATR harmony of the mid vowels. [-high -ATR] vowel occurs when there is no triggering [+high +ATR] vowel. The occurrence of [-high -ATR] vowel is captured by the feature co-occurrence constraint *[-high +ATR], similar to Assamese. The constraint *[-high +ATR] restricts the occurrence of [+ATR] vowel when there is no triggering [+high +ATR] vowel. The feature co-occurrence constraint which becomes relevant to prevent the occurrence of [-high +ATR] in absence of a following [+high +ATR] vowel is discussed below:

(64) *[-high +ATR]: the feature value [+ATR] is marked in [-high] vowels.
(Archangeli and Pulleyblank, 1994)

This constraint plays a role in evaluating words with only mid vowels. The tableau in (64) illustrates that the feature co-occurrence constraint prohibits the occurrence of [e] and [o] in the absence of the triggering high vowels /i/ and /u/. While the highly ranked constraint *[-ATR][+ATR] would try to execute the agreement, *[-high +ATR] constraint would impede the occurrence of [e] and [o]. The tableau in (65) illustrates how the constraint *[-high +ATR] operates.

(65) *[-high +ATR] constraint prohibits the occurrence of [e] and [o] in absence of following [+high +ATR] vowels.

Input: /sɛlɔ/	*[-ATR][+ATR]	*[-high +ATR]	IDENT [ATR]
a. selo		**!	**
b. sɛlo	*!	*	*
c. ☞sɛlɔ			

The tableau in (65) exemplifies that the constraint *[-high +ATR] forbids the occurrence of output with /e/ and /o/ in absence of the triggering [+high +ATR] vowel /i/ and /u/ and *[-ATR][+ATR] penalizes disharmonic sequences. In the tableau above, candidate (c) surfaces as the winning candidate satisfying all the constraints - the harmony-driven constraint *[-ATR][+ATR], the feature co-occurrence constraint *[-high +ATR] and the faithfulness constraint IDENT [ATR].

5.4.3 ATR harmony in the presence of high and mid vowels

The occurrence of [-high +ATR] vowels in positions preceded by [+high +ATR] vowels is unmarked in Deori. The occurrence of forms such as /siɹɛ/ necessitates feature co-occurrence restrictions along with sequential markedness restrictions because [-high +ATR] vowels do not occur in positions which are not followed by [+high +ATR] vowels. The tableau in (66) illustrates how the constraint *[-ATR][+ATR] and *[-high +ATR] operates.

(66) *[-high +ATR] restricts the occurrence of [e] and [o] together with *[-ATR] [+ATR]

Input: /siɹɛ/	*[-ATR][+ATR]	*[-high +ATR]	IDENT [ATR]
a. ☞siɹɛ			
b. siɹe		*!	**

The tableau in (66) exemplifies that the constraint *[-high +ATR] restricts the occurrence of marked sequences such as /i…e/ and /i…o/ in the stem phonology of Deori, resulting in the selection of (66) (a) as the winning candidate. The optimal output /siɹɛ/ fulfills the requirement of the generalization that if [-high +ATR], it can occur only to the left of the [+high +ATR] and not vice-versa.

After discussing the constraints which capture the co-occurrence restrictions of mid and high vowel sequences in Deori, the constraints capturing the opacity of vowels and consonants in Deori are discussed in the next section.

5.4.4 The opacity of low vowel /ɑ/

Cross-linguistically, it is argued that the feature combination [+ATR +low] is disfavored. Similarly, in Deori the feature combination [+ATR +low] is always opaque to harmony. When [+ATR +low] vowel /ɑ/ intervenes between an underlying [+ATR] vowel and an underlying [-ATR] vowel, the intervening vowel /ɑ/ prevents the later from assimilating to the underlying [+ATR] vowel. The low vowel /ɑ/ does not undergo any change and therefore is an opaque segment. In optimality-theory, the dispreference of low [+ATR] vowels is captured by a feature co-occurrence constraint *[+ATR +low] which is undominated (Krämer, 2003; Calabrese, 1988; Archangeli and Pulleyblank, 1994). The feature co-occurrence constraint *[+ATR +low] is also active in Assamese to account for the opacity of the low vowel /ɑ/. The feature co-occurrence constraint which disfavors [+low + ATR] vowel in the surface inventory is discussed below:

(67) *[+ATR +low]

Low vowels must not be [+ATR]

While *[+ATR +low] prevents the surface occurrence of [+ATR +low] vowel, faithfulness constraint IDENT [low] preserves the sonority of the vowel. The faithfulness constraint that preserves the low value of /ɑ/ is expressed as below:

(68) IDENT [low]

Correspondent segments are identical in feature [low] (McCarthy and Prince, 1995).

The inertness of /ɑ/ to the harmony process is accounted for by high ranked *[+ATR +low] and IDENT [low]. These constraints are ranked higher than the harmony-driven constraint *[-ATR] [+ATR]. The tableau in (69) illustrates how the constraint *[+ATR +low] and IDENT [low] operates.

(69) /ɑ/ remains unaltered in presence of the following triggering vowel

Input: /jɔ/+/gɑ/+/ɹi/	*[+ATR +low]	IDENT[low]	*[-ATR] [+ATR]	*[-high +ATR]	IDENT [ATR]
a. ☞ jɔgɑɹi			*!		
b. jogæɹi	*!			**	**

In the above tableau, (69) (a) is the optimal candidate as it satisfies the feature co-occurrence constraint *[+ATR +low] which disfavors the occurrence of the [+low +ATR] vowel. While the faithfulness constraint IDENT[low] is satisfied by both (a) and (b), it is the high ranked constraint *[+ATR +low] which selects the optimal output.

The ranking of *[+ATR +low], IDENT[low] » *[-ATR] [+ATR] » *[-high +ATR] » IDENT [ATR] selects fully faithful *jɔgaɹi* "to cut forcibly", with blocking of regressive assimilation by /ɑ/. The markedness constraint rules out fully harmonic alternatives, that is, *jogæɹi*, where the low vowel becomes [+ATR] and allows regressive spreading of the [+ATR] feature. Similar constraints are also active in Assamese to capture the opacity of /ɑ/. However, in Assamese, low vowel /ɑ/ also changes to [e] and [o] in exceptional circumstances and the change of the vowel /ɑ/ incurs a violation of the faithfulness constraint, unlike Deori. In Deori low vowel /ɑ/ does not change to any other vowel and, hence, the faithfulness constraint IDENT [low] is never violated.

5.4.5 Nasal consonants blocking harmony

Vowel harmony in Deori is also blocked by the intervening nasal consonants in proximity to the triggering vowels as shown in examples (52)-(53) (§ 5.3.6.2). The harmony is blocked when the nasal consonant is immediately preceding the triggering vowel. However, a nasal consonant not adjacent to the triggering vowel does not block the harmonic spreading as in (54). The sequential markedness constraint *[oNi]/[eNi][68] prevents vowel harmony when there is an intervening consonant before the triggering vowel in Deori, similar to Assamese. Since in Deori both the vowels /ɛ/ and /ɔ/ are prevented from harmonizing in presence of a nasal consonant preceding a target vowel, the constraint *[oNi]/[eNi] is essential to account of the consonant blocking harmony in Deori. The sequential markedness constraint that prohibits the spreading of the harmonic feature is expressed as below:

(70) *[oNi]/[eNi]: [+ATR –high ±back] vowels are prohibited when there is an intervening consonant before the triggering vowel.

The constraint *[oNi]/[eNi] takes into account the blocking harmony which is a result of co-occurrence restriction prohibiting nasal and ATR sequences and no such restriction is observed when the nasal consonant occurs elsewhere in the word sequence. The tableau in (71) illustrates how the constraint *[oNi]/[eNi] operates.

(71) Vowel harmony blocked by intervening nasal consonant

Input: /kɔnũ/	*[oNi]/[eNi]	*[-ATR][+ATR]	*[-high +ATR]	IDENT[ATR]
a. ☞ kɔnũ		*!		
b. konũ	*!		*	*

In the tableau above, the sequential markedness constraint *[oNi]/[eNi] is higher ranked than the harmony-driven constraint *[-ATR][+ATR] which prevents vowel harmony when there is a consonant preceding the triggering vowel thereby choosing (a) as the optimal candidate. From the above ranking, it is evident that satisfying the constraint *[oNi]/[eNi] is more essential than satisfying harmony-driven constraint *[-ATR][+ATR]. The harmony-driven constraint *[-ATR][+ATR] ranked lower than the sequential markedness constraint *[oNi]/[eNi] allows the optimal candidate /kɔ̃nu/ in the surface. However, the sequential markedness constraint *[oNi]/[eNi] prohibits the occurrence of nasal and ATR sequence locally and not distally. The

[68] In the analysis of the vowel harmony pattern of Deori, the constraints that account for the vowel harmony pattern in Assamese have been employed to show the theoretical similarity between two genetically different languages. The sequential markedness constraint *[oNi]/[eNi] has been proposed by Mahanta (2007) to account for the nasals blocking vowel harmony in Assamese when closer to the triggering vowel. This pattern is also attested in Deori and hence this constraint has been employed to account for the nasals blocking vowel harmony in Deori.

following tableau shows how non-adjacent nasal consonant does not prohibit the spreading of the [ATR] feature.

(72) Vowel harmony not blocked by non-adjacent nasal consonant

Input: /tʃɛmɛ̃tʃi/	*[oNi]/[eNi]	*[-ATR][+ATR]	*[-high +ATR]	IDENT[ATR]
a. tʃɛmɛ̃tʃi		*!		
b. ☞ tʃemẽtʃi			**!	*

In the above tableau, (72) (b) is selected as the optimal candidate over (a) by the harmony-driven constraint *[-ATR][+ATR] instead of the markedness constraint *[oNi]/[eNi]. In the tableau, both the outputs satisfying the high ranked constraint *[oNi]/[eNi] testifies that blocking by the nasal consonant requires absolute adjacency.

5.5 Conclusion

In this chapter, a detailed analysis of Deori vowel harmony has been discussed. Deori exhibits regressive vowel harmony, similar to Assamese, which spreads from [+high +ATR] vowels /i/ and /u/ and affects only the preceding vowel. The mid vowels /ɛ/ and /ɔ/ surface as [e] and [o] in the stem phonology of Deori when followed by [+ATR] vowels /i/ and /u/ both in the root and root+suffix domain. Vowel harmony in Deori is phonological, whereby a vowel in a word agrees with the phonological feature [±ATR] of another vowel.

Deori and Assamese shares similar vowel harmony pattern[69], both descriptively and theoretically. The similar descriptive facts of vowel harmony in Deori and Assamese are: [+high +ATR] vowels /i/ and /u/ are the triggering vowels that affect the preceding mid vowels with [-ATR] specification; the occurrence of the [-high +ATR] vowels [e] and [o] are determined by the following [+high +ATR] vowels /i/ and /u/; the [-high -ATR] vowels /ɛ/ and /ɔ/ occur with each other and with themselves both in V_1 and V_2 positions but not with [-high +ATR] vowels [e] and [o]; the low vowel /ɑ/ occurs with all the vowels with [±ATR] specifications; the low vowel /ɑ/ and the nasal consonants /m/ and /n/ are opaque to vowel harmony. Apart from the descriptive

[69] Assamese vowel harmony is not exactly allophonic. It is in a stage where it is not exactly phonemic but not allophonic either (Mahanta, 2007). In Assamese a minimal set of 8 words with all the vowels /ɑ,ɛ,e,ɔ,o,i,u,ʊ/ is possible, unlike Deori. However, the commonalities between both the language is that mid vowels [e] and [o] occurs when followed by [+high +ATR] vowels /i/ and /u/ in derived and non-derived monosyllabic and trisyllabic words.

similarities, the theoretical similarities show that the constraints that account for the vowel harmony pattern in Assamese are also active in Deori[70]. The similar sets of constraints active in both the languages are: the sequential markedness constraint *[-ATR][+ATR] which results in regressive [+ATR] harmony leading to the emergence of the vowels [e] and [o] when followed by [+high +ATR] vowels /i/ and /u/; the feature co-occurrence constraint *[+ATR +low] and faithfulness constraint IDENT[low] prevent the alternation of the low vowel /ɑ/ and preserve the underlying quality of the low vowel respectively; the sequential markedness constraint *[oNi]/[eNi] prohibits the spreading of the harmonic feature from propagating further when it immediately precedes a triggering vowel. The ranking of the constraints that capture the regressive vowel harmony pattern both in Assamese and Deori, and the opacity of vowels and consonants in both the languages are summarized below:

(73) Ranking of the constraints

(a) [+ATR] harmony

*[-ATR][+ATR] » [-high +ATR] » IDENT[ATR]

(b) The opacity of low vowel /ɑ/

*[+ATR +low], IDENT[low] » *[-ATR] [+ATR] » *[-high +ATR] » IDENT [ATR]

(c) The opacity of nasal consonants

*[oNi]/[eNi] » *[-ATR][+ATR] » *[-high +ATR] » IDENT[ATR]

The ranking of the constraints shows that the sequential markedness constraint *[-ATR][+ATR] is ranked higher than the faithfulness constraint IDENT[ATR] to result in regressive harmony in Deori. To account for the opacity of [-ATR] vowel /ɑ/, the otherwise highly ranked sequential markedness constraint *[-ATR][+ATR] is ranked below the faithfulness constraint IDENT[low]. Similarly, harmony blocking by intervening nasal consonant is taken care of by the ranking *[oNi]/[eNi] » *[-ATR][+ATR] » IDENT[ATR] where the sequential markedness constraint *[oNi]/[eNi] is ranked higher than the harmony-driven constraint *[-ATR][+ATR]. From the ranking of the constraints, it is evident that *[-ATR][+ATR] dominates *[-high +ATR] constraint which prohibits the unwanted occurrence of [e] and [o], which further dominates the IDENT[ATR] resulting in a language where [e] and [o] emerges as an output of harmony and are allophones. In

[70] However, Assamese needs many more constraints to account for the vowel harmony pattern which is not required in Deori (for detail overview of Assamese vowel harmony pattern see Mahanta, 2007).

the optimality-theoretic analysis, markedness constraints responsible for blocking dominate the harmony-driven constraint so that they may prevent its complete satisfaction which is evident from (73) (b) and (c).

The similarities of vowel harmony pattern in Deori and Assamese is likely to be the result of sustained contact of Deori with Assamese, and to the high degree of bilingualism of the Deori speakers. The similarities indicate that linguistic features of Assamese have gradually seeped in Deori owing to language contact. Apart from the similarities between Deori and Assamese, the dissimilarities in the harmony pattern between the two languages are as follows: Deori does not display exceptional alteration of [+low -ATR] /ɑ/ to [e] and [o] and thus the higher-ranked IDENT[low] constraint is not violated, unlike Assamese. Further, the [+high -ATR] vowel /ʊ/ is not attested in Deori, hence the faithfulness constraint IDENT[high +ATR] is not active in Deori.

The next chapter discusses the nasal harmony pattern in Deori with special reference to the *target*, *transparent*, and *opaque* segments which will shed light on the nasal harmony pattern attested in the language.

Chapter 6 - Nasal Harmony in Deori

6.1 Introduction

In this chapter, the nasal harmony pattern in Deori will be discussed. As we have already mentioned in Chapter 2, there is no height preference in terms of nasal vowels in Deori. All oral vowels in Deori have their nasal counterparts as shown in Table 6.1.

	Front	Back	
high	i ĩ	u ũ	+ATR
mid	ɛ ɛ̃	ɔ ɔ̃	-ATR
low		ɑ ɑ̃	-ATR

Table 6.1: Oral and Nasal vowels in Deori

The allophonic mid vowels [e] and [o] also have nasal counterparts [ẽ] and [õ] in Deori as in *timõɹu* "coconut" *amõdzi* "dirty" *kemõdzi* "cotton" *tʃemẽtʃi* 'ant'. However, there are instances where nasalized [-ATR] mid vowels /ɛ̃/ and /ɔ̃/ do not change to nasalized [+ATR] mid vowels [ẽ] and [õ] even when followed by high vowels /i/ and /u/ as in *jɛ̃.si* "fire. SEL[71]", *disɔ̃.si* "pot.SEL", *bibɔ̃.si* "granary.SEL", *mɔ̃kɔ̃.si* "rice. SEL", *mɛ̃si* "deer". The occurrence of nasalized [ẽ] and [õ] in some case and non-occurrence of nasalized [ẽ] and [õ] in another can be assumed to be an exceptional instance which needs further research to understand these processes if any and thus it is not pursued further in this chapter.

While discussing the nasal harmony pattern in Deori, *triggering*, *target* and *opaque* segments in Deori will be discussed. Like all other harmony systems (like vowel harmony) while triggers lead to the initiation of nasal harmony, targets are subjected to nasal harmony. Again similar to the nomenclature used in vowel harmony an opaque segment or blocker impedes the spread of nasal harmony and a transparent segment does not stop the spread of harmony but allows the spread of harmony without itself undergoing it. Another important goal of this chapter is to show the *directionality* of nasal harmony in Deori. The primary focus of this chapter is to discuss the nasal harmony pattern in Deori. The properties of nasal harmony in Deori are discussed from the framework of Optimality theory (henceforth OT, Prince and Smolensky, 1993/2004). As already discussed in Chapter 1, keep bearing in mind that this dissertation is not a theoretical analysis of Deori phonology. The Optimality theory account of the nasal harmony pattern is taken into

[71] Selective marker

consideration to shed some light on the obstacles that Deori throws up in the way of analyzing the nasal harmony pattern attested in the language. The data incorporated in the analysis of nasal harmony in Deori is based on primary data collection as mentioned in section 1.5 Chapter 1. Data were recorded in a quiet environment in Bordeori village, Narayanpur, Lakhimpur district, and Naam Deori and Upor Deori village, Jorhat district of Assam. The speakers were between 40-55 years of age at the time of data collection. All the speakers were bilingual; they were equally fluent in Assamese apart from Deori. The word list (Appendix 9 and Appendix 10) was thus implemented among the speakers four times each among a set of ten native speakers (5 male and 5 female) and was asked to utter at a moderate pace. From the four recorded tokens of each word, three of the samples were selected for analysis. The samples were collected using a Shure SM-10 head-mounted microphone connected to a Tascam DR 100 MK II recorder and digitized at a sampling frequency of 44.1 kHz and 32-bit resolution.

This chapter is organized as follows. Section 6.2 discusses cross-linguistic nasal harmony patterns. Section 6.3 provides adequate descriptive information about Deori nasal harmony pattern and shows that Deori exhibits an exceptional occurrence of suffixal alternation, i.e., /b/ → /m/ and [ɹ] → /n/ in the derived domain which shows deviation from the cross-linguistic typology of nasal harmony. Section 6.4 discusses nasal harmony pattern in Deori within the Optimality Theory framework and highlights that suffixal alternations in Deori cannot be explained straightforwardly following the cross-linguistic markedness constraints and Section 6.5 summarizes the findings.

6.2 Cross-linguistic nasal harmony pattern

It is well known that the feature [nasal] exists in a language as a result of velum lowering whereby some air passes through the nasal cavity. The feature [nasal] is not a property associated with a single segment rather it is linked to a string of segments and this spreading effect of the feature [nasal] is known as nasal harmony. Nasal harmony has been known to be limited to various prosodic domains - mostly the word but could be limited to bigger morphological domains as well. In the sub-sections below, the cross-linguistic nasal harmony pattern will be discussed which will highlight the properties of nasal harmony pattern attested across languages.

6.2.1 Nasal vowel-consonant harmony and nasal consonant harmony

Nasal harmony is a process where nasalization is spread through vowels and consonants or only consonants over a certain distance. In the nasal vowel-consonant harmony system, both vowels and consonants participate as triggers and targets. Whereas, in the nasal consonant harmony system, only consonants participate and vowels are transparent. Languages such as Sundanese, Applecross dialect of Scottish Gaelic, Warao, Tuyuca, Guaraní, Malay, Kolokuma dialect of Ijo exhibit nasal vowel-consonant harmony and languages such as Kikongo, a Bantu language and Ngbaka, a Niger-Congo language spoken in the Democratic Republic of Congo exhibit nasal consonant harmony. In Kikongo, nasal consonant harmony results in an alternation of voiced stops and approximant /l/ to prevocalic nasal stop at any distance in the stem, e.g. *suk-idi* "wash", *nik-ini* "grind" (Walker, 2011).

In both nasal vowel-consonant harmony and nasal consonant harmony systems, suffixal alternation is common. Languages such as Southern Barasano, Tuyuca, Guaraní which manifests nasal vowel-consonant harmony and languages belonging to Bantu language family such as Mbundu, Yaka, Kongo which manifest nasal consonant harmony display suffixal alternation. In Southern Barasano, the prenasalized segments [^{m}d, ^{n}d, $^{\text{ŋ}}$g] are realized as fully nasal stops [m, n, ŋ] when nasalized and voiced segments [r, w, h] are realized as [n, w̃, h̃] when nasalized, whereas the voiceless segments [p,t,k,s] are transparent segments. Similarly, in Tuyuca, except the voiceless segments which are transparent, all voiced segments have their nasal variants. The voiced segments [b d g r w j h i ɨ u e a o] are realized phonetically as [m n ŋ r̃ w̃ ɲ h̃ ĩ ɨ̃ ũ ẽ ã õ] in nasal context and as [b d g r w j h i ɨ u e a o] in non-nasal context (Barnes, 1996). In Guaraní, all voiced segments have oral and nasal allophones. Oral segments in Guaraní occur in the onset of an oral vowel and nasal allophones occur before nasal vowels. Voiced stops are realized as prenasalized stops in oral context and as fully nasal stops in nasal context. Thus the voiced segments [^{m}b, ^{n}d, d_j, $^{\text{ŋ}}$g, $^{\text{ŋ}}$g^{w}, v, l, r, ɣ, ɣ^{w}] in Guaraní are realized as [m, n, ɲ, ŋ, ŋw, ṽ, l̃, r̃, ɣ̃, ɣ̃^{w}] in the span of nasal harmony (Walker, 1998). In Bantu languages a suffixal consonant which surfaces as [l], [d] or [r] is realized as [n] when preceded by a nasal (Greenberg, 1951; Johnson, 1972; Howard, 1973; Ao, 1991; Odden, 1994; Hyman, 1995; Piggott, 1996; Walker, 2000a, 2000b). From the discussion so far, it is clear that in the nasal vowel-consonant harmony system displaying suffixal alternation all voiced segments change to nasal stop and in nasal consonant harmony system only voiced stops and approximants are the targets (Walker, 2011). In this chapter, it will be shown that suffixal alternation is also attested in Deori. Further, Deori also exhibits some exceptional suffixal alternations which will be discussed in section 6.3.2.1.

6.2.2 Target segments

There is a hierarchy of segmental permeability to nasal spreading (Cohn, 1993a). The extant literature (Schourup, 1972b; Pulleyblank, 1989; Piggot, 1992; Cohn, 1993 a, b; Padgett, 1995a; Walker, 1995, 1998) on nasal harmony posits that the spreading of the feature [nasal] is manifested in a hierarchical variation. The researchers posit that the nasal harmony system adheres to an implicational hierarchy shown in (74) where the segments to the left will undergo nasalization, while those to the right will block.

(74) $_1$Vowels $_2$ Semi vowels $_3$ Liquids $_4$ Fricatives $_5$ Obstruent Stops $_6$

← high-*compatibility with nasalization*-low →

The hierarchy in (74) highlights that the sonorant segments are more compatible with nasalization than non-sonorant segments. While vowels, semi-vowels, and liquids are highly compatible with nasalization, fricatives, and obstruent stops are less compatible with nasalization. The implicational hierarchy in (74) suggests that prohibition on the nasalization of one type entails a prohibition on nasalization of succeeding segments with lower sonority. Thus, for example, the prohibition of nasalized liquids suggests that neither liquids, nor fricatives, nor obstruent stops can be nasalized. The role of a segment in arresting and allowing the nasal spread is language-dependent. For instance, while in Sundanese nasal harmony spreads from a nasal stop and only adjacent vowels and laryngeals become nasalized, e.g. *kumãh̃ã* "how?", *ŋãjak* "to sift", *mãro* "to halve" (Cohn, 1990; Robins, 1957), in Kolokuma dialect of Ijo, a Niger-Congo language of Nigeria, nasality spreads either from a nasal consonant or a nasal vowel and it spreads through vowels, glides, and liquids, e.g. *sɔ̃ɾ̃ɔ̃* "five", *tɔ̃nĩ* "light (a lamp), *j̃ãɾ̃ĩ* "shake" (Williamson, 1987). Further, while nasalization spreads through less vocalic segments such as liquids and, more rarely, fricatives, as in Epena Pedee, e.g. /peɾõɾa/ → [pẽɾ̃õɾ̃ã] "guagua (a groundhog-like animal)", /hẽsaã/ → [h̃ẽs̃ãã] "stinging ant" (Harms, 1985), nasalization also spreads through voiced obstruent stops and alternates to a nasal stop as in Tuyuca, e.g. /wĩdo/ → [wĩnõ] 'wind' (Barnes, 1996).

Glottal segments are also nasalized in phonological representations. Following Schourup (1972) and Piggot (1992), Walker and Pullum (1999) argue that glottal fricatives undergo nasalization and are grouped with vocoids in terms of their compatibility with nasalization as shown in (75) thereby referring to nasalized glottal fricatives as laryngeals for their "glide like phonological classification".

(75) Vowels>Laryngeals>Semivowels>Liquids>Fricatives>Obstruent stops

← high-*compatibility with nasalization*-low →

While laryngeals are grouped with vocoids for their compatibility with nasalization, they also surface as blockers. In their explanation of laryngeals as an opaque segment, Walker and Pullum (1999)[72] state that laryngeals blocking nasal spreading exemplify their phonological classification as obstruents.

6.2.3 Opaque segments

Many early studies (Pulleyblank, 1989; Ohala and Ohala, 1993; Cohn, 1993a; Ladefoged and Maddieson, 1996; Gerfen, 1996) postulate that the incompatibility of segments with nasalization is based on acoustic properties. Ohala and Ohala (1993) state that nasalization of an obstruent stop is not permissible because the lowering of the velum prevents the build-up of air pressure in the oral cavity by allowing air to escape through the nose. Identical to obstruent stops, fricatives are incompatible with nasalization as producing audible friction and audible nasalization simultaneously is strenuous (Cohn, 1993a). Non-nasalization of the voiceless consonants, either voiceless fricatives or voiceless obstruents, is attributed to a condition on feature combination of [-voice] and [+nasal], which is considered as a marked feature (Pulleyblank, 1989). Fricatives and obstruent stops are less compatible with nasalization and hence are subjected to be opaque in the span of nasal harmony. Walker (1998), however, reports that languages such as Applecross dialect of Scottish Gaelic, Itsekeri, Ennemor, exhibit voiceless fricatives as target segment and Tuyuca, a Tucanoan language of Columbia, exhibits voiced obstruents and voiced fricatives as

[72] Walker and Pullum (1999) posits that "what distinguishes glottal continuants in a language like Tereno from others is that although these segments are realized phonetically with glottal articulation, they correspond phonologically to voiceless obstruents, which are incompatible with nasalization, rather than being grouped with the phonological class of laryngeals, which pattern more closely with semivowels" (pg 776).

target segments. Hence, similar to target segments, opaque segments are also language-dependent. Glides which are highly compatible with nasalization also surface as an opaque segment in a language such as Sundanese. In Sundanese, nasalization is blocked by glides, liquids, fricatives, and obstruent stops; in Malay, liquids, fricatives, and obstruent stops are opaque segments; in Ijo, fricatives and obstruent stops are opaque segments and in Scottish Gaelic spoken in Applecross only obstruent stops are opaque to nasal harmony.

6.2.4 Transparent segments

A nasal vowel-consonant system with transparent segments is attested in the Tucanoan language family. In Tuyuca, a Tucanoan language, nasalization spreads from nasal vowels and nasal stops to all segments, except voiceless obstruents. Voiceless obstruents remain oral but do not prohibit the feature [nasal] to spread through them, e.g. *mĩpĩ* "badger", *wãtĩ* "devil", *ãkã* "choke on a bone" (Barnes, 1996). Similar to Tuyuca, in Guaraní, a Tupi language of Paraguay, voiceless segments /p,t,k,k^w,s,ʃ,h/ are transparent segments. In Mòbà Yoruba, both voiced and voiceless segments and fricatives are transparent, for e.g. /egigũ/ → [eg̃ĩg̃ũ] 'bone', /ì-sĩ/ → [ĩ̀s̃ĩ] "worship" (Ajíbóyè, 2001; Archangeli and Pulleyblank, 2007).

In his representationally driven feature-geometric approach of nasal harmony, Piggot (1992) proposes two nasal harmony patterns - Type A and Type B harmony. In Type A harmony, spreading is always blocked and in Type B harmony spreading is never blocked. Walker (1998), however, proposes a new generalization of nasal harmony pattern and states that different nasalization patterns can be unified. While Piggot's Type B nasal harmony pattern divides the target and the transparent segment, Walker's analysis fuses the target and the transparent segment and proposes that transparent segments are potential undergoers of nasal harmony. The implicational hierarchy of segments as shown in (74) has only been applied to systems with blocking, separating them from systems with transparency. However, Walker (1998) proposes that this basic hierarchy governs variation in all nasal harmony. The claim underlying this proposal is that "skipping of segments does not occur, so all nonparticipating segments are blockers. 'Transparent' segments, on the other hand, pattern with the set of targets in allowing nasalization to spread through them" (Walker, 1998, p. 24). Walker further states that "segments behave in only one of two ways in nasal harmony, they either undergo [nasal] spreading or they block, so spreading never skips an intervening segment." (1998, p. 4). In our discussion of Deori, we will see that Deori does not have transparent segments. Segments are either target or opaque to nasal harmony in Deori.

6.2.5 Directionality

The directionality of nasal spreading can be either progressive (left-to-right), or regressive (right-to-left) or bidirectional. In languages such as Johore dialect of Malay, an Austronesian language of Malaysia, and in Capanahua, nasalization targets a similar set of segments but the direction of spreading is different in both the languages. While in Johore dialect of Malay spreading of nasalization spreads progressively from a nasal stop to vowels, laryngeals, and glides, e.g. *pənə̃ŋãh̃ãn* "central focus", *mə̃nãw̃ãn* "to capture" (Onn, 1980), in Capanahua nasalization spreads regressively from nasal vowels and nasal stops to vowels and glides e.g. *h̃ãmawi* "step on it", *h̃ãmãʔ̃õña* "coming stepping", *bĩmi* "fruit" (Loos, 1969; Piggott, 1992). Walker (1998) incorporates the spreading constraint (Spread-R or Spread-L) to capture the directionality in nasal harmony languages. Bidirectional nasal spreading is reported in languages such as Tuyuca, a Tucanoan language, and in Guaraní, a Tupi language of Paraguay. While in Tuyuca voiceless stops are transparent segments and do not prohibit bidirectional spreading, in Guaraní voiceless stops, are target segments and undergo nasalization. Guaraní bidirectional spreading is blocked only by stressed oral syllables. For instance, /^{n}do-roi-^{n}du-ˈpãi/ → [nõɾ̃õĩnũˈpãĩ] "I don't beat you", /aˌkãɾaˈɰ^{w}e/ > [ãˌkãɾ̃ãˈɰ^{w}e] "hair (of the head)" (Rivas, 1975). Walker (1998) states that although the direction of spreading is not predictable, languages exhibiting unidirectional spreading "rightward nasalization across syllables is much more common than nasalization to the left" (p. 65). In this chapter, it will be shown that Deori exhibits unidirectional spreading which is progressive.

With this background on nasal harmony pattern attested cross-linguistically, we will start presenting the details of nasalization in Deori.

6.3 Nasal harmony pattern in Deori

As presented in Chapter 2, nasalization in Deori is derived through the process of nasal effacement wherein the word-final nasal consonant is deleted and its manner component is regressively left behind on the preceding vowel. Jacquesson (2005) states that apart from the final vowels being nasalized in Deori after the subsequent deletion of the nasal consonant, underlying nasal vowels also exist in the language. Hence, in our analysis, we consider the nasalization of final vowels in Deori as a result of nasal effacement and the initial vowel is either underlyingly nasalized or contextually nasalized (in proximity to a nasal consonant). Jacquesson (2005) posits that the presence of a nasal vowel in word leads to the nasalization of all adjacent vowels within the root boundary. However, in this chapter, it will be shown that nasalization in Deori extends beyond the root boundary and targets the suffixal segment as well. Further, nasalization in Deori also targets consonants apart from vowels. The instances of nasal harmony are discussed in turns. Section 6.3.1 discusses the nasal harmony pattern in underived words and section 6.3.2 discusses the nasal harmony pattern in the derived word domain.

6.3.1 Nasal harmony pattern in disyllabic words in underived word domain

In this section, the target and the opaque segment in monomorphemic disyllabic words are discussed. However, the occurrence of glide [w] and glottal fricative /ɦ/ in the span of nasal harmony is not discussed in this section for the following reasons: Glide [w] occurs only as a suffix (for example: *wa* “thematic marker”), hence, its role as a target segment is discussed in the derived domain in section 6.3.2. Glottal fricative /ɦ/ occurs word-initially in root words; hence, its role in the context of nasal harmony in monomorphemic disyllabic roots is irrelevant. However, its role in the span of nasal harmony in the derived domain is illustrated in section 6.3.2 considering the locative suffix marker /ɦɔ/.

Vowels are the triggering segment in Deori which affects glides, and liquids as can be seen in the following examples.

(76) Liquid [ɹ] and glide /j/ are target segments in Deori.

Liquid [ɹ]		Glide /j/	
a. gãɹ̃ɔ̃	‘pot’.	d. tʃĩj̃ã	‘fish/wife of younger brother’
b. gĩɹ̃ĩ	‘second month of the Assamese calendar’	e. ãj̃ã	‘daughter in law’
c. dzuɹɔ̃	‘summer’	f. gijã	‘planter’

In (76) (a-f) the final vowel is nasalized as a process of nasal effacement as the underlying representation of the words as mentioned in Jacquesson (2005) and Deori (2008) are: *<gãrong>* ~ */gãɹɔŋ/* → *gãɹ̃ɔ̃* “pot” (Jacquesson, 2005; Deori, 2008), *<gĩɹing>* ~*/gĩɹiŋ/* → *gĩɹ̃ĩ* “second month of the Assamese calendar” (Jacquesson, 2005; Deori, 2008), *<dzuɹɔng>* ~ */dzuɹɔŋ/* → *dzuɹɔ̃* “summer” (Jacquesson, 2005; Deori, 2008), *<tʃĩjang>* ~ */tʃĩjaŋ/* → *tʃĩj̃ã* “fish/wife of younger brother” (Jacquesson, 2005; Deori, 2008), *<ãjang>* ~ */ãjaŋ/* → *ãj̃ã* “daughter in law”

(Jacquesson, 2005; Deori, 2008) and <*gijang*> ~ /*gijaŋ*/ → *gijã* “planter” (Jacquesson, 2005; Deori, 2008) and the initial vowel is assumed to be underlyingly nasalized. Considering examples (76) (a, b, d, and e) it can be speculated that nasalization of the final nasal vowels in Deori spread leftward thereby nasalizing the sonorant segment occurring to the left of the nasal vowel. However, this generalization would result in wrongly interpreted data as in (76) (c) **dzũɹ̃ɔ̃* and (76) (f) **gĩj̃ã*, which is an unattested form in Deori. Thus, we assume that nasalization in (76) (a, b, d, e) spreads from the initial vowel to the adjacent sonorant segment thereby nasalizing liquid [ɹ] and glide /j/ and the final vowel is nasalized through the process of nasal effacement. Effacement is diachronic in Deori, not synchronic. Nasal harmony in Deori is a synchronic process and the deletion of final nasals may have either been (a) the impulse for nasal harmony or (b) led to the presence of nasalized vowel and consonants or (c) both. We do not have any evidence that it is a process in the synchronic grammar and no such claim has been made. An alternative role of liquid [ɹ] is evident in Deori in the derived domain. While in (76) (a-b), liquid [ɹ] undergoes nasalization and changes to nasalized liquid [ɹ̃], in derived domain liquid [ɹ] undergoes nasalization and changes to nasal consonant /n/. This instance of the alternating segment in the span of nasal harmony will be discussed in detail in section 6.3.2.1. Liquid /l/ in Deori is restricted to word-initial position, and the only occurrence of liquid /l/ in the span of nasal harmony is *ã lepeduɹ* → *ã l̃ẽpeduɹ* “my goat”, *nɔ̃ li* → *nɔ̃ l̃ĩ* “2nd person singular/plural.necklace”. Here, oral /l/ changes to nasalized /l̃/ when preceded by a nasal vowel. In *ã lepeduɹ* → *ã l̃ẽpduɹ* “my goat”, nasalization from 1st person singular pronoun *ã* spreads to liquid /l/ and then to the adjacent vowel /ɛ/, but the intervening voiceless stop /p/ stops nasalization from propagating further, which shows voiceless stop /p/ is opaque to nasal harmony in Deori.

Apart from vowels, nasal consonants also trigger nasal harmony in Deori as discussed below:

(77) Nasal consonants triggering nasal harmony

a.	mĩɹ̃ũ	‘uncooked rice’
b.	nĩj̃ã	‘cook’
c.	mɔ̃kɔ̃	‘rice’
d.	mũsɑ̃	‘grass, weed’
e.	mɛ̃bɑ̃	‘fat’
f.	mɔ̃si	‘man’
g.	mĩtʃɔ	‘platform of the house’
h.	timũ	‘mango’

i. tʃimĩ 'tail'

Example (77) shows that the nasals /m/ or /n/ trigger nasalization to the adjacent sonorant segment. In (77) (a) *mĩɹ̃ũ* "uncooked rice" and in (77) (b) *nĩj̃ã* "cook", we assume that the initial vowel is contextually nasalized (in close proximity to a nasal consonant) and the final vowel is nasalized through the process of nasal effacement as the underlying representation of the words are <*mĩɹung*> ~ /*mĩɹuŋ*/ → *mĩɹ̃ũ* (Jacquesson, 2005) and <*nĩj̃ang*> ~ /*nĩj̃aŋ*/ → *nĩj̃ã* (Deori, 2008) respectively. Thus, nasalization from the nasal consonants spread to the adjacent vowel which in turn spreads to the adjacent sonorant segment and nasalizes the [+continuant] [ɹ] and /j/. Similarly, in (77) (c) *mɔ̃kɔ̃* "rice" and (77) (d) *mũsã* "grass, weed", we assume that the initial nasal consonant triggers nasalization on the adjacent vowel, and the nasalization of the vowel in the final syllable is derived through the process of nasal effacement as the underlying representation of the words are <*mɔ̃kɔng*> ~ /*mɔ̃kɔŋ*/ → *mɔ̃kɔ̃* (Brown, 1895) and <*mũsaŋ*> ~ /*mũsaŋ*/ → *mũsã* (Jacquesson, 2005). Furthermore, in (77) (c, d) the intervening [-voice] stop /k/ and [-voice] fricative /s/ are not affected by nasalization. Example (77) (e-g) *mɛ̃ba* "fat", *mɔ̃si* "man" and *mĩtʃɔ* "platform of the house", shows that the initial vowel is contextually nasalized and nasalization is prohibited from spreading further by an intervening [+voice] obstruent /b/, [-voice] fricative /s/, and [-voice] affricate /tʃ/ respectively. Hence, the lexical sets *mɛ̃ba*, *mɔ̃si*, and *mĩtʃɔ*, though minimally attested, show that nasalization does not spread through [+voice] obstruent stop /b/, [-voice] fricative /s/, and [-voice] affricate /tʃ/ in Deori. Words such as (77)(h) *timũ* "mango" and (77)(i) *tʃimĩ* "tail" show that while nasal consonant triggers nasalization on the adjacent vowel (final vowel), the initial vowel remains oral and is not affected by the following nasal consonant. It exemplifies that oral vowels can occur to the left of the nasal consonant but not to the right of the nasal consonant. Although the examples above suggest that nasalization does not spread leftwards in Deori, directionality in Deori will be clear in derived word sequences which will be discussed in section 6.3.2. Next, we discuss words with a final nasalized vowel, unlike example (76) and (77) (a-g).

(78) [+voice] obstruent stops /b/ /d/ /g/ | [-voice] obstruent stops /p/ /t/ /k/

a. bibɔ̃	'granary'	h. opũ	'arm'
b. ibã	'flower'	i. ditɔ̃	'pot'
c. tɑdũ	'spoon'	j. ʧitũ	'rope'
d. gɑdũ	'pillow'	k. ɑtã	'arrow'

e. ɑgũ 'knee'
f. digĩ 'thread'
g. ugɑ̃ 'field'

l. ɑkũ 'ear/upland'
m. ʧikɛ̃ 'rat'
n. ekũ 'smoke'

(79) Fricative /s/

a. ɑsɔ̃ 'bamboo cleft for mat'
b. disɔ̃ 'pot'
c. gisɔ̃ 'lower rack above fireplace'
d. isɑ̃ 'shawl'
e. usũ 'bracelet'

(80) Affricate /ʧ/

a. ɑʧɔ̃ 'house'
b. ʧɔʧɛ̃ 'shame'
c. mĩtʃɔ 'platform of the house'

Affricate /dz/

d. udzũ 'navel/bamboo tube'
e. sudzɛ̃ 'rice beer'
f. gudzũ 'spear'
g. pidzɔ̃ 'raw'

In the examples (78-80), it can be seen that the final vowels are nasalized and the initial vowels are oral. These examples show that nasalization does not spread leftwards in Deori as it is arrested from spreading regressively by [±voice] obstruent stops, [-voice] fricative, and [±voice] affricates, which are less compatible with nasalization. Had it been not blocked by the [±voice] obstruent segments, we would have wrongly interpreted data as **bĩbɔ̃* "granary", **ẽkũ* "smoke", **ũgɑ̃* "field", **ĩsɑ̃* "shawl", **ʧɔ̃ʧɛ̃* "shame", **ũdzũ* "navel/bamboo tube" which are not attested in the language.

After a detailed examination of the underived words, a nasal harmony pattern in derived words is examined in the following section. Derived words are good test words for the directionality of nasal harmony in Deori.

6.3.2 Nasal harmony pattern in derived word domain

Directionality in Deori can be verified when root+suffix words are taken into consideration. If harmony is regressive then the feature [nasal] will spread to the left and if harmony is progressive then the feature [nasal] will spread to the right. In this section, it will be shown that Deori nasal harmony spreads beyond the root boundary, triggering nasalization of the suffixal segments and the direction of spreading is progressive. At first, the spread of nasalization through target segments, i.e., glottal fricative and glides will be discussed, followed by a discussion on opaque segments that halt the harmonic spreading.

Glottal fricative /ɦ/, and glides [w] and /j/ are target segments in Deori. The locative suffix -*ɦɔ*, the thematic marker -*wa*, and the possessive marker -*jɔ* have a nasal variant -*ɦ̃ɔ̃*, -*w̃ã*, and -*j̃ɔ̃* respectively as shown in examples (81-86).

(81)	Fricative /ɦ/ after an oral vowel			
	a. dzi.ɦɔ	→	dziɦɔ	‘water.LOC’
	b. lɑ.ɦɔ	→	lɑɦɔ	‘there.LOC’
	c. tʃi.ɦɔ	→	tʃiɦɔ	‘tongue.LOC’
	d. pɔpɔ.ɦɔ	→	pɔpɔɦɔ	‘tree.LOC’
(82)	Fricative /ɦ/ after a nasal vowel			
	a. udzũ.ɦɔ[73]	→	udzũɦ̃ɔ̃	‘navel/bamboo tube. LOC’
	b. ditɔ̃.ɦɔ	→	ditɔ̃ɦ̃ɔ̃	‘throat.LOC’
	c. bibɔ̃.ɦɔ	→	bibɔ̃ɦ̃ɔ̃	‘granary.LOC’
	d. gisɔ̃.ɦɔ	→	gisɔ̃ɦ̃ɔ̃	‘lower rack above fireplace.LOC’
(83)	Glide [w] after an oral vowel			
	a. gu.wɑ	→	guwɑ	‘grasshopper. THEMATIC’
	b. tʃu.wɑ	→	tʃuwɑ	‘pig.THEMATIC’
	c. ti.wɑ	→	tiwɑ	‘louse.THEMATIC’
(84)	Glide [w] after a nasal vowel			
	a. dɑ̃.wɑ[74]	→	dɑ̃w̃ɑ̃	‘mosquito.THEMATIC’
	b. nɔ̃.wɑ	→	nɔ̃w̃ɑ̃	‘2nd person sing/pl. THEMATIC’
	c. ʧĩj̃ɑ̃.wɑ	→	ʧĩj̃ɑ̃w̃ɑ̃	‘the fish.THEMATIC’
(85)	Glide /j/ after an oral vowel			
	a. bɑ.jɔ	→	bɑjɔ	‘2nd person singular.POSSESSIVE’
	b. dzɑ.ɹi.jɔ	→	dzɑ.ɹi.jɔ	‘2nd person plural.PROG.POSSESSIVE’
(86)	Glide /j/ after a nasal vowel			
	a. ɑ̃.jɔ	→	ɑ̃j̃ɔ̃	‘1st person singular.POSSESSIVE’
	b. nɔ̃.jɔ	→	nɔ̃j̃ɔ̃	‘3rd person singular/plural.POSSESSIVE’

The oral and nasal variants of glottal fricative /ɦ/~/ɦ̃/, glides [w]~[w̃], and /j/~/j̃/ are exemplified in examples (81-86). In example (81), the glottal fricative /ɦ/ occurs as a [-nasal -sonorant] segment and in (82) the glottal fricative /ɦ/ surfaces as a [+nasal +sonorant] segment. In the nasal harmony domain, the final nasal vowel of the root word triggers nasalization and spreads to the adjacent segment thereby making glottal fricative /ɦ/ a nasalized segment. Similarly, in (83) and (85) glides [w] and /j/ occur as an oral segment and in (84) and (86) glides [w] and /j/ are

[73] Locative suffix.
[74] Demonstrative marker.

nasalized when it occurs in a nasal harmony span. The data in (82), (84), and (86) show that glottal fricative /ɦ/, and semivowels [w], and /j/ undergo nasalization and are target segments in Deori. Following Walker and Pullum (1999), nasalized glottal fricative /ɦ/ can be termed as laryngeals for their glide like phonological classification and are grouped with highly compatible segments, vowels, and glides. Nasalization of the glottal fricative /ɦ/ in Deori agrees with the implicational hierarchy shown in (75).

While glottal fricative /ɦ/ is a target segment in Deori nasal harmony, [-voice] fricative /s/ and [±voice] affricate /tʃ/ and /dz/ are opaque to nasal harmony in Deori. The [+continuant] /s/ and [-continuant] /tʃ/ and /dz/ are unaffected by nasalization and halts the nasalization spread as exemplified in the following examples (87-89).

(87)	Fricative /s/			
	a. jɛ̃.si	→	jɛ̃si	'house.SEL'
	b. gũ.si	→	gũsi	'grasshopper.SEL'
	c. ɑtʃɔ̃.si	→	ɑtʃɔ̃si	'home.SEL'
	d. digĩ.nɑ̃.si	→	digĩnɑ̃si	'thread.DET.SEL'
	e. tɑdũ.nɑ̃.si	→	tɑdũnɑ̃si	'spoon.DET.SEL'
	f. tʃitũ.nɑ̃.si	→	tʃitũnɑ̃si	'rope.DET.SEL'
(88)	Affricate /tʃ/			
	a. dugɔ̃.tʃɑlɛ	→	dugɔ̃tʃɑlɛ	'before.ABL[75]'
	b. ɑ̃.tʃɑlɛ	→	ɑtʃɑlɛ	'1^{st} person singular.ABL'
	c. nɔ̃.tʃɑlɛ	→	nɔ̃tʃɑlɛ	'3^{rd} person singular.ABL'
(89)	Affricate /dz/			
	a. ɦidzɛ̃.dzi.ɹi	→	ɦidzɛ̃dziɹi	'see.SPA[76].PRES PROG'
	b. gĩjũ.dzi.ɹi	→	gĩjũdziɹi	'swim.SPA.PRES PROG'
	c. tʃɔ̃.dzi.ɹi	→	tʃɔ̃dziɹi	'collect.SPA.PRES PROG'

In examples (87) (a-f), the feature [nasal] cannot spread through [-voice] fricative /s/ as its spreading is impeded and hence the vowel following the fricative segment remains unaffected. Further, the [nasal] feature in the classifier *mɛ̃-* is also impeded from spreading further by the intervening [-voice] fricative /s/, for example: (87) (g) *mɛ̃sa* "tiger" and (87) (h) *mɛ̃si* "deer". Similarly, in (88) (a-c) the [nasal] feature is blocked by [-voice] affricate /tʃ/ from spreading further and in (89) (a-c) the harmonic spreading of the [nasal] feature is blocked by the

[75] Ablative marker
[76] Spatial marker

intervening [+voice] affricate /dz/. Examples (87-89), show that fricative and affricates in Deori block nasal spreading and are opaque to nasal harmony.

Obstruent stops /p,t,k,d, g/ are opaque to nasal harmony in Deori as it blocks nasal spreading. As can be seen in the following examples the [±voice] obstruent stops block the nasal spreading from spreading across the [-voice] obstruent segments as shown in examples (90-92) and [+voice] obstruent segments as shown in examples (93-94) below.

(90) [-voice] obstruent stop /p/

a. nĩj̃ã.pɑ.ɹi	→	nijãpɑɹi	'cook.CAU.PROG'	→	'made to cook'
b. ɦidzɛ̃.pɑ.ɹi	→	ɦidzɛ̃pɑɹi	'see. CAU.PROG'	→	'made to see'
c. nɔ̃.pɑ.ɹi	→	nɔ̃pɑɹi	'do.CAU.PROG'	→	'made to do'

(91) [-voice] obstruent stop /t/

a. pɛ̃.jɑ.ti	→	pɛ̃j̃ãti	'sell.NEG.not yet'	→	'not yet sold'
b. nĩ.jɑ.ti	→	nĩj̃ãti	'drink.NEG.not yet'	→	'not yet drunk'
c. mũ.jɑ.ti	→	mũj̃ãti	'ripe.NEG.not yet'	→	'not yet ripe'
d. dzũ.jɑ.ti	→	dzũj̃ãti	'write.NEG.not yet'	→	'not yet written'

(92) [-voice] obstruent stop /k/

a. ɦidzɛ̃.ku.n	→	ɦidzɛ̃kun	'see.FUT[77].IMP'	→	'will see'
b. nijã.ku.n	→	nijãkun	'cook.FUT.IMP'	→	'will cook'
c. pũ.ku.n	→	pũkun	'put on.FUT.IMP'	→	'will put on'
d. tʃɔ̃.ku.n	→	tʃɔ̃kun	'collect. FUT.IMP'	→	'will collect'

(93) [+voice] obstruent stop /d/

a. pũ.nɛ̃.du	→	pũnɛ̃du	'put on.IMP.APPL[78]'	→	'put clothes on somebody'
b. tʃɔ̃.nɛ̃.du	→	tʃɔ̃nɛ̃du	'collect.IMP.APPL'	→	'collect from somebody'
c. tũ.nɛ̃.du	→	tũnɛ̃du	'throw.IMP.APPL'	→	'throw at somebody'

(94) [+voice] obstruent stop /g/

a. ɦidzɛ̃.gɛ	→	ɦidzɛ̃gɛ	'see.NEG'	→	'could not see'
b. nĩj̃ã.gɛ	→	nĩj̃ãgɛ	'cook.NEG'	→	'could not cook'
c. nĩ.gɛ	→	nĩgɛ	'drink.NEG'	→	'could not drink'
d. tʃɔ̃.gɛ	→	tʃɔ̃gɛ	'collect.NEG'	→	'could not collect'

In (90)(a-c), spreading of the feature [nasal] is blocked by [-voice] bilabial stop /p/, in (91)(a-d) the nasal spreading is blocked by [-voice] alveolar stop /t/ and in (92)(a-d) the nasal spreading is blocked by [-voice] velar stop /k/. Similarly, in (93)(a-c) spreading of the [nasal] feature is blocked by an intervening [+voice] alveolar stop /d/ and in (94)(a-d) spreading of the [nasal]

[77] Future marker
[78] Applicative marker

feature is blocked by the intervening [+voice] velar stop /ɡ/. The examples (87-94) show the role of fricative, affricates, and stops as opaque segments in Deori. From these examples, it is evident that the feature [nasal] is stopped from spreading further by the intervening [±voice] obstruents /p, t, k, d, ɡ/, [-voice] fricative /s/, [±voice] affricate /tʃ/ and /dz/. It further shows that nasal harmony in Deori is a strictly rightward process.

The discussion so far shows that in Deori vowels, laryngeals, liquid, and glides are target segments and fricative, affricates, and obstruent stops are opaque segments. Directionality in Deori is progressive which spreads from left-to-right. The target and the opaque segment in Deori agree with the implicational hierarchy in (74). However, there are a few exceptional occurrences in Deori that show deviation from the cross-linguistic nasal harmony typology. The exceptional occurrences in Deori are: (a) [+continuant] liquid [ɹ] changes to sonorant stop /n/ when preceded by a nasal vowel in the derived domain, unlike underived domain, and (b) [+voice] obstruent stop /b/ undergoes nasal harmony in the derived domain and changes to /m/ when preceded by a nasal vowel. While [+voice] alveolar and velar stops /d/ and /ɡ/ block nasal harmony in Deori, [+voice] bilabial stop /b/ undergoes nasalization in derived domain and changes to /m/. In the underived domain, [+voice] obstruent stop /b/ blocking nasal spreading is rarely attested in Deori (the only example found is: *mɛ̃ba* → "fat"). Liquid [ɹ] is a target segment both in the derived and the underived domain, but in derived domain liquid [ɹ] changes to /n/, unlike underived domain. The instances of alternating suffix /b/ → /m/ and [ɹ] → /n/ when preceded by a nasal vowel are discussed more elaborately in the next section.

6.3.2.1 Oral-nasal suffixal alternation

Nasal harmony in Deori exhibits the presence of alternating suffix, depending on the preceding vowel they are attached to. The alternating suffix in Deori is referred to as an *allophonic variation* by Jacquesson (2005). However, our analysis of the data shows that the alternating suffixal consonant /b/ → /m/, [ɹ] → /n/ preceding a nasal vowel is an instance of *nasal coalescence*. The nasal vowel has a dominant influence on the following suffix which results in an alternation of the suffixal consonants /b/ → /m/ and [ɹ] →/n/. We will first discuss the examples of alternation of obstruent stop /b/ to nasal sonorant stop /m/ in (95) which will be followed by a discussion on the alternation of liquid [ɹ] to nasal sonorant stop /n/ in (96).

(95) Oral and nasal realization

(i) after oral vowels

/b/

a.	ʧɑ.bɑ	→	ʧɑbɑ	'bad.VN'
b.	kɔ.bɑ	→	kɔbɑ	'come.VN'
c.	ɦɑ.bɑ	→	ɦɑbɑ	'eat.VN'
d.	bɔ.bɑ	→	bɔbɑ	'beat.VN'
e.	ɦɑ.bɛm[79]	→	ɦɑbɛm	'eat+PST TRANS'
f.	bɔ.bɛm	→	bɔbɛm	'beat+PST TRANS'
g.	lɛ.bɛm	→	lɛbɛm	'give+PST TRANS'
h.	li.bɛm	→	libɛm	'cut+PST TRANS'

(ii) after nasal vowels

/m/

a.	bɔ̃.ba	→	bɔ̃mɑ̃	'somewhere.VN'
b.	kɑ̃.ba	→	kɑ̃mɑ̃	'hot.VN's
c.	ɦɔ̃j̃ɑ̃.ba	→	ɦɔ̃j̃ɑ̃mɑ̃	'truth.VN'
d.	ɦidzɛ̃.ba	→	ɦidzɛ̃mɑ̃	'see.VN'
e.	nĩj̃ɑ̃.bɛm	→	nĩj̃ɑ̃mɛ̃m	'cook+PST TRANS'
f.	ɦidzɛ̃.bɛm	→	ɦidzɛ̃mɛ̃m	'see+PST TRANS'
g.	dzũ.bɛm	→	dzũmɛ̃m	'pierce+PST TRANS'
h.	nɔ̃.bɛm	→	nɔ̃mɛ̃m	'need+PST TRANS'

In the examples above, it is evident that the verbal-noun suffix *-ba* and *-bɛm* are realized as *ba* and *bɛm* after oral roots (95) (i) and changes to *mɑ̃* and *mɛ̃m* after nasal roots (95) (ii). Cole and Kisseberth state that "an obstruent in a nasal domain can realize the feature [nasal] in two ways: by combining [nasal, obstruent] and surfacing as a prenasalized stop or by losing the obstruent feature and surfacing as a full nasal stop" (1994, p. 4). Deori exhibits the latter in which an obstruent stop loses its obstruent feature in the suffixal position and surfaces as a nasal stop in a nasal harmony domain. However, in Deori, while voiced obstruent /b/ loses its obstruent feature in the nasal domain and changes to nasal stop /m/, voiced stops /d/ and /g/ surface as opaque segments.

Identical to the coalescence of /b/ with /m/, coalescence of [+sonorant] liquid [ɹ] with [+sonorant] nasal stop /m/ in a derived domain is evident in the following examples:

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[79] As mentioned in Chapter 5 (section 5.3.4.1) *bɛm* and *ɹɔm* are past tense marker which gets attached to transitive and intransitive verb respectively. *mɛm* and *nɔm* are the nasal variant of *bɛm* and *ɹɔm* which gets attached to roots with final nasal vowel.

(96) Oral and nasal realization

(i) after oral vowel

[ɹ]

a. ʧuʧɑ.ɹɛ	→	ʧuʧɑɹɛ	'good health.FOC'
b. sɑbɑ.ɹɛ	→	sɑbɑɹɛ	'illness.FOC'
c. sigɑ.ɹɛ	→	sigɑɹɛ	'morning.FOC'
d. ɦɑ.ɹɛ	→	ɦɑɹɛ	'eat.FOC'
e. ku.ɹɔm	→	kuɹɔm	'fall.PST INTR[80]'
f. sɑ.ɹɔm	→	sɑɹɔm	'to become PST INTR'
g. tʃi.ɹɔm	→	tʃiɹɔm	'dead PST INTR'
h. jɔ.ɹi	→	joɹi	'cut.PROG[81]'
i. kɔ.ɹi	→	koɹi	'go.PROG'

(ii) after nasal vowel

/n/

a. ʧĩʝɑ̃.ɹɛ	→	ʧĩʝɑ̃nɛ̃	'fish.FOC'
b. nĩʝɑ̃.ɹɛ	→	nĩʝɑ̃nɛ̃	'cook.FOC'
c. ʧɔʧɛ̃.ɹɛ	→	ʧɔʧɛ̃nɛ̃	'shame.FOC'
d. ɦidzɛ̃.ɹɛ	→	ɦidzɛ̃nɛ̃	'see.FOC'
e. nĩʝɑ̃.ɹɔm	→	nĩʝɑ̃nɔ̃m	'cook.PST INTR'
f. pũ.ɹɔm	→	pũnɔ̃m	'put on. PST INTR'
g. pɔ̃.ɹɔm	→	pɔ̃nɔ̃m	'excees. PST INTR'
h. ɦidzɛ̃.ɹi	→	ɦidzɛ̃nĩ	'see.PROG'
i. nĩʝɑ̃.ɹi	→	nĩʝɑ̃nĩ	'cook.PROG'

In (96-i) (a-i) suffixes *-ɹɛ*, *-ɹi*, and *-ɹɔm* remain oral following an oral root and in (96-ii) (a-i) suffixes *-ɹɛ*, *-ɹi*, and *-ɹɔm* change to *-nɛ̃*, *-nĩ*, and *-nɔ̃m* respectively when preceded by a nasal vowel. It is shown in section 6.3.1, example (76) (a-b) and (77 a), that liquid [ɹ] is a target segment in underived words as well; however, in underived domain liquid [ɹ] does not change to a sonorant stop /n/, unlike derived domain. In derived domain, [-continuant +sonorant] [ɹ] changes to [+continuant +sonorant] /n/ when preceded by a nasal vowel. However, when an opaque segment intervenes between a nasal vowel and liquid [ɹ] the coalescence of liquid [ɹ] with nasal stop /n/ is impeded as shown in (97) (a-c) below.

80 Intransitive verb

81 Progressive marker

(97) Spreading of nasalization is stopped by an intervening opaque segment /dz/

a. ɦidzɛ̃.dzi.ɹi	→	ɦidzɛ̃dziɹi	'see.SPA[82].PRES PROG'
b. gĩjũ.dzi.ɹi	→	gĩjũdziɹi	'swim.SPA.PRES PROG'
c. tʃɔ̃.dzi.ɹi	→	tʃɔ̃dziɹi	'collect.SPA.PRES PROG'

In the examples above, the root final nasal vowel fails to trigger nasalization on the following suffix as it is prevented by [+voice] affricate /dz/ which is opaque to nasal harmony in Deori. Similarly, in (98) (a-c), spreading of the feature [nasal] is blocked by an intervening causative suffix *-pa* as [-voice] obstruent stop /p/ is opaque to nasal harmony in Deori, and hence the alternation of the progressive marker [ɹi] → /ni/ is hindered.

(98) Spreading of nasalization is stopped by an intervening opaque segment /p/

a. nijɑ̃.pɑ.ɹi	→	nijɑ̃pɑɹi	'cook.CAU.PROG'	→	'made to cook'
b. ɦidzɛ̃.pɑ.ɹi	→	ɦidzɛ̃pɑɹi	'see. CAU.PROG'	→	'made to see'
c. nɔ̃.pɑ.ɹi	→	nɔ̃pɑɹi	'do.CAU.PROG'	→	'made to do'

From the discussion so far it is evident that Deori has a set of alternating suffixes as in (99), a set of coalescence suffixes as in (100) and a set of non-alternating oral suffixes as in (101). The list of alternating, coalescence, and the non-alternating suffixes is presented below.

(99) Alternating suffix

	Oral	Nasal	
a.	ɦɔ	ɦ̃ɔ̃	'Locative suffix'
b.	wɑ	w̃ɑ̃	'Thematic marker'
c.	jɔ	jɔ̃	'Possessive marker'

(100) Nasal coalescence

	Oral	Nasal	
a.	bɑ	mɑ	'Verbal noun'
b.	bɛm	mɛm	'Past tense' (with a transitive verb)
c.	ɹɔm	nɔm	'Past tense' (with an intransitive verb)
d.	ɹɛ	nɛ	'Focus marker'
e.	ɹi	ni	'Progressive marker'

(101) Non-alternating suffix

a.	pɑ	'Causative marker'
b.	ti	'Negative'

[82] Spatial marker

c. ku 'Future perfect'
d. du 'Applicative marker'
e. gɛ 'Negation (incomplete action)'
f. si 'Selective marker'
g. tʃɑlɛ 'Ablative marker'
h. dzi 'Spatial marker'

While the alternating suffixes in (99) change their feature specification from [-nasal] to [+nasal] in nasal harmony domain, the coalescence suffixes in (100) change their feature specification from [+voice -sonorant -nasal] /b/ to [+voice +sonorant +nasal] /m/ and [+voice +sonorant -nasal] [ɹ] to [+voice +sonorant +nasal] /n/ in nasal domain. The non-alternating suffixes in (101) surface as oral irrespective of the root morpheme they are attached to. When a nasal root is followed by a non-alternating suffix and then an alternating suffix the alternating suffix surfaces as oral following the non-alternating suffix. This suggests that non-alternating suffixes are opaque to nasal harmony and blocks the extension of nasal harmony from propagating further.

Although morpheme alternation is attested in languages such as Southern Barasano, Guaraní, and Tuyuca cross-linguistically (discussed in § 6.2.1), morpheme alternation in Deori is different. The similarity in suffixal alternation in languages such as Southern Barasano, Guaraní, and Tuyuca is that there is a clear distinction between voiced and voiceless obstruents, and all the voiced obstruent stops undergo nasalization and are realized as nasal sonorant stop, unlike Deori. In Deori, while voiceless obstruent stops /p,t,k/, [+voiced] alveolar and velar stops /d/ and /g/ are opaque to nasal harmony, [+voice] obstruent stop /b/ undergoes nasalization in derived domain and changes to /m/. This unusual pattern of suffixal alternation in Deori does not conform to the implicational hierarchy shown in (74). To account the compatibility difference between voiced and voiceless segments cross-linguistically, Walker (1998) posits that although the implicational hierarchy shown in (74) is a "good predictor of the likelihood of segments undergoing nasalization, there are some other factors that contribute to the pattern of nasalization" (p. 63). She further posits that the clear distinction of nasalization spreading through [+voice] segments and not through [-voice] segments lead to the cross-linguistic variability in the ranking of [±voice] fricatives and [±voice] stops. It has been well attested in the literature that voiced fricatives are more compatible with nasalization and voiceless stops are less compatible with nasalization based on the continuancy and voicing. Thus, the segregation of the obstruent class of segments according to their continuancy and voicing as in (102) accounts the nasal harmony pattern in languages such as Southern Barasano and Tuyuca where voiced segments undergo nasalization and voiceless segments surface as transparent segments.

(102) voiced fricatives > voiceless fricatives > voiced stops > voiceless stops (Walker, 1998)

Although the hierarchy in (102) shows the segregation between the class of obstruents according to the continuancy and voicing, Deori nasal harmony pattern does not conform to the hierarchy in (102) as well. Considering the nasal harmony pattern in Deori, if voiced obstruent is placed above [±voice] fricative than there will be an infringement of both continuancy and voicing since obstruent stop is less compatible with nasalization than fricative. Furthermore, ranking the voiced obstruent stops above the fricatives would disregard the opacity of [+voice] stops /d/ and /g/ and would consider the [+voice] stops /d/ and /g/ as target segments which is an unattested pattern in Deori. Thus, neither the five-way classification of nasal hierarchy scale shown in (74) nor the nasal hierarchy scale based on continuancy and voicing in (102) predicts the alternation of the suffixal consonants in Deori. Piggott (1992), Rice (1993), and Piggott & Van der Hulst (1997) have postulated that in languages where obstruent stops undergo nasalization and changes to nasal stops, the obstruent stops belong to the set of sonorant segments. Piggot (1992) further suggests that in languages where obstruent segments block nasal spreading they are contrastive phonemes and in languages where obstruent segments undergo nasalization and change to nasal consonant there is no phonemic contrast between the voiced stops and the nasal stops. However, Deori does not comply to these claims as well. In Deori, obstruent stop /b/ and nasal stop /m/ are contrastive phonemes, yet [+voice] obstruent stop /b/ allows spreading through it and changes to nasal consonant /m/ when preceded by a nasal vowel in the derived domain.

Moreover, in Deori, liquid [ɹ] is a target segment both in the derived and underived domain which conforms to the implicational hierarchy in (74), however, there is an exceptional occurrence of liquid [ɹ] as a nasal sonorant /n/ in the derived domain, unlike underived domain. A similar pattern of /r/ → /n/ alternation is evident in Southern Barasano. The difference between Southern Barasano and Deori is that while in Southern Barasano, the alternation of /r/ → /n/ is across derived and underived words, in Deori the alternation of [ɹ] → /n/ is attested only in the derived domain. In underived domain liquid [ɹ] undergoes nasalization and changes to nasalized liquid [ɹ̃]. Hence, implicational hierarchy in (74) which predicts the compatibility of liquid [ɹ] with nasalization in Deori, it does not predict the exceptional occurrence of [ɹ] →/n/ in the language. Liquid /l/ is also a target segment in Deori but it does not change to any nasal stop, unlike liquid [ɹ]. Further, [+voice] obstruent stop /b/ and liquid [ɹ] belong to two different place features. While obstruent stop /b/ is bilabial, liquid [ɹ] is alveolar which further refutes any featural similarity to substantiate its coalescence with nasal stops in Deori. Hence, at this point, we do not have any proper explanation that could justify the exclusive alternation of /b/ → /m/ and [ɹ] → /n/ in Deori. It can be conjectured that the exceptional occurrence of alternative suffix in Deori highlights a pattern which cannot be analyzed following the unified typology of nasal harmony.

6.3.3 Summary of nasal harmony pattern in Deori

Deori exhibits nasal vowel-consonant harmony where vowels and nasal consonants are triggering segments. All compatible segments with nasalization such as glides, laryngeals, liquids, approximants are target segments, and less compatible segments such as fricatives, affricates, and obstruent stops are opaque to nasal harmony in Deori. Segments are either target or opaque in Deori. Transparent segments are unattested in Deori. Nasal harmony in Deori is progressive which spreads left-to-right to the adjacent sonorant segment. Nasalization in Deori spreads from root to suffix and is not restricted within the root boundary. Deori exhibits suffixal alternation (/b/ → /m/ and [ɹ] → /n/) which shows a deviation from the cross-linguistic nasal harmony pattern. From the discussion so far it is evident that while the target and the opaque segment in Deori agree with the implicational hierarchy in (74) and (75), the suffixal alternations (/b/ → /m/ and [ɹ] → /n/) in the derived domain do not agree with the implicational hierarchy nor to the hierarchy based on voicing and continuancy as shown in (102). Further, suffixal alternations in Deori cannot be straightforwardly captured within the constraint-based framework of Optimality Theory, to which we turn next.

6.4 Nasal harmony in Deori: an OT account

An introduction to OT is illustrated in chapter 5 (section 5.4), so it will not be repeated here to avoid redundancy. Walker (1998) is the first analysis of nasal harmony within a constraint-based theoretical framework, which presents a cross-linguistic variation of nasal harmony. Walker has shown that "ranking of the constraint driving nasal spreading at all of the possible points in relation to the nasalization hierarchy achieves precisely the cross-linguistic variation which is attested. Importantly, the unified typology is obtained by positing all of the nasalization constraints as violable” (1998, p.3). Walker (1998) has formulated a unified typology of featural markedness constraints which captures nasal harmony pattern cross-linguistically and has ruled out faithfulness constraints. The markedness constraints, as discussed below, account for both blocking and transparency of nasal harmony cross-linguistically. The ranking of the segments is such that less compatible a segment higher ranked is its constraint.

(103) *NasObsStop » *NasFric » *NasLiQ » *NasGlide » *NasV

Walker (1998) discusses the markedness constraints in (103) formally in terms of feature specifications as follows:

(104) *NasObsStop: *[+nasal, -continuant, -sonorant] » *NasFricative: *[+nasal, +continuant, -sonorant] » *NasLiquid: *[+nasal, +approximant, +consonantal] » *NasGlide: *[+nasal +glide –consonantal] » *NasV: *[+nasal +approximant -consonantal].

Thus, for instance, *NasObsStop refers to the constraint prohibiting the combination of features: [+nasal, -continuant, -sonorant]. Affricates are opaque in Deori. The opacity of affricates can be achieved by a nasal markedness constraint *NasAffricate which will prohibit the occurrence of nasalized affricates. *NasAffricate is not included in the nasalized hierarchy ranking in (103). Since affricate is described as a stop-fricative sequence which begins as a plosive by stopping the air from leaving the vocal tract and releases it through a constricted glottis like a fricative, we assume that the nasal markedness constraint *NasAffricate can be ranked below the higher-ranked constraint *NasObsStop » *NasFricative. While nasalized markedness constraints in (103) determine the target and the opaque segment in a language, spreading constraint determines the direction of nasal spreading in a language. Hence, Walker (1998) states that the nasal markedness and the spreading constraint together characterizes the basic typology of nasal harmony. The spreading constraint formulated by Walker (1998) captures the spreading of the [+nasal] feature within the domain of the morpheme as discussed below:

(105) Spread([+nasal],M) (Walker, 1998)

Let n be a variable ranging over occurrences of the feature specification [+nasal], and S consists of the ordered set of segments $s_1 \ldots s_k$ in a morpheme M. Let Assoc(n, s_i) mean that n is associated to s_i, where $s_i \in S$.

While the spreading constraint SPREAD([+nasal], M) suggests that the spreading of the [+nasal] feature on a segment in a morpheme be linked to all segments in that morpheme, it explicitly says nothing on the direction of spreading. The SPREAD([+nasal], M) constraint is suitable for languages exhibiting bidirectional spreading such as Tuyuca as reported in Walker (1998), however, it does not capture the spreading of [+nasal] feature in languages where spreading is unidirectional. Henceforth, Walker formulates spreading constraint which specifically encodes different direction of nasality either rightwards or leftwards. The spreading constraint which accounts for progressive nasal harmony is Spread-R([+nasal], Pwd) and regressive nasal harmony is Spread-L([+nasal], Pwd). Since Deori exhibits progressive nasal harmony, the spreading constraint Spread-R([+nasal], Pwd) will be active in achieving nasal harmony in Deori. The Spread-R([+nasal], Pwd) as formulated by Walker (1998) is discussed below:

(106) SPREAD-R([+nasal],Pwd) (Walker, 1998)

Let n be a variable ranging over occurrences of the feature specification [+nasal], and S consist of the sequence of segments $s_1 \ldots s_k$ in the prosodic word P. Let Assoc(n, s_i) mean that n is associated to s_i, where si$\in$S.

The spreading constraint in (106) suggests that the feature occurrence linked to a segment s_i will be linked to any segment s_j which occurs after s_i and in this case s_j should be higher than s_i. While the ranking of the markedness constraints in (103) is fixed cross-linguistically, the constraint commanding nasal harmony is language-dependent. The ranking of the nasalized markedness constraints is intrinsically done with respect to each other. While satisfying the spreading constraint will lead to the violation of the markedness constraints, optimizing the markedness constraints will violate the spreading constraint and will result in avoiding forming nasalized segments. Hence, in a language like Spanish which displays no nasal harmony, the spreading constraint SPREAD[+nasal] will be ranked lower than the nasalized markedness constraints and in Tuyuca where all segments including the obstruent stop undergo nasalization the spreading constraint SPREAD[+nasal] will outrank the nasalized markedness constraints as illustrated in (107) below:

(107) Hierarchical variation through constraint ranking (Walker, 1998)

a. *Spanish*

*NASOBSSTOP » *NASFRICATIVE »*NASLIQUID » *NASGLIDE » *NASVOWEL » SPREAD[+nasal]

b. *Tuyuca*

SPREAD[+nasal] » *NASOBSSTOP » *NASFRICATIVE »*NASLIQUID » *NASGLIDE » *NASVOWEL

A constraint accounting cross morpheme spreading is necessary to account for the spreading of the [nasal] feature across morpheme. Walker (1998) proposes that cross-morpheme spreading is driven by the word-spreading constraint as discussed below:

(108) SPREAD([+nasal], W)

Let n be a variable ranging over occurrences of the feature specification [+nasal], and S consist of the ordered set of segments $s_l \dots s_k$ in a word W. Let Assoc(n, s_i) mean that n is associated to s_i, where si$\in$S.

Walker states that the word-spreading constraint analyzes spreading across morphemes "as demand on spreading any occurrence of a [+nasal] feature to all segments within the word" (1998, p. 118). With this background on the markedness and the spreading constraints that account for the nasal harmony pattern cross-linguistically, we now proceed to discuss the interaction of these constraints to account for the nasal harmony pattern in Deori. Additionally, it will be shown that the cross-linguistic markedness constraints cannot account for the suffixal alternation in Deori.

6.4.1 Target segments in Deori - vowels, glides, liquid, and glottal fricative.

In Deori, vowels, glides, liquid, and glottal fricative are target segments that undergo nasalization. Hence, to account for the target segment the spreading constraint SPREAD-R([+nasal], Pwd) will outrank the nasal markedness constraints *NASLIQ » *NASGLIDE » *NASV in Deori. The tableau in (109) shows the ranking of the higher-ranked spreading constraint SPREAD-R([+nasal], Pwd), which nasalizes the adjacent sonorant segments.

(109) Vowels are target segments in Deori

I: /tʃimĩ/	SPREAD-R([+nasal],Pwd)	*NASV
a. tʃimi	*!	
b. ☞tʃimĩ		*

The tableau in (109) shows that vowels are progressively nasalized in Deori. The spreading constraint SPREAD-R([+nasal], Pwd) only allows the spreading of the [nasal] feature to affect the vowel in the right of the triggering nasal sonorant stop and not otherwise. The tableau selects candidate (b) as the optimal candidate as it satisfies the higher-ranked spreading constraint SPREAD-R([+nasal], Pwd).

The tableau in (110) shows that glides are target segments in Deori. The higher ranked spreading constraint SPREAD-R([+nasal], Pwd) allows the spreading of nasalization to the adjacent sonorant segment, which nasalizes glide /j/. The spreading of the [nasal] feature across morpheme is achieved by the SPREAD([+nasal], W), which is ranked lower than the SPREAD-R([+nasal], Pwd) constraint.

(110) Glides are target segment in Deori

I: /pɛ̃/+/jɑ/+/ti/	SPREAD-R([+nasal],Pwd)	SPREAD ([+nasal],W)	*NASGLIDE
a. pɛ̃jɑti	****!	****!	
b. ☞ pɛ̃j̃ɑ̃ti			*

The tableau in (110) selects candidate (b) over (a) as the optimal candidate and this selection is done by the higher-ranked spreading constraint SPREAD-R([+nasal], Pwd).

The tableau in (111) below shows that liquid [ɹ] is a target segment in Deori. Liquid [ɹ] is a target segment both in the derived and underived domain, however, in the derived domain, it undergoes nasalization and changes to /n/, unlike underived domain. The following tableau shows how the spreading constraint SPREAD-R([+nasal], Pwd) allows the [nasal] feature to spread to the adjacent liquid [ɹ] which results in nasalized liquid [ɹ̃].

(111) Liquid [ɹ] is a target segment in Deori

I: /gɑ̃ɹɔ/	SPREAD-R([+nasal],Pwd)	*NASLIQ
a. gɑ̃ɹɔ	**!	
b. ☞gɑ̃ɹ̃ɔ̃		*

The tableau in (111) selects candidate (b) as the optimal candidate as it satisfies the higher-ranked spreading constraint SPREAD-R([+nasal], Pwd). Candidate (a) fatally violates the higher-ranked spreading constraint SPREAD-R([+nasal], Pwd) thereby losing to the candidate (b).

The target segment in Deori is taken care of by ranking spreading constraint SPREAD-R([+nasal], Pwd) over the markedness constraints *NASLIQ » *NASGLIDE »*NASV. The higher ranked spreading constraint SPREAD-R([+nasal], Pwd) enforces the occurrence of nasalized liquid, nasalized glides, and nasalized vowels in Deori. Similar to the target segment, the markedness, and the spreading constraint can capture opacity in Deori which is discussed in the following section.

6.4.2 Opaque segments in Deori - obstruent stops, fricative, and affricates

Cross-linguistically, to account for the target segment spreading constraint is ranked higher than the markedness constraints, and to account for the opaque segment the spreading constraint is ranked lower than the markedness constraints. Similarly, in Deori the markedness constraints are ranked higher than the spreading constraint to account for the opacity of segments. Voiced obstruents /d/ and /ɡ/, voiceless obstruents /p,t,k/, voiceless fricative /s/ and [±voice] affricates /tʃ/ and /dz/ are opaque to nasal harmony in Deori. However, voiced obstruent stop /b/ in a suffix undergoes nasalization and changes to a sonorant stop /m/. The interaction of the constraints to capture the opacity of the obstruent segment is shown in the following tableaus. The spreading of the [nasal] feature across morpheme is achieved by the SPREAD([+nasal], W), which is ranked lower than the SPREAD-R([+nasal], Pwd) constraint. The higher ranked markedness constraint *NASOBSSTOP over SPREAD-R([+nasal], Pwd) accounts for the opacity of obstruent stops as shown in tableau (112) below.

(112) Opacity of voiceless obstruent stop

I: /nɔ̃/+/pɑ/+/ɹi /	*NASOBSSTOP	SPREAD-R([+nasal],Pwd)	SPREAD ([+nasal],W)
a. ☞nɔ̃pɑɹi		****!	****
b. nɔ̃p̃ɑ̃ɹ̃ĩ	*!		

In tableau (112), candidate (b) fatally violates the higher-ranked constraint *NASOBSSTOP and loses to candidate (a). The winning candidate (a) shows that the harmonic feature is blocked from spreading further by an intervening [-voice] obstruent stop /p/, which is opaque to nasal harmony. The opacity of [+voice] obstruent stop is illustrated in tableau (113) below.

(113) Ruling out nasalized /d̃/

I: /pũ/+/nɛ̃/+/du/	*NASOBSSTOP	SPREAD-R([+nasal],Pwd)	SPREAD ([+nasal],W)
a. ☞pũnɛ̃du		**!	**
b. pũnɛ̃d̃ũ	*!		

In tableau (113), the high ranked nasal markedness constraint * NASOBSSTOP chooses (a) as the optimal candidate over (b). Tableau (112) and (113) show that voiceless and voiced obstruents are opaque to nasal harmony in Deori.

Similarly, fricative /s/ and affricates /tʃ/ and /dz/ are opaque segments in Deori. To account for the opacity of fricative and affricates, the nasal markedness constraint *NASFRIC and *NASAFFRICATE will outrank the spreading constraint SPREAD-R([+nasal], Pwd), which will prohibit the occurrence of nasalized fricatives and nasalized affricates respectively. Tableaus in (114) and (115) illustrate how the nasal markedness constraints *NASFRIC and *NasAFFRICATE and spreading constraint SPREAD-R([+nasal], Pwd) operate to ban nasalized fricatives and nasalized affricates respectively in Deori.

(114) Ruling out nasalized fricatives

Input: /jɛ̃/+/si/	*NASFRIC	SPREAD-R([+nasal],Pwd)	SPREAD ([+nasal],W)
a. ☞jɛ̃si		**!	**
b. jɛ̃s̃ĩ	*!		

In tableau (114), candidate (b) fatally violates the higher-ranked nasal markedness constraint *NASFRIC thus losing to the optimal candidate (a). The lower-ranked constraint SPREAD-R ([+nasal], PWD) and SPREAD ([+nasal], W) is equally violated by the winning candidate (a) as the higher-ranked constraint *NASFRIC prohibits the harmonic spreading of the [nasal] feature to the adjacent segment thereby prohibiting the occurrence of nasalized fricative in Deori. Tableau (115) shows the opacity of affricates in Deori.

(115) Ruling out nasalized affricates

I: /tʃɔ/+/dzi/+/ɹi/	*NASAFFRICATE	SPREAD-R([+nasal], Pwd)	SPREAD ([+nasal],W)
a. ☞tʃɔ̃dziɹi		**!	**
b. tʃɔ̃dz̃ĩɹi	*!	*	*
c. tʃɔ̃dz̃ĩɹ̃ĩ	*!		

The tableau in (115) selects (a) as the optimal candidate as it satisfies the higher-ranked constraint *NASAFFRIC. *NASAFFRIC constraint outranking the spreading constraint bans the occurrence of nasalized affricates in Deori. Hence, in Deori [±voice] affricates are opaque to nasal harmony. The opaque segment in Deori is taken care of by the ranking *NASOBSSTOP » *NASFRIC » *NASAFFRICATE » SPREAD-R([+nasal],Pwd). In the next section, it will be shown that the markedness constraints that accounted for the target and the opaque segments in Deori cannot capture the suffixal alternation of /b/ → /m/ and [ɹ] → /n/ in Deori.

6.4.3 Exceptional occurrences of /b/ → /m/ and [ɹ] → /n/

The markedness constraints are not sufficed to account for the suffixal alternations of /b/ → /m/ and [ɹ] → /n/ in Deori. The higher ranked markedness constraint *NASOBSSTOP halts nasalization to spread to obstruent stops as can be seen in tableau (112) and (113) and is not sufficient to generate the required output /b/ → /m/ in the derived domain. Further, if the higher ranked markedness constraint *NASOBSSTOP is ranked lower than the spreading constraint SPREAD-R([+nasal], Pwd), then the optimal output will be **bɔ̃b̃ã* instead of *bɔ̃mã* which is an unattested form in Deori. In either case, the alternation of /b/ → /m/ is not captured by the markedness constraints. To achieve the suffixal alternation of /b/ → /m/ an additional constraint is necessary which will capture only the alternation of /b/ → /m/ and not /d/ → /n/ or /g/ → /ŋ/ in Deori in the derived domain. The same problem arises in the suffixal alternation of [ɹ] → /n/. Liquid [ɹ] is a target segment both in the derived and the underived domain. To account for the nasalized liquid [ɹ̃] in the underived domain, the spreading constraint SPREAD-R([+nasal], Pwd) is ranked higher than the markedness constraint *NASLIQ as can be seen in tableau (111). However, the same ranking of constraints would generate nasalized liquid [ɹ̃] in the derived domain instead of [ɹ] → /n/ which is an unattested form in Deori. Thus, to account for the exceptional occurrences of /b/→/m/ and [ɹ] → /n/ an additional ad-hoc constraint will be needed specifying that only a labial stop /b/ and an alveolar approximant [ɹ] undergoes nasalization and changes its feature specification in derived context, and not in underived context. There are low ranking IDENT constraints for /b/ and [ɹ] unlike the high ranking IDENT constraints for the other stops and fricatives but cross-linguistically it may not be common to select only one voiced and one approximant[83] for this alternation and only in the derived context. The markedness constraints as shown in (103) as formulated by Walker (1998) do not provide any clue in this regard. At this point, we may see alternating suffixes in Deori as either exceptional occurrences or as indications that other processes may have interfered. In either case, we believe that these occurrences certainly need further investigation.

6.5 Conclusion

In this chapter, a detailed analysis of the nasal harmony pattern in Deori has been discussed. Deori exhibits progressive nasal harmony which spreads from a nasal vowel and a nasal consonant to adjacent sonorant segments. The span of nasalization continues until blocked by an intervening opaque segment. Vowels to the right of a nasal sonorant stop or a nasal vowel are always nasalized whereas vowels occurring to the left of a sonorant segment are not nasalized in Deori. It suggests that nasalization in Deori spreads only from the left-to-right direction. Vowels, glides, and liquids are target segments in Deori that agree with the implicational hierarchy scale shown in (74). Glottal fricative too is grouped with vocoids which agrees with the implicational hierarchy scale shown in (75). Nasalization in Deori is strictly local as skipping of segments does not occur in Deori and all non-participating segments are blockers. Voiceless obstruent stops /p,t,k/, voiced obstruent stops /d/ and /g/, fricative /s/, and affricates /tʃ/ and /dz/ are opaque segments in Deori. However, voiced obstruent /b/ is a target segment as it undergoes nasalization and changes to /m/ in the derived domain. Further, liquid [ɹ] alternates to /n/ in the derived domain, unlike the underived domain. Deori conforms to the general pattern of target segments following the implicational hierarchy in (74) but does not satisfy the unified typology of nasal harmony in terms of suffixal alternations of /b/→/m/, [ɹ]→/n/. In terms of suffixal alternations, Deori neither conforms to the implicational hierarchy shown in (74) nor the segregation of obstruents according to their voicing and continuancy as shown in (102). Although morpheme

[83] In Deori, approximant /l/ undergoes nasalization and changes to nasalized /l̃/ but does not change to any nasal stop, unlike approximant [ɹ].

alternation has been reported in languages such as Southern Barasano, Tuyuca, and Guaraní; Deori is different from these languages. In these languages (Southern Barasano, Tuyuca, and Guaraní), all voiced segments have their nasal variants, unlike Deori. In the span of nasal harmony, the voiced obstruent segments, in the aforementioned languages, undergo nasalization and surface as nasal stops, and the voiced oral sonorant segments surface as nasal sonorant segments, irrespective of the derived and the underived context. Unlike these languages, we observed a different process in Deori – in case of suffixal alternations only /b/ and [ɹ] changes to /m/ and /n/ in the derived domain and not other segments.

The higher ranked spreading constraint SPREAD-R([+nasal], Pwd) over markedness constraints account for the target segment in Deori, and the higher-ranked markedness constraints over spreading constraint accounts for the opaque segment in Deori. However, the markedness constraints that predicts the nasal harmony pattern cross-linguistically fail to capture the exceptional suffixal alternations in Deori in the derived domain. Modification of constraints in OT in capturing borrowings from a different language is attested in the works of Tsuchida (1995) and Davidson and Noyer (1997). Tsuchida (1995) states that OT constraints must be modified to account for the phonology of English loan words in Japanese. Similarly, Davidson and Noyer (1997) state that borrowings from Spanish into the Penutian language Huave violate Huave stress rules, thus, to account for the lexical borrowings re-ranking of the constraints is necessary. Nasalization in Deori is considered as an areal feature and is adopted from languages such as Mishmi and Tani dialects of Arunachal Pradesh with whom Deori was in close contact with (Jacquesson, 2005). Hence, it can be assumed that exceptional occurrences of suffixal alternations in Deori are contact-induced innovation which necessitates an additional constraint to account for such occurrences.

Chapter 7 - Conclusion

7.1 Introduction

In this dissertation, a study on the phonology of Deori has been reported. The primary aim of this work was to examine the phoneme inventory of Deori, word prosodic structure and prominence pattern in Deori, tonal distinction maintained by younger generation speakers, perception of tone by younger and older generation speakers, and phonological processes such as vowel harmony and nasal harmony in Deori. This chapter summarizes the findings discussed in chapters 2-6 and the future scope in regard to this research work is also emphasized. Further, this chapter summarizes the language vitality assessment of Deori as reported in Acharyya and Mahanta (2019).

The chapter is organized as follows: Section 7.2-7.6 summarizes the findings discussed in chapter 2 to chapter 6. Section 7.7 summarizes the language vitality assessment of Deori as reported in Acharyya and Mahanta (2019). Further, section 7.8 provides closing remark and future research prospects.

7.2 Phoneme inventory of Deori

Chapter 2 examines the phoneme inventory of Deori. The findings suggest that Deori has 14 distinct consonants /p,t,k,b,d,g,m,n,s,tʃ,dz,j,l,ɦ/ and three allophones [ŋ], [ɹ], and [w]; 10 distinct vowels (5 oral /ɑ,i,ɛ,ɔ,u/ and 5 nasal vowels /ɑ̃,ĩ,ɛ̃,ɔ̃,ũ/) and two allophones [e] and [o]. The phonemes [+nasal] /n/, [+lateral] /l/, and [+stop] /p/ have three allophonic variations, [+nasal] [ŋ], [-lateral] [ɹ], and [+continuant] [w] respectively. The vowels [e] and [o] occur when followed by [+ATR +high] vowels /i/ and /u/ and not otherwise. The findings in the chapter show that Deori exhibits a wide range of free variation, of which the salient phonological variations are (a) free variation of [±spread glottis] /p/, /t/, /k/ and /p^h/, /t^h/, /k^h/ (b) free variation of [±delayed release, ±anterior] /s/ and /tʃ/, and vice-versa and (c) free variation of [±delayed release] /dz/ and /z/. The absence of glottal stop /ʔ/ and reduced centralized vowel /ə/ in the phoneme inventory of Deori and inclusion of voiced alveolar fricative /z/ as a free variant of voiced alveolar affricate /dz/ shows that language contact has gradually influenced the phoneme inventory of Deori leading to simplification of phonemes in Deori.

7.3 Prominence pattern in Deori

Chapter 3 makes an investigation on the word prosodic structure and prominence pattern in Deori. The findings show that the canonical syllable structure in Deori is (C)V(C), with an optional onset and an optional coda. Deori exhibits an iambic stress pattern with final prominence. Deori maintains a weak-strong rhythmic profile and a well-formed foot is formed by lengthening the stressed vowel which attains a mora. Stress in Deori is realized with an increase in duration but not intensity and f_0. The unstressed and the stressed vowel have durational differences but the durational difference doesn't affect the quality of the vowel in stressed and unstressed positions. The findings further show that there is no evidence of sesquisyllables in Deori in any particular way. The important findings in this chapter are the absence of sesquisyllables and manifestation of iambic stress in Deori.

7.4 Production and Perception of tone in Deori

Chapter 4 investigates the production and perception of tones in Deori. The findings of the production experiment show a trend of underlying tone reversal H>L, L>H mostly in monosyllabic words. In disyllabic words, an inconsistent f_0 pattern was observed across all words, and tone overlap was observed in words such as *nĩnĩ, baɹi, tiɹi, tʃĩʒã*. Tone overlap was also observed in the initial syllable of *akũ* and the final syllable of *udzũ*. Furthermore, the words that have significant tonal distinctions among older generation speakers have either a) undergone complete tone reversal among younger generation speakers as in *kɔ*, or b) have tonal distinctions in either of the syllable as in *udzũ* and *akũ* or c) maintain no tonal distinctions as in *tʃĩʒã, tiɹi*, *nĩnĩ*, and *baɹi*.

The perception test results show that there is a perceptual difficulty among younger generation speakers in identifying the distinct tonal categories. The perception test results correlate with the production test results which indicate that younger generation speakers have difficulty in producing and perceiving the distinctive tonal categories. While older generation speakers were able to rightly identify the tonal categories, except one speaker (SP14 had perceptual difficulty in identifying the tonal category of the stimuli *tʃi*), younger generation speakers had perceptual difficulty in identifying the tonal categories. Younger generation speakers (those who participated in the experiment) identified the high tone stimuli as the low tone stimuli and vice-versa and failed to identify the exact tonal category most of the time.

Production and the perception test results unveiled a process of tonoexodus in Deori. The gradual tonal reduction and tonal contour variations across speakers can be attributed to long term bilingual contact with Assamese, a non-tonal language. Following the findings in Mahanta *et al.* (2017), it can be assumed that the inherently prominent tonal words may become an anchor for metrical structure facilitating the transition from tone to stress in Deori.

7.5 Vowel Harmony

Chapter 5 discusses the vowel harmony process in Deori. The findings show that Deori exhibits regressive vowel harmony, similar to Assamese, which spreads from [+high +ATR] vowels /i/ and /u/ and affects only the preceding vowel. The mid vowels /ɛ/ and /ɔ/ surface as [e] and [o] in the stem phonology of Deori when followed by [+ATR] vowels /i/ and /u/, both in the root and root+suffix domain. The similarities of vowel harmony pattern in Deori and Assamese is considered to be the result of sustained contact of Deori with Assamese, and a high degree of bilingualism of the Deori speakers.

The constraints that are active in both the languages are: (a) the sequential markedness constraint *[-ATR][+ATR] which results in regressive [+ATR] harmony, (b) the feature co-occurrence constraint *[+ATR +low], and faithfulness constraint IDENT[low] prevent the alternation of the low vowel /ɑ/ and preserve the underlying quality of the low vowel respectively and (c) the sequential markedness constraint *[oNi]/[eNi] prohibits the spreading of the harmonic feature from propagating further when it immediately precedes a triggering vowel. Similar vowel harmony pattern in Deori and Assamese shows a linguistic similarity between two genetically different languages which can be attributed to geographical proximity.

7.6 Nasal Harmony

Chapter 6 discusses the nasal harmony pattern attested in Deori. Deori exhibits a progressive nasal harmony pattern that spreads from a nasal vowel and a nasal consonant to adjacent sonorant segments and the span of nasalization continues until blocked by an intervening opaque segment. Vowels to the right of a nasal sonorant stop or a nasal vowel are always nasalized whereas vowels occurring to the left of a sonorant segment are not nasalized which suggests that nasalization spreads from the left-to-right direction in Deori. Vowels, glides, and liquids are target segments in Deori which are highly compatible with nasalization. Glottal fricative /ɦ/ is also a target segment in Deori. Opaque segments in Deori are fricative /s/, affricates /tʃ/ and /dz/, voiceless obstruent stops /p,t,k/ and voiced obstruent stop /d/ and /g/. However, voiced obstruent stop /b/ surfaces as a target segment and changes to /m/ in the derived domain. Further, liquid [ɹ] changes to /n/ in the derived domain, unlike the underived domain. In the underived domain, liquid [ɹ] changes to nasalized liquid [ɹ̃].

The findings in this dissertation show that the higher-ranked spreading constraint SPREAD-R([+nasal], Pwd) over markedness constraints account for the target segment in Deori and the higher-ranked markedness constraints over spreading constraint accounts for the opaque segment in Deori. However, the higher-ranked markedness constraints that predict the nasal harmony pattern cross-linguistically fails to capture the exceptional occurrence of suffixal alternations in Deori /b/ → /m/ and [ɹ] → /n/ in the derived domain. Further, the findings show that the nasal harmony pattern in Deori does not agree with the segregation of obstruents according to their voicing and continuancy as well. Thus, to capture the suffixal alternation in Deori some additional constraints will be needed which will specify that only a labial stop /b/ and an alveolar approximant [ɹ] undergoes nasalization and changes its feature specification in derived context, and not other segments.

After this summary of the main points in each chapter, we would like to throw some light on other recent research on Deori. The particular research that we would like to talk about is specifically on the vitality issue of Deori. The main driving force of the article is to investigate if Deori will survive the onslaught of time and along with it socio-economic pressure of keeping such a small language alive. In the following section, the findings in Acharyya and Mahanta (2019) have been summarized.

7.7 Language vitality assessment of Deori

Following the nine factors of language vitality assessment outlined in UNESCO (2003 a) and the language vitality assessment questionnaire (2003 b), Acharyya and Mahanta (2019) have mentioned that intergenerational language transmission which is considered as an important factor in deciding the vitality status of a language is not completely disrupted in Deori. Children grow up learning Deori until they enter the education system. From the interaction with Deori community members, Acharyya and Mahanta (2019) have mentioned that intergenerational language transmission of Deori is not completely obstructed as the community members understand that intergenerational language transmission is the foundation to preserve the language. However, it has been also mentioned that younger generation speakers use Deori at home, but not as extensively as older generation speakers. There is a general tendency among the speakers to use more Deori with older generation speakers and more Assamese with younger generation speakers. While in the pre-school period, parents foster the essence of Deori in their children by verbally interacting in the language, in the education domain Assamese overpowers Deori. Children mostly go to Assamese medium schools, and wealthier and urban families also send children to English medium schools. Once a child enters the school premises he/she starts using the Assamese to communicate with their friends and also does not keep the two languages apart, such that both are used with relative fluency. In the religious domain, Deori is extensively used. All social ceremonies such as marriages, birth rites, and death rites are practiced traditionally following Deori customs, and religious hymns are sung in the Deori language. This shows that in the religious domain Deori is extensively used.

It has been mentioned that to protect the ethnic identity of the Deori community, some organizations were set up such as All Assam Deori Sanmilan, All Assam Deori Students' Union, Deori Sahitya Sabha, and All Assam Deori Autonomous Council.[84] The demand for converting the Deori Autonomous Council to Sixth Schedule (Article 244-A) status of the constitution by the All Assam Deori Students' Union is already underway, and in this regard, they have submitted a memorandum to the present Prime Minister of India in the year 2016.[85] The inclusion of the Deori Autonomous Council in the Sixth Schedule would provide the community with some autonomy (recognized by the Government) to maintain their socio-political rights. However, the Government has not yet acquiesced to their demand.

Further, the Deori Sahitya Sabha and the State Council of Education Research and Training (SCERT) of the Assam government have jointly published pedagogical materials and have pleaded with the State Government of Assam and the Central Government of India to introduce Deori as a compulsory subject in the school curriculum and to appoint Deori

[84]The main aim of these organizations is to provide maximum possible autonomy for the social, economic, educational, ethnic, and cultural development within the framework of the Constitution of India.

[85]Memorandum submitted to the Hon'ble Prime Minister, Government of India, Parliament House, New Delhi by All Assam students Union (AADSU), on January 19th, 2016.

teachers in schools. After prolonged debates and a series of demands, the government of Assam gave Deori the status of a “language” through the office order number A (1) E, 338/99/572 in 2005 and has included the language in the Primary School for 3rd and 4th standard students (ages 8–10 years) as a subject. However, due to the lack of teachers, it could not be fully operationalised as a subject in schools. In another development, Dibrugarh University, a state-funded university of Assam, has taken an initiative to introduce a six-month certificate course in Deori in the Centre for Language Studies, established under the university in 2010. The local intellectuals and the community members have expressed their gratitude to the university for initiating such a course. However, they believe that Deori as a compulsory subject in the school curriculum will prove more beneficial to the learners as an intervention at an early age would make them far better speakers than introducing it at a much later stage.

Acharyya and Mahanta (2019) mainly highlight that the language is vital in the local context, but it is vulnerable in its socialization spaces. Deori speakers are assimilating with the Assamese community and all Deori speakers are competent bilinguals. The increased contact of Deori with the Assamese, the lack of exposure of the language in new media, and the inaccessibility of language materials to the entire Deori community makes the existence of Deori vulnerable to the predatory power of bigger languages in the long-run.

Further, it has been mentioned that despite the optimism of the speakers towards their mother tongue some measures has to be taken for the sustainability of the language in the long run. All Deori speakers are at least bilingual (if not multilingual), and Assamese is moving into all socialization spaces. If Deori survives in the distant future without any intervention, it can be predicted that it will perhaps acquire more features and structures of Assamese. Table 7.1 shows the scores for the nine factors in the UNESCO scale as reported in Acharyya and Mahanta (2019).

Sl. No	Factor	Values	Label
1.	Intergenerational Language Transmission	5	Language is used by all generations, including children.
2.	Absolute number of speakers	32,376	2011 census
3.	Proportion of Speakers within the Total Population	3	A majority speak the language
4.	Trends in Existing Language Domains	4	Multilingual parity
5.	Response to New Domains and Media	1	Minimal
6.	Materials for Language Education and Literacy	2	Written materials exist but they may be useful for some members of the community
7.	Governmental & Institutional Languages and Policies including Official Status and Use	4	Differentiated support
8.	Community Members' Attitudes toward their Own Language	4	Most members support language maintenance
9.	Amount and Quality of Documentation	3	Fair

Table 7.1: Summary of UNESCO factors for Deori as reported in Acharyya and Mahanta (2019, p. 538)

Table 7.1 shows that Factors 5, 6, and 7 needs attention as it scores low grades on the UNESCO scale. Introducing Deori in new media, a sufficient number of teachers to teach Deori as a subject in schools, and the Government's uninhibited support would result in a sustainable mechanism conducive for the development of the language. If these problems are rectified, then there is the hope of survival for Deori, but only with sustained and conscious efforts aimed at revitalizing.

The vitality assessment of Deori as reported in Acharyya and Mahanta (2019) highlights that there is a lot of cultural value of the language in the community and the native speakers believe that the pride in their mother tongue will enable them to retain their language. However, the findings in this dissertation highlight that the effect of language contact and its consequences for the linguistic features of the language is inevitable. If proper measures are not taken then in the future, urbanization and industrialization will be causing a swing toward language shift, from Deori-Assamese bilingualism to Assamese monolingualism. There are previous instances of such a language shift in Assam. For example, the Moran and Chutiya languages are known to have undergone extinction and all the speakers have shifted to Assamese (Gurdon, 1904). Deori may be able to survive if serious efforts are made for its revitalization and it remains to be seen how these are made possible in the future.

7.8 Implications and future research

The findings of this study are expected to enrich the understanding of the linguistic features of an 'endangered' language. This dissertation is the first study on Deori which examined the phonological features of Deori, augmented with acoustic evidence. This study has acquainted us with the phonological characteristics of a less documented language which is gradually been affected by language contact and bilingualism.

The important findings in this dissertation are the simplification of phonemes in Deori, absence of sesquisyllables and the manifestation of the iambic stress system in Deori, gradual loss of tone in Deori mainly among younger generation speakers, Deori vowel harmony is close to Assamese vowel harmony, and in terms of nasal harmony, Deori exhibits an exceptional occurrence of suffixal alternations /b/ → /m/ and [ɹ] → /n/ which is only attested in the derived domain.

The loss of tonal distinctions among younger speakers provides information on the frequency of language use by different generations, mostly younger generation and language contact with the atonal language, Assamese. The analysis of the nasal harmony pattern presented in Chapter 6 bears important implications for the cross-linguistic nasal harmony pattern. Deori presents an individual instance where the suffixal alternation of /b/ → /m/ and [ɹ] → /n/ in the derived domain does not conform to the unified typology of nasal harmony. This makes Deori a typologically interesting language as it neither conforms to the nasalizability hierarchy scale nor to the hierarchy scale based on continuancy and voicing. Further, the absence of sesquisyllables and the presence of iambic stress patterns also contribute to the understanding that despite being a Tibeto-Burman language, Deori is different from other genealogically related languages.

Amidst the above mentioned implications, this study also has certain limitations and requires further investigation. In terms of tone, certain phonetic variables may also play a role in influencing particular pitch properties of certain words across tones and speakers. Vowel quality and laryngeal properties may influence slightly different pitch heights within a particular tone. This is an area of investigation we intend to explore in the future. A discrimination task will also help us understand whether speakers across different generations can distinguish tonal categories as belonging to the same category or different categories. Furthermore, a generational approach of the phonological processes such as vowel harmony and nasal harmony pattern may give an insight into the generational differences (if any) in the realization of the phonological processes. Future research has to also concentrate on developing the means for the revitalization of Deori and the development of resources for teaching the language.

APPENDIX

Appendix 1 Deori vowel and consonant minimal sets

Sl.no.	Deori	English	Sl.no	Deori	English
1.	pu	weave	11.	gɛ	hard
2.	tu	oil	12.	dzɛ	give birth
3.	bu	wife of an elder brother	13.	sɑ	ill
4.	du	cock	14.	ɦɑ	eat
5.	pi	break	15.	kɑ	hot
6.	ti	louse	16.	tɑ	yam
7.	tʃi	blood	17.	tʃɔ	to contain
8.	dzi	water	18.	bɔ	beat
9.	kɛ	go	19.	kɔ	come
10.	pɛ	sell	20.	dzɔ	run

Appendix 2 Deori consonant minimal sets

Sl.no.	Deori	English	Sl.no	Deori	English
1.	pipɔ	'tree'	11.	ɑkũ	'ear/upland'
2.	bibɔ̃	'granary'	12.	bekũ	'beans'
3.	tʃiti	'fruit'	13.	simi	'needle'
4.	midi	'deity, God'	14.	gumi	'elder sister's husband'
5.	ɑkũ	'ear/upland'	15.	mɛ̃sɑ	'tiger'
6.	ɑgũ	'knee'	16.	isɑ	'say'
7.	mɛ̃pu	'lizard'	17.	udzũ	'navel/bamboo tube'
8.	tɔpɛ̃	'blanket'	18.	kudzi	'spade'
9.	tʃitũ	'rope/old'	19.	sudzɛ̃	'rice-beer'
10.	ɑtiri	'stone'	20.	ɑdzi	'son-in-law'

Appendix 3 Nasal-Oral vowels minimal pairs

Sl. no.	Oral	Gloss	Sl.no.	Nasal	Gloss
1.	kɑ	'bitter'	11.	kɑ̃	'burn'
2.	dzɑ	'dance'	12.	dzɑ̃	'sharp'
3.	pɛ	'rice cake'	13.	pɛ̃	'sell'
4.	dɛ	'big'	14.	dɛ̃	'sound'
5.	gɛ	'hard'	15.	gɛ̃	'paint'
6.	bi	'peel'	16.	bĩ	'carry'
7.	di	'draw a line'	17.	dĩ	'pull'
8.	bɔ	'beat'	18.	bɔ̃	'put on a hat'
9.	dzu	'call'	19.	dzũ	'pierce'
10.	pu	'weave'	20.	pũ	'nasal'

Appendix 4 Deori word stress data set - disyllables

Sl.no.	Deori	English	Sl.no	Deori	English
1.	kotũ	ear-ring	13.	mɔ̃kɔ̃	rice
2.	giku	brain	14.	kɑnũ	year
3.	dugɑ	east	15.	mɑ̃ku	wife of father's younger brother
4.	midzi	milk	16.	buɹu	stomach
5.	gubɔ	head	17.	digi	thread
6.	tɔpɛ̃	blanket	18.	zibi	bowl
7.	kɛpɛ	cotton	19.	siɹi	night
8.	tɑdũ	spoon	20.	sudzɛ̃	rice-beer
9.	bɔsɛ	towel	21.	siɹɛ	world
10.	mĩĩũ	uncooked rice	22.	tʃegu	bow
11.	tʃɑgu	road	23.	joɹu	bride
12.	sɑdzɛ	music	24.	sɛlɔ	home-made cigarette
			25.	lubɛ	pole for driving boat

Appendix 5 Deori minimal pair data set for tone production

Sl.no.	Deori	English	Sl.no.	Deori	English
1.	li	'necklace'	14.	li	'heavy'
2.	tu	'oil'	15.	tu	'deep'
3.	tʃu	'pig'	16.	tʃu	'speech'
4.	tʃi	'blood'	17.	tʃi	'to make'
5.	kɔ	'go'	18.	kɔ	'pluck'
6.	ɑkũ	'ear'	19.	ɑkũ	'upland'
7.	tʃĩjɑ̃	'fish'	20.	tʃĩjɑ̃	'wife of younger brother'
8.	udzũ	'navel'	21.	udzũ	'bamboo tube'
9.	tiɹi	'banana'	22.	tiɹi	'hang from a tree'
10.	bɑɹi	'garden'	23.	bɑɹi	'carry on back'
11.	kiɹi	'poor'	24.	kiɹi	'to furnish with heddles'
12.	tʃitũ	'rope'	25.	tʃitũ	'old'
13.	nĩnĩ	'hold'	26.	nĩnĩ	'rescue from water'

Appendix 6 Deori vowel harmony data set - disyllables

Sl.no.	Deori	English	Sl.no.	Deori	English
1.	kiɹi	'thread'	48.	tʃɑgu	'road'
2.	tiɹi	'banana'	49.	ɑkũ	'ear/upland'
3.	siɹi	'night'	50.	tʃɛpɛ	'cold'
4.	simĩ	'needle'	51.	kɛpɛ	'cotton'
5.	tʃitũ	'rope/old'	52.	sɛlɔ	'home-made cigarette'
6.	tʃinũ	'brother in law'	53.	gɛkɔ	'lizard'
7.	pitʃu	'meat'	54.	bɔsɛ	'towel'
8.	tidzu	'jackfruit'	55.	tɔpɛ̃	'blanket'
9.	udzũ	'navel'	56.	pɔpɔ	'tree'
10.	buɹu	'stomach'	57.	mɔ̃kɔ̃	'rice'

11.	dubu	‘snake’	58.	gɛpɑ	‘basket’
12.	mũsu	‘cow’	59.	mɛ̃bɑ	‘fat’
13.	tuɹi	‘thatch’	60.	tʃɛpɛ	‘cold’
14.	budzi	‘sister-in-law’	61.	kɛpɛ	‘cotton’
15.	siɹɛ	‘world’	62.	ekũ	‘smoke
16.	gimɛ̃	‘respectable person’	63.	tʃegu	‘bow’
17.	ditɔ̃	‘neck’	64.	bɔsɛ	‘towel’
18.	bibɔ̃	‘granary’	65.	tɔpɛ̃	‘blanket’
19.	mĩĩɔ̃	‘dish’	66.	pitʃɔ	‘forehead’
20.	pidzɔ	‘raw’	67.	disɔ	‘pot’
21.	sudzɛ̃	‘rice beer’	68.	ɦɔjɔ	‘true’
22.	duɹɛ	‘donkey’	69.	pɔpɔ	‘tree’
23.	gumɛ̃	‘part of fish trap’	70.	opũ	‘arm’
24.	lubɛ	‘pole for driving boat’	71.	joɹu	‘bride’
25.	gubɔ̃	‘head’	72.	kotũ	‘ear-ring’
26.	buɹɔ	‘where’	73.	ɑsi	‘mountain’
27.	duɹɔ	‘bird’	74.	ɑdzi	‘son-in-law’
28.	sosi	‘middle’	75.	tʃikɑ	‘heart’
29.	mosi	‘person’	76.	pisɑ	‘son’
30.	nodzi	‘plough’	77.	ɑgũ	‘knee’
31.	beku	‘beans’	78.	tʃɑgu	‘road’
32.	tʃegu	‘bow’	79.	dukɑ	‘bird’
33.	ekũ	‘smoke’	80.	tʃutʃɑ	‘dried fish’
34.	tʃeku	‘soul’	81.	gusɑ	‘chin’
35.	opũ	‘arm’	82.	sɑdzɛ	‘hay’
36.	joɹu	‘bride’	83.	tʃɑlɛ	‘dative marker’
37.	kotũ	‘ear-ring’	84.	ɑdzɛ	‘urine’
38.	jotu	‘slave’	85.	gɛpɑ	‘basket’
39.	gisɑ	‘comb’	86.	mɛ̃bɑ	‘fat’
40.	tʃĩj̃ã	‘fish/wife of younger brother’	87.	ɑtʃɔ̃	‘house’
41.	giɹɑ	‘old’	88.	gɑ̃ĩɔ̃	‘pot/throat’
42.	ɑsi	‘mountain’	89.	jɔmɑ̃	‘fish trap’
43.	ɑdzi	‘son-in-law’	90.	mɔ̃sɑ	‘child’
44.	dukɑ	‘bird’	91.	ɑtɑ̃	‘arrow’
45.	mũkɑ	‘husband’	92.	ɑjɑ	‘wife of son’
46.	ugɑ	‘cry’	93.	kɔnũ	‘year’
47.	tɑdũ	‘spoon’			

Appendix 7 Deori vowel harmony data set - trisyllables

Sl.no.	Deori	English
1.	seɹegi	'bamboo instrument used in working the thread.'
2.	sipɛɹɛ	'door'
3.	boɹogi	'roof of the house'
4.	lepeduɹ/lepeduɹu	'goat'
5.	mɛ̃dzɑti	'violet color'
6.	sɔkɑtu	'cane'
7.	gupɔnĩ	'lid'
8.	gɑɹɔmĩ	'soot'
9.	ɑmõdzi	'dirty'
10.	kemõdzi	'cotton'
11	tʃemẽtʃi	'ant'

Appendix 8 Deori vowel harmony data set – derived words

Sl.no.	Deori	English	Sl.no.	Deori	English
1.	nɔ̃.nĩ	'do. PROG'	41.	nĩj̃ɑ̃.n	Future
2.	ɦidzɛ̃.nĩ	'see.PROG'	42.	nĩj̃ɑ̃.ku.n	Future Perfect
3.	ɦɑ.i	'eat.simple present'	43.	nĩj̃ɑ̃.nĩ	Past Progressive
4.	ɦɑ.bɛ	Imperative	44.	nĩj̃ɑ̃.nũ.m.dɛ	Past Perfect
5.	ɦɑ.bɛ.m	Past	45.	odzo.i	Simple Present
6.	ɦɑ.n	Future	46.	ɔdzɔ.bɛ	Imperative
7.	ɦɑ.ku.n	Future Perfect	47.	ɔdzɔ.bɛ.m	Past
8.	ɦɑ.ɹi	Progressive Past	48.	ɔdzɔ.n	Future
9.	ɦɑ.ɹu.m.dɛ	Perfect	49.	odzo.ku.n	Future Perfect
10.	ko.i	'pluck.simple present	50.	odzo.ɹi	Past Progressive
11.	kɔ.bɛ	Imperative	51.	odzo.ɹu.m.dɛ	Past Perfect
12.	kɔ.bɛ.m	Past	52.	gĩj̃ũ.ĩ	'swim.simple present'
13.	kɔ.n	Future	53.	gĩj̃ũ.mɛ̃	Imperative
14.	ko.ku.n	Future Perfect	54.	gĩj̃ũ.mɛ̃.m	Past
15.	ko.ɹi	Progressive	55.	gĩj̃ũ.n	Future
16.	ko.ɹu.m.dɛ	Past Perfect	56.	gĩj̃ũ.ku.n	Future Perfect
17.	ku.i	'fall. simple present'	57.	gĩj̃ũ.nĩ	Past Progressive
18.	ku.ɹɔ	Imperative	58.	gĩj̃ũ.nũ.m.dɛ	Past Perfect
19.	ku.ɹɔ.m	Past	59.	ɦidzẽ.ĩ	'see.simple present'
20.	ku.n	Future	60.	ɦidzɛ̃.mɛ̃	Present Imperative
21.	ku.ku.n	Future Perfect	61.	ɦidzɛ̃.mɛ̃.m	Past
22.	ku.ɹi	Progressive Past	62.	ɦidzɛ̃.n	Future
23.	ku.ɹu.m.dɛ	Past Perfect	63.	ɦidzẽ.ku.n	Future Perfect
24.	ke.i	'go.simple present'	64.	ɦidzɛ̃.nĩ	PastProgressive

25.	kɛ.ɹɔ	Imperative	65.	ɦidzɛ̃.nũ.m.dɛ	Past Perfect
26.	kɛ.ɹɔ.m	Past	66.	ito.i	'look.simple present'
27.	kɛ.n	Future	67.	itɔ.bɛ	Imperative
28.	ke.ku.n	Future Perfect	68.	itɔ.bɛ.m	Past
29.	ke.ɹi	Progressive	69.	itɔ.n	Future
30.	ke.ɹu.m.dɛ	Past Perfect	70.	itɔ.ku.n	Future Perfect
31.	dzi.i	'buy.simple present'	71.	ito.ɹi	Past Progressive
32.	dzi.bɛ	Imperative	72.	itɔ.ɹu.m.dɛ	Past Perfect
33.	dzi.bɛ.m	Past	73.	bɔ.tɛ.ɹi	'kill.action. PROG'
34.	dzi.n	Future	74.	jɔ.tɛ.ɹi	'cut.action. PROG'
35.	dzi.ku.n	Future Perfect	75.	bɔ.tɛ.dzu	'beat.action. reciprocate'
36.	dzi.ɹi	Present Progressive	76.	jɔ.tɛ.dzu	'cut.action.reciprocate'
37.	dzi.ɹu.m.dɛ	Past Perfect	77.	jɔ.gɑ.ɹi	'dig.upwards. PRED'
38.	nĩj̃ã.ĩ	'cook.simplepresent'	78.	tɛ.gɑ.ɹi	'store.upwards.PRED'
39.	nĩj̃ã.mɛ̃	'Imperative'	79.	bɛ.gɑ.ɹi	'tremple.upwards.PRED'
40.	nĩj̃ã.mɛ̃.m	Past	80.	nidzɛ̃.mɑ̃.dzu	'know.particle. reciprocativeaction'
			81.	jɔ.pɑ.ɹi	'cut.CAU. PRED'

Appendix 9 Deori nasal harmony data set

Sl.no.	Deori	English	Sl.no.	Deori	English
1.	gɑ̃ɹ̃ɔ̃	'pot'	21.	digĩ	'thread'
2.	gĩɹ̃ĩ	'second month of the Assamese calendar'	22.	ugɑ̃	'field'
3.	dzuɹ̃ɔ̃	'summer'	23.	opũ	'arm'
4.	tʃĩj̃ɑ̃	'fish/wife of younger brother'	24.	ditɔ̃	'pot'
5.	ɑ̃j̃ɑ̃	'daughter in law'	25.	ʧitũ	'rope'
6.	gijɑ̃	'planter'	26.	ɑtɑ̃	'arrow'
7.	mĩɹ̃ũ	'uncooked rice'	27.	ɑkũ	'ear/upland'
8.	nĩj̃ɑ̃	'cook'	28.	ʧikɛ̃	'rat'
9.	mɔ̃kɔ̃	'rice'	29.	ekũ	'smoke'
10.	mũsɑ̃	'grass, weed'	30.	ɑsɔ̃	'bamboo cleft for mat'
11.	mɛ̃bɑ̃	'fat'	31.	disɔ̃	'pot'
12.	mɔ̃si	'man'	32.	gisɔ̃	'lower rack above fireplace'
13.	mĩtʃɔ	'platform of the house'	33.	isɑ̃	'shawl'
14.	timũ	'mango'	34.	usũ	'bracelet'
15.	tʃimĩ	'tail'	35.	ɑʧɔ̃	'house'
16.	bibɔ̃	'granary'	36.	ʧɔʧɛ̃	'shame'
17.	ibɑ̃	'flower'	37.	mĩtʃɔ	'platform of the house'
18.	tɑdũ	'spoon'	38.	udzũ	'navel'
19.	gɑdũ	'pillow'	39.	sudzɛ̃	'rice beer'
20.	ɑgũ	'knee'	40.	gudzũ	'spear'

			41.	pidzɔ̃	‘raw’

Appendix 10 Deori nasal harmony data set - derived words

Sl.no.	Deori	English	Sl.no.	Deori	English
1.	dzi.ɦɔ	‘water.LOC’	25.	nĩ.gɛ	‘drink.NEG’
2.	lɑ.ɦɔ	‘there.LOC’	26.	tʃɔ̃.gɛ	collect.NEG’
3.	tʃi.ɦɔ	‘tongue.LOC’	27.	tʃɔ̃.dzi.ɹi	‘collect.SPA.PRES PROG’
4.	gu.wɑ	‘grasshopper. THEMATIC’	28.	nɔ̃.pɑ.ɹi	‘do.CAU.PROG’
5.	tʃu.wɑ	‘pig.THEMATIC’	29.	dzɑ.ɹi.jɔ	‘2nd person plural.PROG.POSSESSIVE’
6.	ti.wɑ	‘louse.THEMATIC’	30.	ɑtʃɔ̃.si	‘home.SEL’
7.	bɑ.jɔ	‘2nd person singular.POSSESSIVE’	31.	digĩ.nɑ̃.si → digĩnɑ̃si	‘thread.DET.SEL’
8.	ɑ̃.jɔ → ɑ̃j̃ɔ̃	‘1st person singular.POSSESSIVE’	32.	tɑdũ.nɑ̃.si → tɑdũnɑ̃si	‘spoon.DET.SEL’
9.	nɔ̃.jɔ → nɔ̃j̃ɔ̃	‘3rd person singular/plural.POSSESSIVE’	33.	tʃitũ.nɑ̃.si → tʃitũnɑ̃si	‘rope.DET.SEL’
10.	jɛ̃.si	‘house.SEL’	34.	dugɔ̃.tʃɑlɛ	‘before.ABL’
11.	gũ.si	‘grasshopper.SEL’	35.	ɦidzɛ̃.dzi.ɹi	‘see.SPA.PRES PROG’
12.	ɑ̃.tʃɑlɛ	‘1st person singular.ABL’	36.	gĩj̃ũ.dzi.ɹi	‘swim.SPA.PRES PROG’
13.	nɔ̃.tʃɑlɛ	‘3rd person singular.ABL’	37.	ɦidzɛ̃.pɑ.ɹi	‘see. CAU.PROG’
14.	tʃɔ̃.dzi.ɹi	‘collect.SPA.PRES PROG’	38.	nijɑ̃.pɑ.ɹi	‘cook.CAU.PROG’
15.	nɔ̃.pɑ.ɹi	‘do.CAU.PROG’	39.	pɔpɔ.ɦɔ	‘tree.LOC’
16.	pɛ̃.jɑ.ti → pɛ̃j̃ɑ̃ti	‘sell.NEG.not yet’	40.	udzũ.ɦɔ → udzũɦ̃ɔ̃	‘navel/bamboo tube. LOC’
17.	nĩ.jɑ.ti → nĩj̃ɑ̃ti	‘drink.NEG.not yet’	41.	ditɔ̃.ɦɔ → ditɔ̃ɦ̃ɔ̃	‘throat.LOC’
18.	mũ.jɑ.ti → mũj̃ɑ̃ti	‘ripe.NEG.not yet’	42.	bibɔ̃.ɦɔ → bibɔ̃ɦ̃ɔ̃	‘granary.LOC’
19.	dzũ.jɑ.ti → dzũj̃ɑ̃ti	‘write.NEG.not yet’	43.	gisɔ̃.ɦɔ → gisɔ̃ɦ̃ɔ̃	‘lower rack above fireplace.LOC’
20.	pũ.ku.n	‘put on.FUT.IMP’	44.	ɦidzɛ̃.ku.n	‘see.FUT.IMP’
21.	tʃɔ̃.ku.n	‘collect. FUT.IMP’	45.	nijɑ̃.ku.n	‘cook.FUT.IMP’
22.	pũ.nɛ̃.du	‘put on.IMP.APPL’	46.	ɦidzɛ̃.gɛ	‘see.NEG’
23.	tʃɔ̃.nɛ̃.du	‘collect.IMP.APPL’	47.	nĩj̃ɑ̃.gɛ	‘cook.NEG’
24.	tũ.nɛ̃.du	‘throw.IMP.APPL’			

List Of Presentations And Publications

Presentations

- 8th Students Conference of Linguistics in India (SCONLI), 2014, organized by University of Kashmir. Title of the paper presented: "Acoustic analysis of phonemes in Deori".
- Workshop on Tone and Intonation (WTI), 2016, organized by IIT Guwahati. Title of the paper presented: "Tone and Intonation in Deori".
- (With S. Mahanta). 33rd South Asian Languages Analysis Round Table (SALA), 2017, organized by Adam Mickiewicz University in Poznan, Poland. Title of the paper presented: "Deori tonal contrasts: A generational account".
- (With S. Mahanta). 6th International conference on endangered and lesser-known languages (ELKL 6), 2018, organized by Central Institute of Indian Languages Mysore. Title of the paper: "Language endangerment scenario of Deori: a sociolinguistic survey".
- (With S. Mahanta). Tonal Aspects of languages (TAL), 2018, organized by Beuth University, Berlin. Title of the paper: "Production and Perception of tones in Deori".
- (With S. Mahanta). 16th Annual Conference of the French Phonology Network (RFP), 2018, organized by the Laboratory Structures Formelles du Langage (Université Paris 8). Title of the paper: "Phonology of Deori".

Publications

- Prarthana Acharyya and Shakuntala Mahanta. (2018). Production and Perception of Lexical Tones in Deori. Sixth International Symposium on Tonal Aspects of Languages (TAL). ISCA, (pp. 93-97).
- Prarthana Acharyya and Shakuntala Mahanta. (2019). Language vitality assessment of Deori: an endangered language. Language Documentation and Conservation (LD&C). Volume 13, (pp. 514-544).

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