The Phonetics and Phonology of Word Stress and Tone in the Dharamshala Variety of Tibetan

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by

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Declaration of Originality

I hereby declare that the work which is being presented in the thesis entitled The Phonetics and Phonology of Word Stress and Tone in the Dharamshala Variety of Tibetan has been solely authored by me. It presents the result of my own independent investigation/research conducted during the time period from August 5, 2017 to December 30, 2024, under the supervision of Dr. Somdev Kar, Associate Professor, IIT Ropar.To the best of my knowledge, it is an original work, both in terms of research content and narrative, and has not been submitted or accepted elsewhere, in part or in full, for the award of any degree, diploma, fellowship, associateship, or similar title of any university or institution. Further, due credit has been attributed to the relevant state-of-the-art and collaborations (if any) with appropriate citations and acknowledgments, in line with established ethical norms and practices. I also declare that any idea/data/fact/source stated in my thesis has not been fabricated/ falsified/ misrepresented. All the principles of academic honesty and integrity have been followed. I fully understand that if the thesis is found to be unoriginal, fabricated, or plagiarized, the Institute reserves the right to withdraw the thesis from its archive and revoke the associated Degree conferred. Additionally, the Institute also reserves the right to appraise all concerned sections of society of the matter for their information and necessary action (if any). If accepted, I hereby consent for my thesis to be available online in the Institute's Open Access repository, inter-library loan, and the title & abstract to be made available to outside organizations.

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List of Abbreviations

DT	Dharamshala Tibetan
LT	Lhasa Tibetan
C	Consonant
V	Vowel
OT	Optimality Theory
GEN	Generator
EVAL	Evaluator
CON	Constraints
TETU	The Emergence of the Unmarked
RED	Reduplicant

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List of Constraints

*VOICED-CODA: Obstruents must not be voiced in the coda position.

IDENT-IO (VOICE): The specification for the voicing of the input must be preserved in the output.

FT-BIN: Feet are binary under moraic or syllabic analysis.

PARSE-σ: Syllables are parsed by feet.

RH TYPE=TROCHEE: Feet have initial prominence.

RH TYPE=IAMB: Feet have final prominence.

ALL-FT-L: Align (Ft, Left, PrWd, Left)

LEFTMOST: Align (Hd-Ft, Left, PrWd, Left)

ALIGN-RIGHT: Align the right edge of a prosodic word with the right edge of a foot.

*ALIGN-RIGHT: Do not align the right edge of a prosodic word with the right edge of a foot.

*RH TYPE=T: Feet have non-initial prominence.

WSP: Weight to stress principle. Heavy syllables are stressed.

*FLOAT: A tone must be associated with a TBU.

NOCONTOUR: No contour tone is allowed.

*LONGTONE: A tone may be associated with at most one TBU.

ONE-T/μ: There should be one tone per mora.

NOFUSION: Separate underlying tones must stay separate.

HEAD-MAX-TONE: Preserve the underlying tones of head syllables.

MAX-IO: Input segments must have output correspondents.

MAX-TONE: Preserve all underlying tones.

DEP-TONE: No addition of tones.

IDENT-TONE: The value of tone associated with a TBU would be the same in both input and output.

IDENT-IO-TONE-LEFT: The leftmost tone of an utterance is identical to its input.

IDENT-IO-T-NC: IDENT-IO-TONE-NUMERICAL CONNECTOR. The value of the input tone of the numerical connector is the same in the output.

TONE VALUE $^{\text{UPWARDS}}$: A low or mid tone would become mid or high tones respectively if preceded by a mid or high tone.

TONE VALUE $^{\text{DOWNWARDS}}$: A high tone would go one step down if preceded by a mid, low or high tone. A mid tone would go one step down if preceded by a mid or low tone in the latter case.

MAX-BR: Every element in B has a correspondent in R.

MAX-BR (STRESS): Every stressed syllable of B has a correspondent in R.

MAX-BR (TONE): Every tonal element in B has a correspondent in R.

MAX-IO: Input segments must have output correspondents.

MAX-IO (STRESS): The stress pattern of the input must be the same in the output.

MAX-IO (TONE): Every tone in the input will have a corresponding tone in the output.

IDENT-BR: Let α be a segment in B, and β be a correspondent of α in R.

IDENT-BR (TONE): Let α be a tone in B, and β be a correspondent of α in R.

OCP: Two identical elements are prohibited in the adjacent positions.

DOWNSTEP: If there are two high tones in the adjacent syllables, the second H is downstepped.

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Abstract

This study focuses on the word stress and tone patterns of the Dharamshala Tibetan (DT), a variety of Tibetan spoken by the Tibetans in exile community in Dharamshala, India. Tone and stress have been studies from the points of view of both phonetics and phonology. Tibetan belongs to the Bodish subgroup of the Tibeto-Burman group of languages. The language is widely spoken in Tibet, China, Nepal, parts of India, and among the Tibetan diaspora throughout the world. The Tibetan language can be broadly divided into three regional divisions, namely, the central or the Lhasa dialect group, the Kham dialect group, and the Amdo dialect group. The standard variety of Tibetan is based on the variety spoken in central Tibet, in and around Lhasa. The origin of Tibetan speakers in India can be traced to the three aforementioned geographical and dialectal regions of Tibet. Most of their ancestors left Tibet and went to India in the decades following 1959, after China's military annexation of Tibet. The three main Tibetan dialect groups are not always mutually intelligible. In order to cater to the need for a standard variety and a common medium of communication, the native speakers of Tibetan in Dharamshala have created a relatively composite variety of Lhasa Tibetan (LT), which has both phonological and morphological influences from the other two dialectal groups. Naturally, DT can be regarded as a composite language variety.

In this situation, the present work examines the status of tone and stress through the exploration of different acoustic correlates. Two production experiments have been conducted. The acoustic observables considered in this study include the fundamental frequency (f0) (height and direction), duration, and intensity. A one-way repeated measures ANOVA followed by a generalized linear regression modeling (GLM) and estimated marginal means (EMMs) confirmed a three-way tonal contrast viz., high (HT), mid (MT), and low (LT) in this variety. A one way ANOVA is conducted to examine the acoustic correlates of stress. More than 90% of stimuli have the left headed stress pattern with left to right directionality and weight insensitivity. Only two words are found with right headed stress. A few monosyllabic words with heavy syllables are also found.

The current study also focuses on the phonology of stress and tone in DT. Optimality theory (OT), a constraint-based framework has been used as the theoretical framework. The current work also aims to provide a systematic theorisation of DT word stress in terms of theuniversal parameters like culminativity, location of the head, direction, and quantity sensitivity. A phonological exploration of DT tone sandhi is also included. The majority of the DT words are left-headed, maintains a left to right directionality, and consists of light syllables. Degenerate foot is accepted. Right headed feetin DT are quantity insensitive. A small set of monosyllabic DT words are also found, which are stressed by default.

Qualitative values of the citation tones may go up or down in the impact of the tone preceding it. Dharamshala Tibetan contains three level tones, H, M and L. A few DT compound words have been listed for analysing their tonal behaviour. Simultaneously, the tonal behaviour of the individual words which are the building blocks of the aforementioned compound words and phrases is also studied. DT has two types of tonal behaviour when two or more tones congregate. Firstly, a left to right oriented change in terms of tone sandhi might occur, where the qualitative values of the citation tones change. The category of tone may go up or down in the impact of the tone preceding it. Secondly, the leftmost tone does not change but can cause change in tone category.

Stress and tone in DT is also examined in the context of reduplication. The placement of the stress in DT reduplication depends on the number of syllables the base carries. In case of a base with a single syllable, the stress would be on the base, and the reduplicant would lack the stress. In case of a bisyllabic base, the whole stress pattern would be copied in the reduplicant. In case of tonal reduplication of the instances with monosyllabic base, the suffixal reduplicant undergoes a change in tone in DT. For instances with bisyllabic bases, the reduplicant can copy the tone pattern of the base. In certain cases, the H tones in the RED might undergo downstepping. Maintaining TETU is the main goal in DT regarding stress and tone reduplication, rather than complete copying.

Chapter 1

Introduction to the thesis

1. Introduction

Word stress and lexical tone hold a unique position in the domains of both phonetics and phonology. In the case of a language like Tibetan, which is mainly known as a tonal language, both stress and tone deserve a systematic analysis, especially when the study is concerned with a variation of Tibetan, which remains unexplored in terms of any formal linguistic analysis. The current study contains two production experiments to strengthen the basic qualitative and quantitative information regarding stress and tone in the Dharamshala Tibetan language. The study, afterwards, proceeds to offer phonological analysis of stress and tone by using the framework of the Optimality theory (Prince & Smolensky,1993). The mechanisms of stress and tone are further explored in the domain of reduplication as well.

The target language of this study is Dharamshala Tibetan (henceforth DT), and it primarily originated from the Lhasa Tibetan (henceforth LT) dialect group. It is also influenced by the two other major Tibetan dialect groups, namely Amdo and Kham. DT is spoken in Dharamshala, a town in the Kangra district of the state of Himachal Pradesh, India. It is spoken by the Tibetan diaspora who reside in Dharamshala. Tibetan people first came to India in large groups in 1959, after China's military annexation of Tibet, and the decades post-1959 (Norbu, 2001). DT is modelled primarily after LT, as the Tibetan people needed a lingua franca to communicate on a daily basis. LT was already established as the standardised version of Tibetan. LT was also the language used in the court in Tibet. Various Tibetan dialect groups are not always mutually intelligible. As a result, the need for a common language which can be used for everyday usage was present. However, the distinct linguistic influences of the dialects the Tibetan speakers spoke at home in Tibet also have influenced the version of LT they were speaking in the exile. As a result, the LT spoken in the Lhasa region of Tibet is distinct from the Tibetan spoken in Dharamshala, especially visible in the sphere of phonology and phonetics, and sometimes in the case of the usage of different words to refer to the same object. This topic will be explored in greater detail later in the current chapter.

This chapter is organised into the following subsections. Section 1.1 includes a brief introduction to word stress and tone. Section 1.2 incorporates a description of the Dharamshala Tibetan language (DT) and the local Tibetan speech community. It also includes a brief description of the segmental phonology of DT. Section 1.3 contains a detailed literature review concerning stress and tone of the different dialect groups of Tibetan. Section 1.4 offers a brief description of Optimality theory as a theoretical framework. Section 1.5 contains the research questions to be explored in this thesis. Finally, section 1.6 provides a brief description of the upcoming chapters.

1.1 Word stress and tone

The current work focuses on two suprasegmental features, namely, word stress and tone. Hayes (1995, p. 25) rightly suggested that word stress has a rhythmic structure with a strong and weak relationship between different syllables or morae. It is the emphasis put on the certain syllables or morae in a word. Stress is relative as the prominence of one syllable is calculated in terms of that of the other. In order to provide a description of word stress in a language, parameters like the location of the stressed syllable in a foot, the directionality of the stress placement, iterativeness, boundedness, rule governedness, and quantity sensitivity need to be considered. In the case of the Pintupi word /ˈtʲuʈaja/ ‘many’, the stress pattern is left-headed, left-to-right oriented, and quantity insensitive (Kager, 1999, p. 164). The last syllable is extrametrical. Secondary stress is allowed. However, the degenerate foot is not allowed in Pintupi. The stress pattern is rhythmic and recurring. The word /ˈmaɭaˌwana/ ‘through (from) behind’ also contains the same stress pattern like the initial word with an addition of a secondary stress. In the second case, a secondary stress is assigned to the third syllable, because it is not the last syllable in the word. An additional syllable is available to create a foot containing two syllables. The situation is not the same in the case of the first word, as the third syllable is also the last. If a stress is assigned on the third syllable, a degenerate foot would be created, which is restricted in Pintupi.

(1) Stress pattern of the Pintupi words /ˈtʲuʈaja/ and /ˈmaɭaˌwana/ (Kager, 1999a, p. 164)

(a) (ˈtʲuʈa)ja	'many'
(b) (ˈmaɭa)(ˌwana)	'through (from) behind'

On the other hand, lexical tone is also regarded as one of the main suprasegmental features. A tonal language uses pitch in such a way that it can change the meaning or grammatical function of a word (Yip, 2002, p. 1). Pitch is phonological in a tonal language. Mandarin, Cantonese, Tibetan, Sylheti, Bantu, and Mixtec are all examples of tonal language. Yip (2002, p.2) has offered the following example in which a pitch change can cause the word /yau/ to have six different meanings in Cantonese.

(2) Different meanings of the word /yau/ (Yip, 2002, p. 2)

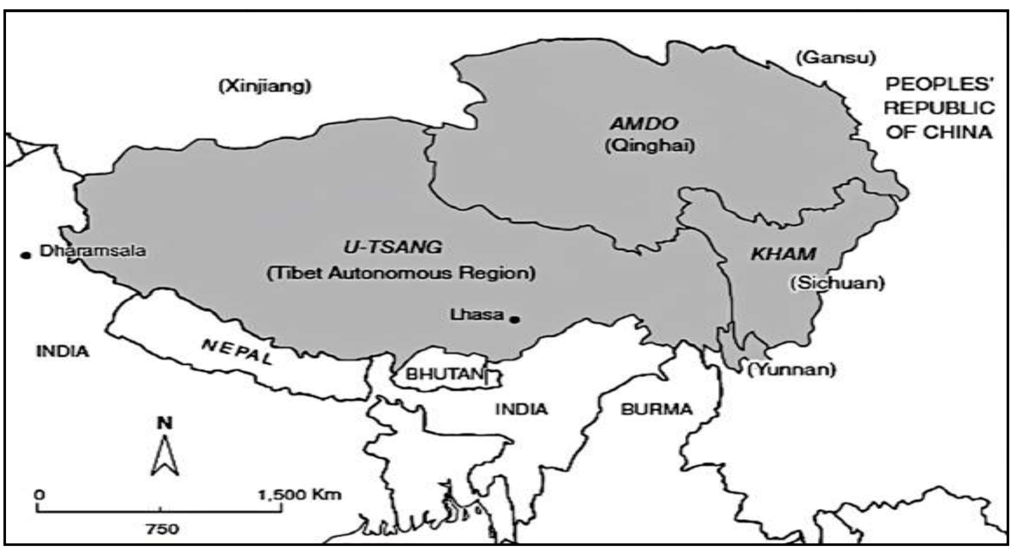
(a) high rising	'paint (noun)'
(b) mid level	'thin'
(c) low level	'again'
(d) very low level	'oil'
(e) low rising	'have'
(f) high level	'worry'

1.2 Dharamshala Tibetan: The language in question and the local speech community

Modern Tibetan belongs to the Bodish subgroup of the Tibeto-Burman group of languages (DeLancey, 2006a, p. 255). It is spoken in Tibet, China, Nepal, India, and among the Tibetan diaspora all over the globe. The Tibetan language can be broadly divided into three regional variations, namely, the central or the Lhasa dialect group, the

Kham dialect group, and the Amdo dialect group (Samuels, 2014). Each of these major dialectal and geographical areas can be subdivided into smaller regions. It is possible that a Tibetic variety is spoken in the Kham region, but it does not adhere to the phonological characteristics of the Kham dialect group (Sun, 2003). Geographical, historical, and political groupings of languages might be helpful overall, but such groupings lack nuance. The standard variety of Tibetan is based on the variety spoken in central Tibet, in and around Lhasa. Classical Tibetan is the written form of the language used by all the dialect groups. Tibetan speakers living in India belong to the Tibetans in exile community. Their origin can be traced to the three aforementioned geographical and dialectal regions of Tibet.

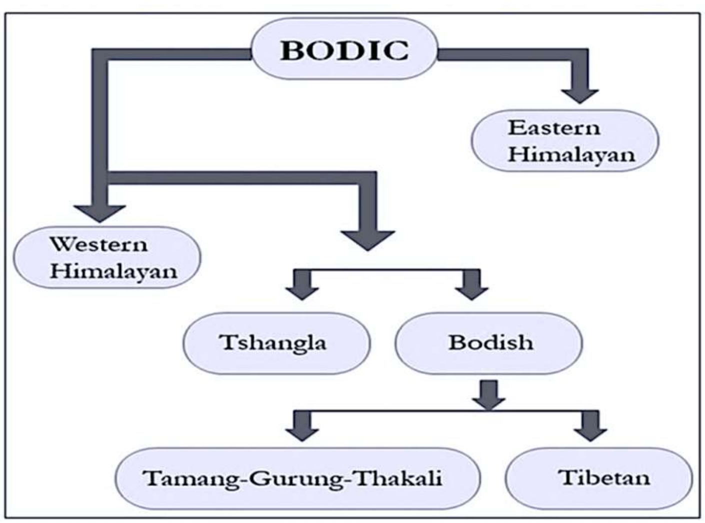
(3) Map 1: Map of Tibet showing the traditional Tibetan geographical and dialect divisions (McConnell, 2016, p. 44)



A phylogenetic study reaffirms that the Sino-Tibetans split into Sinitic and Tibeto-Burman groups near the Yellow River of Northern China around eight thousand years ago (Zhang et al., 2020). Through reconstruction and assessing the language contact situation, it is possible to create an idea about the pre-split parent language. It is simultaneously possible to establish a genetic relationship among many languages that emerged from the parent language. However, it is challenging to construct a family tree of the Sino-Tibetan since a large number of diversified groups of languages are part of this family. Over time, different reconstructions have been proposed for the rather established languages within different subgroups of this language family.

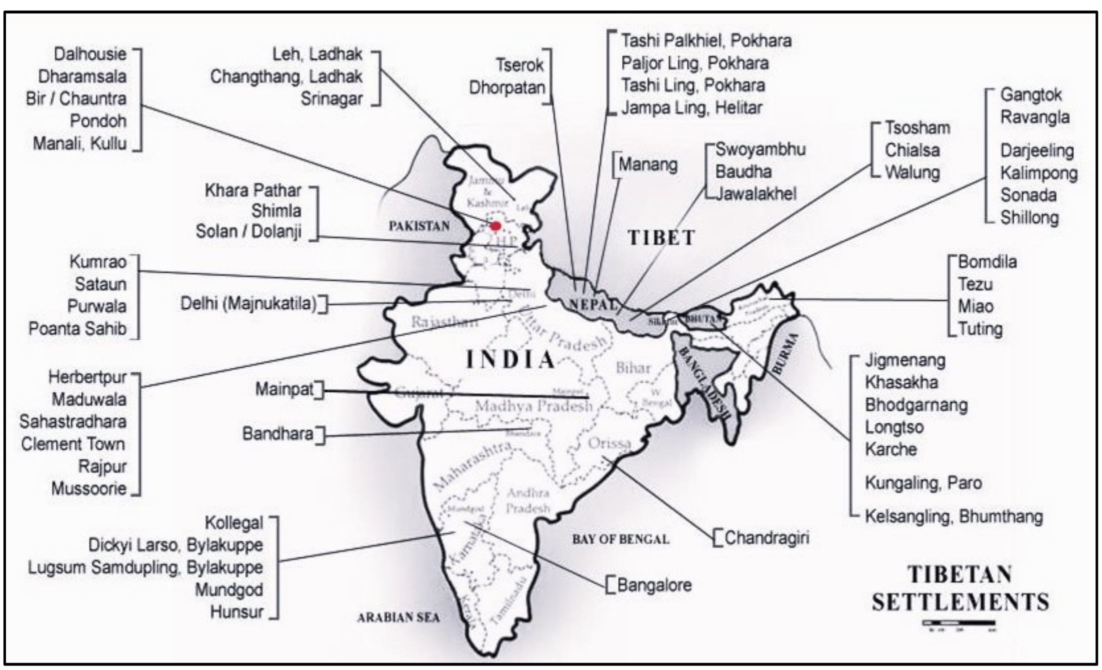
It is worth mentioning that differences in opinions exist among linguists about such reconstructions primarily due to the absence of a universal and consistent principle to create the groupings and the sub-groupings. For instance, Shafer (1955) declined the idea that the Sino-Tibetan is divided into Sinitic and Tibeto-Burman subgroups. On the other hand, Benedict (1972, p. 6) suggested that Chinese and Tibeto-Karen developed at the first stage after the proto-language split. Tibeto-Karen is further divided into Karen and Tibeto-Burman subgroups. Bradley (1997) discussed how different classifications of the modern Sino-Tibetan language family carry many differences. In Shafer's classification (1955), the Western Tibeto-Burman group is known as the Bodic group. Benedict termed this group Tibetan and Kanauri, along with the Himalayan. The Tibetan language belongs to the Bodish subgroup of the Bodic branch. DeLancey (2006a, p. 255) proposed the most concise family tree that reveals the foundation of the modern Tibetan.

(4) Figure 1: Family tree of the Bodic group of languages (DeLancey, 2006a, p. 255)



The Tibetan diaspora in exile is deeply passionate about preserving their culture and language. Classical Tibetan is the written form of Tibetan, practiced by all the dialect groups. The scriptures associated with Buddhism are composed using classical Tibetan. Tibetans are residing all over the country, including places like but not limited to Ladakh, Dharamshala, parts of New Delhi, Dehradoon, different parts of Karnataka, etc. (Lauer, 2015). Approximately, fifteen thousand Tibetans reside in Himachal Pradesh currently, among which seven thousand live in Dharamshala (Jang, 2024). Most of their ancestors left Tibet and settled in India in the decades following 1959 (Norbu, 2001). The Tibetan people's spiritual and former political head, Dalai Lama, resides in Dharamshala. Tibetans have schools all over India where both Tibetan culture and religion and modern education are taught. The medium of instruction are both Tibetan and English. The children come from households where their parents' ancestors might hail from two different dialectal regions of Tibet. A Tibetan child has most likely friends and acquaintances from different dialect groups.

(5) Map 2: Major settlements of the Tibetan community in India (Central Tibetan Relief Committee, 2002)



It is impossible to appreciate how DT came to possess certain unique phonological traits without having a proper understanding of the concepts like speech community (Milroy, 2002), and language contact (Dodsworth, 2017; Hartley, 1996). The three main Tibetan dialect groups often lack mutual intelligibility. In order to cater to the need for both a standard language, and a common medium of communication, the native speakers of Tibetan in Dharamshala have created a relatively composite variety of LT. It includes phonological influences from the other dialectal variations. The compositeness can be seen in the phonological and lexical domains of everyday speech. This composite LT variety is referred to as DT in this paper. Some of the variations found in everyday DT speech are mentioned below. It must be noted that the first two examples can be treated as instances of free variation, as a DT speaker can use either version.

(6) Variations present in everyday DT speech

(i) The phrase /ŋe khyoga/ ‘my husband’ in LT might become /ŋe ʧholkha/ if the speaker's family is from the Kham region.

(ii) Speakers with family from the Amdo region might replace the /b/ with /w/ in some words. In that way, the word /bab/ ‘descend’ can become /wab/.

(iii) There are different lexical expressions to define the same concept in different dialect groups. The term for ‘aunt’ is /huru/ in LT, whereas in Kham, it is /asu/.

A brief description of the phonological inventory of DT is provided. Twenty-eight consonants and six vowels in Dharamshala Tibetan are observed. The consonant inventory comprises of thirteen stops viz., /p, p^{h}, b, t, t^{h}, d, ʈ, ʈ^{h}, ɖ, k, k^{h},g, and ʔ/, four nasals, viz., /m, n, ɲ, and ŋ/, four fricatives, viz., /s, z, ʃ, and h/, four affricates, viz., /ts, dʒ, ʈʃ and ʈʃ^{h}/.The tap /ɾ/ and the retroflex flap /ɽ/ are used interchangeably sometimes. The lateral approximant /l/ is also present. It can be observed that the DT maintains a three-way contrast in its stop category, viz., voiceless unaspirated, voiceless aspirated, and voiced unaspirated. The six vowels in DT include /i, e, a, ɔ, o, and u/.

1.3 Previous works on word stress and tone of the different Tibetan Dialect Groups

A large number of linguistic studies on the segmental phonology of contemporary Tibetan dialect groups have been conducted (DeLancey, 2006a, 2006b; Gong, 2021; Green, 2012; Huang, 2019; Sun, 2006, 1986, 2003; Suzuki, 2011). However, no phonological or any formal linguistic work on the Dharamshala variety of Tibetan could be found. Since DT is bound to share phonological similarities with the three dialect groups of Tibetan, it is worth mentioning that phonological works on word stress and tone were undertaken in the three dialect groups.

Caplow (2009) offered a reconstruction of Proto-Tibetan bisyllabic non-verbs. The stress is positioned in the second syllable in such cases. She further added that right-headed iambic stress is prevalent in the Rebkong Amdo variety of Amdo. In Shingnyag Tibetan, a dialect of Amdo, the first syllable might be prominent in the case of polysyllabic words (Suzuki & Wangmo, 2017). Suzuki (2017) mentioned that the Trung variety of the Kham dialect has iambic stress, whereas the Bodgrong variety does not. (Watters, 2002, pp. 23–24) conveyed that in the Kham dialects, only polysyllabic words might have stress on the last syllable as it is generally long. If all the syllables are light, the last syllable gets stressed. If the long syllable is not at the end of the word, it still gets stressed.

Meredith (1990) considered that word stress in the standard variety, Lhasa Tibetan (LT), depends on syllable weight. The heavy syllable is supposed to attract stress. In the absence of a heavy syllable, the syllable with the higher tone is the candidate for stress. If there is no tonal difference, the stress gets assigned to the leftmost syllable. Tournadre and Dorje (2003, p. 38) partially agreed with Meredith's observation. Their notion of stress in the standard variety was that it is generally left-headed. Lim (2018) explained that Meredith’s consultant was a native speaker of the Kham dialect of Tibetan. Meredith has essentially collected data from a Kham Tibetan speaker living in Nepal. Hence, Meredith’s postulation of LT stress is erroneous.

According to Denwood (1999), progressive vowel harmony present in Tibetan indicates the presence of a trochaic stress system. In the case of Tibetan progressive vowel harmony, the vowel height of the second syllable assimilates with that of the first syllable. Denwood explained that the vowel of the weaker (unstressed) syllable assimilates to the vowel height of the stronger (stressed) syllable, as in /ʔin.bøː/→[ʔɪḿ býː] 'Anglo Tibetan,' where ø→y transfer is present. Monich (2011) agreed with Denwood's observation, whereas Lim (2018) considered this observation inconclusive as instances of regressive vowel harmony are also available in the standard Tibetan following the analysis of Dawson (1980). If the presence of progressive vowel harmony is an indication of the presence of words with trochaic stress, Lim opined that the presence of regressive vowel harmony should be an indication of the presence of Tibetan words with an iambic stress pattern.

Different researchers have often questioned the status of tonal contrasts in Tibetan. For example, the studies conducted on the tonal system of the standard Tibetan or Lhasa Tibetan (henceforth LT) to date reported contradictory findings, which are quantitative and qualitative in nature. The number of tones posited by different scholars ranges between zero to eight. Jäschke (1881) was the first modern scholar to study tones in Tibetan. He was the first one to claim a two-way tonal contrast, viz., high and low in the Lhasa variety. The observations made by Jäschke (1881) were later on re-examined by Chao (1930) and Sprigg (1955). They also confirmed the presence of high and lone tones in LT. Civera (1970) treated Tibetan as an atonal language.

Kjellin (1977) conducted one of the earliest acoustic experiments and attempted to examine the possible tonal contrasts following LT's f0 variations and duration. The study by Kjellin is an interesting case as he identified six different pitch contours: H level (short), High level (long), HL (long), LH (short), LH (long), LHL (long). A later study (Qu & Tan, 1983), however, reported the presence of four-way tonal contrasts in LT. Their analysis is closely tied to the segmental trait of syllables. They have mentioned the presence of two high and two low tones. In every category, one is associated with a long syllable and the other with a short syllable. As a result, it can be said that their analysis of LT had two basic tonal divisions, namely, H and L.

Duanmu (1992) and Yip (2002), on the other hand, observed a two-way tonal contrast in LT, albeit the quality of the contrastive tones slightly differs from the ones reported in earlier studies. Both Duanmu and Yip argued in favour of a H (high) vs. LH (low-high) contrast, contrary to the H vs. L contrast reported in Jäschke (1881), Chao (1930), and Sprigg (1955). Monich (2011) also favoured a two-tone analysis. Lim (2018) argued in favour of a three-way tonal contrast in LT, viz., two level tones- L and H, and a contour tone- LH.

Hu and Xiong (2010) found a clear division between LT high and low tones, and the difference is evident during the onset of the tones. H has the highest f0 onset between 270-320 Hz, whereas L has the lowest onset between 190-240 Hz. However, the offset part of L can be as high as H and vice versa. Secondly, an eight-tone analysis was proposed. Syllable types and tonal contours are correlated in LT. CVSonorant is treated as long syllables historically and has surfaced as long syllables. They bear either H or LH tones. CV syllables are historically short, and surfaced in the experiment as CVh (a CV syllable with aspiration). It carries H level and LHH tones. CVStop, another historically short variant, is realised as CV (ʔ), also a short syllable. It carries either HLS or LHS tones. CVNStop, another historically short syllable, has surfaced in the experiment as a long CVN(ʔ). It bears either HL or LHL tones. The tonal behaviour shows HL and LHL might emerge as distinctive tones in the future; the short tones on CVh and CV (ʔ) tend to merge.

Hu (2012) confirmed the H and L tonal divisions in LT, along with the presence of the tonal contours. The level tones owe their emergence to the simplification of the consonant clusters both preceding and following the nucleus as a compensatory mechanism. Hu also agreed that H has been associated with historically voiceless onset and L with voiced onsets that lost voicing over a long period in LT. It is also the syllables having prefixes with sonorant initials became H, and if the prefixes had non sonorant affixes, they would turn to L. Different syllable types and emergence of contour tones are correlated in LT. Hu examined these assumptions with the help of LT articulatory and acoustic data using an Electromagnetic Articulograph from three LT speakers. EMA data shows the kinematics of the lip and tongue, which are essential for making vowel and consonant sounds. Monosyllabic LT words and morphemes in citation form were used in the experiment. A total of eight types of syllable and tone combinations were used. The syllable types are mentioned as follows $CVS_{(sonorant)}$ (long syllables with high tone), CVS (low toned long syllables), (CVh) (aspirated syllables with high tone), (CVh) (aspirated with low tone), (CVʔ) (checked syllable with H), (CVʔ) (checked syllable with L), (CVNʔ) (checked syllable with H), and (CVNʔ) (checked syllable with L). The experiment shows that only CVS syllables result in long tones, H and LH. All the other tones, originating from other syllable types, result in short tones. HS and LHH result from the CVh syllable, whereas HLS and LHS are from the CVʔ syllable type. Lastly, HL and LHL are resulted from CVNʔ syllable. Hu explained that these tones are in the complementary distribution. This understanding fuels the scholars who favour LT two-tone analysis, as all these tones can be explained as surface forms of the H and L tones.

Watters (2002, p. 37) offered an account of Kham tones. There are two citation tones in Kham, viz., H and L. Phonation and tones are related in the Kham Tibetan. According to Watters, both voice and tone register create multiple tonal surface forms from the basic H and L tone types. Amdo dialects are mostly atonal (Janhunen & Norbu, 1999).

Apart from coming up with his idea of LT comprising of three tones, Duanmu (1992) also provided an account of how the citation tones of LT work when they are operating in the context of a compound word, phrase, and sentence. His idea of LT tonal function is known as the Lhasa tone rules. Duanmu was the proponent of tonal deletion, followed by the tonal spreading approach in the LT tonology. This approach describes LT tones in the phonological context. In short, only the tone of the leftmost syllable retains its tone, whereas all the other tones get deleted when words associated with multiple tones are pronounced. Eventually, the tone attached to the first syllable spreads to the remaining syllables.

Nishida (1975) provided a detailed account of Tibetan tonogenesis. Nishida argued that, in the first stage, the complex consonant clusters were all retained. As a result, the Proto-Tibetan remained an atonal language. In the second stage, however, much of the complexity was lost along with the loss of [±voice] contrasts among the stop categories, especially in the syllable onset position. The application of the perturbed f0 was a compensatory mechanism (to maintain the lexical contrasts) came into existence due to the loss of apparent voicing contrasts (amongst the stop categories), and the simplification and reduction of complex consonant clusters became apparent only in the third stage. In the third stage, the presence of increased tonemes can be observed. The Tibetan language was atonal at the Nishida (1979) proposed a mechanism of sound changes leading to the development of the tones in Tibetan.

(7) Sound changes suggested by Nishida (1979) leading to eventual tonogenesis in Tibetan

Period 1	Period 2
1. Voiceless stops	Voiceless stops with a High (H) tone
2.1 Voiced stops	Voiceless aspirated stops and fricatives with a Low (L) tone
2.2. Voiceless stops	Voiceless unaspirated stops and fricatives with a Low (L) tone
3. Voiceless and aspirated nasals	Voiced Nasals with a High (H) tone

At some point in history, Tibetan might have maintained three-way consonantal contrasts, viz., voiceless aspirated, voiceless unaspirated, and voiced unaspirated. Zhang (1987) added a few more observations to Nishida's proposed sound change patterns with greater details. Zhang argued that the Old Tibetan unaspirated voiced stops and unaspirated voiced fricatives, at the first stage, lost the voicing contrasts and became voiceless, unaspirated counterparts. However, at the same time, the original unaspirated voiceless segments (stops and fricatives) were realised as aspirated counterparts. The aspiration was possibly induced on the originally unaspirated stops and fricatives to avoid the likely chaotic confusing state that was likely to surface due to the (forced) changes on the first set of phonemes (voiced stops and voiced fricative sounds losing the [+voice] property).

The written documents from the eighth and ninth centuries recorded many voiced stops, fricatives, and affricates as voiceless unaspirated counterparts. Finally, the systematic orthography development also indicated that the originally voiceless aspirated stops and affricates also started to surface (at least in the written documents) as voiceless unaspirated at this stage. Such written evidence provide a clear indication of the ongoing changes in the contemporary Tibetan phonological inventory. The three above mentioned simultaneous processes eventually led to many (likely) homophonous pairs.

The chaos displayed in the writing system cannot be ignored, especially considering that it happened when the writing system was moving towards a standardisation process. Instead, this chaos is an indication of the significant development of patterned sound change that eventually might have led to the generation of tonal contrasts in this language. Zhang viewed these consistent patterns as a testimony to the attempt initiated by contemporary writers to accommodate the sounds which had undergone change or sounds which were newly introduced in the inventory. A few instances of the sound changes noted above are provided in the following chart.

(8) Orthographic developments leading to sound changes (Zhang, 1987)

	Orthographic representation	Middle-Old Tibetan Version	Gloss
1.	ded	ted	chase
	zhi'u	shi'u	guard
	jo-bo	co-bo	master
2.	btcu	btchu	ten
	btsan	btshan	stubborn
	gtum	gthum	vicious
3.	phul	pul	devote
	thos	tos	smell
	khong-co	kong-co	princess

In this context, it is worth noting that the literature on tone and tonogenesis attest to the loss of [±voice] contrasts as one of the primary parameters to the development of tonal contrasts in a given language (Kingston, 2011, p. 2305; Yip, 2002, p.7). As the difference of voicing is lost, difference in pitch becomes phonemic or contrastive so that difference in meanings between two homophones can be distinguished Hu (2012) and Matisoff (2000) observed that the so-called tonal languages become relatively simplified regarding syllable structure with zero to quite a limited number of consonant clusters. In such cases, tone emerges as a compensatory mechanism to adjust, and maintain the lexical contrasts.

1.4 A brief description of the mechanisms of the Optimality theory

According to Optimality theory (Prince & Smolensky, 1993) the surface form of the human language results from the conflict between different constraints. OT is an evolutionary development of the generative grammar framework. The mechanism of the generative model is a collection of rules and rule ordering, whereas OT is a constraint-based framework. Generative grammar is based on the idea that the grammar of every language is made of a set of universal and inviolable rules. As a result, the generative model follows the idea of universality in the strictest sense. In the case of OT, the constraints are universal but violable. It is not the fulfilment of all the constraints that makes a phonological form optimal; instead, the candidate with the least expensive violation of the constraints becomes optimal. Even though the constraints are universal, their value in a specific language is decided by the language specific ranking. Languages vary based on the different ranking of the same set of constraints. Both traditional generative framework and OT treat grammar as an input and output device and share the idea of universality.

Ideas like lexicon, richness of the base, GEN, and EVAL are essential to the framework of Optimality Theory. The underlined forms of the morphemes are stored in the lexicon. It contains contrastive information regarding morphemes. The lexicon provides all the relevant information to the GENERATOR (GEN) so that it can generate some probable outputs. However, the OT constraints are not implemented at the input level or the underlined representation. This specific idea is known as the richness of the base. GEN creates a set of probable outputs from the input supplied by the lexicon. The surface form is chosen based on a specific language's EVALUATOR or constraint hierarchy.

There are two types of constraints available in OT, markedness and faithfulness. Markedness constraint is strictly implemented on the output. In contrast, the faithfulness constraint refers to both underlined representation and output, as it demands the output to be identical to the input regarding a concerned feature. Constraints are in the domination relationship with each other. EVAL is the core component of the OT mechanism and is language-specific. The optimal candidate incurs the least number or degree of violations. Hence, it is the most harmonious candidate. Markedness constraints need the output candidates to fulfil a set of structural requirements. The optimal candidate is supposed to be well formed. Markedness constraints push for unmarked and simpler surface forms. Such forms are more common typologically and, in many cases, easier to produce from the articulatory standpoint. However, some marked structures are permitted in every language. Faithfulness constraints intend to lessen the featural difference between the input form and the surface form. Simply put, a faithfulness constraint requires the output to be the same as the input. These two types of constraints are in opposition to each other. Enforcing the unmarked and simpler surface forms is only possible if the lexical contrast between the input and output is allowed. On the other hand, for the input to be identical to the output, the lexical contrasts between the input and output must be removed.

(9) *VOICED-CODA (Kager, 1999, p. 14)

Obstruents must not be voiced in the coda position.

(10) IDENT-IO (VOICE) (Kager, 1999, p. 14)

The specification for the voicing of the input must be preserved in the output.

The initial constraint is a markedness constraint, which intends to enforce voiceless codas. On the other hand, the faithfulness constraint intends to preserve the voicing value of the input in the output. In the case of Dutch, the constraint *VOICED-CODA dominates IDENT-IO (VOICE), whereas, in English, the ranking of these two constraints is the opposite. As a result, English contains voiced codas, but Dutch does not.

(11) FT-BIN (Prince & Smolensky, 1993, p. 92)

Feet are binary under moraic or syllabic analysis.

(12) PARSE-σ (Prince & Smolensky, 1993, p. 92)

Syllables are parsed by feet.

When FT-BIN dominates PARSE-σ, the degenerate foot gets prohibited in that language. Pintupi, an Australian language, does not allow a degenerate foot (Kager, 1999). As a result, all the words with an even number of syllables can be parsed into feet;

however, when Pintupi words contain an uneven number of syllables, the last syllable is made extrametrical. Pintupi stress is quantity insensitive and free from degenerate foot, so it needs two syllables to create a foot. A model tableau is used to show how the constraints work in the OT.

(13) Tableau 1: A model OT tableau

Input	Constraint 1	Constraint 2	Constraint 3	Constraint 4
(a)☞ Candidate 1			**	
(b) Candidate 2		*!		
(c) Candidate 3	*!		*	*

In this model tableau, candidate 1 is the optimal candidate and it incurs two violations of constraint 3, which happens to be a lower ranking constraint. Candidate 2 fatally violates the constraint 2. Even though it is only one violation, it is the violation of the second highest ranking constraint. As a result, candidate 2 gets out of the competition. The violation of constraint 1 committed by candidate 3 is fatal. It also violates constraint 3 and 4.

Two or more constraints can share the same rank. In that case, the constraints that dominate one constraint from this group will also dominate others. In the model tableau, constraints 1 and 2 dominate constraints 3 and 4. The factorial typology of the model tableau is as follows.

(14) Constraint 1≫Constraint 2≫Constraint 3, Constraint 4

1.5 Research Questions

A sufficient amount of background information on the stress and tone systems of the different dialect groups of Tibetan has been collected. Though DT is primarily based on LT, the linguistic influence of the Amdo and Kham groups cannot be neglected in the overall structure of DT. The literature review provides some hints regarding the probable stress and tonal structures of DT. A substantial probability of DT consisting of left-headed stress is present. Additionally, if tone exists in DT, then H and L tones should be a part of the tonal inventory. With these points kept in mind, providing comprehensive answers to the following questions is attempted throughout the thesis.

Q1. What kinds of stress patterns are available in DT?

Q2. How are the stress contrasts exhibited through the acoustics correlates, viz., mean intensity, duration and f0?

Q3. Does the Dharamshala Tibetan variety exhibit tonal contrasts? If so, how are the tonal contrasts maintained in terms of quantity and quality?

Q4. How are the tonal contrasts, if any, exhibited in terms of different acoustic dimensions, viz., height of f0, direction of the f0 change, intensity, and duration?

Q5. How can word stress and tone in DT be theorised through OT?

Q6. How to theorise word stress and tone in DT in the context of reduplication?

Apart from these questions, the thesis will further explore a few more points regarding the stress and tone system. The status of DT will be examined using the typological dichotomy of tonal language and stress accent language. Iambic-trochaic law and how different acoustic observables in DT act in reference to the law will be examined. Tone-stress alignment in DT will also be discussed. The upcoming and final section of this chapter looks at the organisation of the chapters.

1.6 Organisation of the thesis

This remaining thesis is divided into five chapters. Chapter 2 discusses in detail the acoustics of DT stress and tone. Two lists of stimuli are provided for the two separate production experiments. The results of the statistical experiments are discussed later to explore the DT stress pattern and how many different types of tones are available in DT. Additionally, it is answered which specific correlates are most reliable in measuring stress and tone in DT.

Chapter 3 offers an Optimality theoretic formulation of the different stress patterns in DT. It includes an in-depth exploration of the universal characteristics of stress and how these characteristics are embodied in the OT constraints. A language should usually have only one ranking. The phonological situation regarding the existence of multiple patterns is explained in terms of a central or core pattern and exceptional or peripheral patterns.

Chapter 4 elaborates on how the citation tones in DT behave in the company of other tones in the domains of compound words and phrases. A list of stimuli is chosen, and the tones are studied in the citation and surface forms. Finally, an OT analysis is proposed. Along with that, tone sandhi is explored in the case of a morphological element whose tone category does not change in the influence of other tones.

Chapter 5 explores the behaviour of stress and tone in the domain of reduplication in DT. In the case of both stress and tone, maintaining the emergence of the unmarked (TETU) is higher priority than fully copying the stress and tone patterns of the base into the RED. However, even if by completely copying the stress and tone pattern in the RED, TETU can still be achieved, the stress and tone pattern gets copied in such cases. OT has been used as the theoretical framework in this chapter.

Chapter 6 offers a conclusion to the thesis. It provides a summary of all the chapters. It includes a discussion on how the binary approach to differentiate between a stress and tone language always does not work. A succinct deliberation on the Iambic-Trochaic law is also presented. Additionally, a brief analysis on how stress and tone are aligned in DT is offered. Finally, it also offers a discussion on the limitations of the work and further scope of future research on this topic, and this marks the end of this chapter as well as the thesis.

Chapter 2

Acoustic Correlates of Word Stress and Tone in the Dharamshala Tibetan

2.1 Introduction

Lhasa Tibetan (LT) has been primarily regarded as a tonal language (Duanmu, 1992; Hu, 2012; Kjellin, 1977; Lim, 2018). Additionally, different opinions concerning the word stress pattern of LT have also been provided by different scholars (Denwood, 1999; Monich, 2011; Tournadre & Dorje, 2003). As Dharamshala Tibetan (DT) is primarily a variation of LT, the literature available on LT stress and tone is likely to offer significant clues regarding the probable stress and tone patterns of DT. Tibetan people from the Amdo and Kham regions are also the inhabitants of the DT speech community, and these two language groups also contain different tonal and stress pattern (Caplow, 2017; Janhunen & Norbu, 1999; Suzuki, 2017; Watters, 2002, Pp. 23–24). Some impact of the stress and tone of the said two language groups being present in DT is also a possibility.

One of the essential steps in the study of stress and tone is to objectively examine the audio sample of the said language data to provide an analysis of the acoustic correlates, namely, f0, intensity, duration, etc. This step ensures two things. Firstly, it assists in the classification of the stress and tone, both quantitatively and qualitatively, in the concerned language. Secondly, it also provides a clear understanding of the individual roles each correlate plays in the formation of the said suprasegments. As the previous chapter has already provided a detailed discussion of the scholarly opinions regarding the tone and stress of LT and the other two Tibetan language groups, the current chapter will offer an acoustic and statistical study of the acoustic correlates of both word stress and lexical tone.

Two different production experiments are conducted to examine the acoustic properties of DT stress and tone. A set of bisyllabic, trisyllabic and quadrisyllabic Tibetan words are used as stimuli for the experiment on stress. As the said acoustic correlates of the different syllables are compared to ascertain the stress pattern, words containing at least two syllables are needed in this case. On the other hand, a set of monosyllabic Tibetan minimal pairs and triplets are utilised to examine the acoustics of DT tone in a different experiment. This chapter intends to provide satisfactory answers to the following set of questions.

Q1. What kinds of word stress patterns are available in the Dharamshala variety of Tibetan language?

Q2. If a predictable stress pattern exists in the DT, how are the acoustic correlates like intensity, duration, f0, etc., responsible for the formation of the stress pattern individually?

Q3. Does the DT variety exhibit tonal contrasts? If so, how are the tonal contrasts maintained in terms of quantity and quality? Are the tonal contrasts, if any, similar to those reported for the standard Tibetan?

Q4. How are the tonal contrasts exhibited in terms of different acoustic dimensions, viz., f0 directionality, f0height, intensity, and duration?

Section 2 is divided into two parts. Section 2.1 is concerned with the DT L1 speakers who participated in the study. It describes different conditions which made these people suitable for the production experiments. Section 2.2 includes the technicalities of data recording, post-recording handling of data, and finally, extraction of the values of acoustic correlates. Section 3 is divided into two parts. Sections 3.1 and 3.2 list the stimuli for stress and tone experiments in the successive order. Section 4 provides the statistical reasoning behind the DT word stress experiment. Sections 4.1, 4.2 and 4.3 convey the results of the one-way repeated measure ANOVA test on DT bisyllabic, trisyllabic and quadrisyllabic words. Section 4.4 describes the details of the ANOVA test on the right-headed DT words. Section 4.5 briefly discusses all the statistical results found in section 4. Section 5 puts forward reasoning behind why an ANOVA based justification is not sufficient in the case of tone determination in DT. Section 6.1 includes an ANOVA based timepoint analysis of the acoustic correlate f0 directionality. Section 6.2 concerns itself with the ANOVA analysis of other correlates like f0 height, intensity and duration. Section 7 adds a simple generalized linear regression modeling (GLM), and estimated marginal means (EMMS) of the acoustic correlates are generated. The chapter ends with a conclusion in section 8.

2.2 Methodology

2.2.1 Participants

Nine native speakers, five female and four male, participated in both of the production experiments. The participants belong to the age group of early twenties to early forties. Their educational qualifications range from high school graduation to bachelor's degrees in different fields. None of the participants had speech disorders or hearing loss during data elicitation. All of them had intact teeth. None of them suffered from cold or breathing issues during the data collection.

They were fluent in DT and could read the Tibetan script. The participants also had varying degree of proficiency in English and Hindi, the two languages they need for daily communication with the local community and others. The primary medium of interaction with the participants was English, followed by Hindi in a few cases. The recording process and the purpose of this data collection were explained to each participant. An informal consent related to data usage was taken from each participant during the recording.

2.2.2 Data recording and annotation

The environment of speech data elicitation strongly influences the quality of the data produced. A complete soundproof lab setup was unavailable since the data was collected in the field. A significant chunk of the data was collected in the private closed rooms of the participants during mornings and afternoons when the outside noise is minimal. In other cases, different classrooms were used. Noises emanating from machines like fan, refrigerator or a computer were also kept minimal. The presence of carpet-covered floors further ensured minimal noise distortion. Data was recorded on a Zoom H2N recorder connected with a Rode compact unidirectional microphone. The distance between the mouth of the participants and the microphone was approximately 25 mm to ensure a minor noise intervention and turbulence-free speech data. The speech data was recorded with 44.1 kHz and 32-bit resolution sampling frequency. The data elicitation sessions lasted from approximately forty-five to sixty minutes. Rest was provided to the participants in between the speech data elicitation.

A dataset was constructed with the help of a Tibetan L1 speaker. The constructed dataset was cross-examined with other native speakers. All the words were written using the Tibetan script. A priming sentence was recorded first to trigger the meaning of the target word. The participants were instructed to produce the scripted priming sentence first, followed by the target word using a fixed sentence frame of /ŋa X lab in/ 'I will say X', where X is the target word. Each participant was shown a demo using a few filler items to make them comfortable with the experimental procedure. The participants used a regular speaking rate while producing the scripted sentences. All the words were manually randomised. The whole set was repeated six times with a considerable gap between sessions. If there was any issue with the elicitation of any of the sentences, the participants were asked to repeat it again to cut down faulty data. The best five iterations for each word produced by each participant are selected and utilised for the final analysis.

Post-recording, the target words were manually annotated using Praat (Boersma & Weenink, 2010). Multiple tiers were created to mark each target syllable's f0, duration, and intensity. The Praat script used for information extraction was written by Gope (2016). This script was used to extract the measurements of all the acoustic dimensions considered for the study on lexical stress and tone, viz., mean f0 (or f0 height), f0 direction (divided into eleven equally paced time points), duration, and intensity. For visual observation, the measured values were averaged across all the repetitions for each target word.

2.3 Stimuli for the production experiments

2.3.1 Stimuli for the Word Stress experiment

This experiment uses bisyllabic, trisyllabic, and quadrisyllabic DT words as stimuli. Twelve bisyllabic, six trisyllabic and four quadrisyllabic words are used in the case of the supposedly left-headed words. Since bisyllabic words are found to be the highest in number according to the primary data, the number of bisyllabic words as stimuli is highest in the experiment. Only one bisyllabic and one trisyllabic supposedly right-headed word is found during the fieldwork.

Since bisyllabic DT words are readily available, words with either the same vowel or similar vowel quality in both syllables have been selected for achieving the same or similar environment. It was done so that the values of the acoustic parameters to be extracted from these words are accurate. However, a similar approach was not possible to employ in the case of trisyllabic and quadrisyllabic words due to less availability. The following lists (1-4) contain the stimuli for the production experiment on DT word stress. The DT words are shown with stress marks and the foot structure.

(1) Bisyllabic DT words (Left-headed)

(a)	(ˈʈʰɔŋ.mo)	‘female friend’	(g)	(ˈpak.pa)	‘skin’
(b)	(ˈtʃʰo.mo)	‘lake’	(h)	(ˈpu.gu)	‘child’
(c)	(ˈge.gen)	‘teacher’	(i)	(ˈda.wa)	‘moon’
(d)	(ˈpʰo.mo)	‘daughter’	(j)	(ˈpʰu.ʧung)	‘child’

(e)	(ˈka.wa)	‘thick’	(k)	(ˈkʰa.wa)	‘snow’
(f)	(ˈʃi.mi)	‘cat’	(l)	(ˈnor.bu)	‘gem’

(2) Trisyllabic DT words (Left-headed)

(a)	(ˈrim.po)(ˌʧʰe)	‘lama’	(d)	(ˈɖem.doŋ)(ˌkʰaŋ)	‘museum’
(b)	(ˈpiŋ.ga)(ˌbʰu)	‘male cousin’	(e)	(ˈsa.pa)(ˌsaŋ)	‘Friday’
(c)	(ˈmen.si)(ˌkʰaŋ)	‘hospital’	(f)	(ˈkʰe.raŋ)(ˌso)	‘you’

(3) Quadrisyllabic DT words (Left-headed)

(a)	(ˈpin.ga)(ˌbʰu.mo)	‘cousin sister’	(c)	(ˈdo.la)(ˌri.mo)	‘rock painting’
(b)	(ˈma.ni)(ˌkar.lo)	‘prayer wheel’	(d)	(ˈni.ʃu)(ˌsa.ni)	‘twenty-two’

(4) Bisyllabic and trisyllabic DT words (Right-headed)

(a)	(po.ˈta).la	‘Potala palace’
(b)	(ʧʰi.ˈwa)	‘death’

The basic DT syllable structure is (C)V(C). Like LT, DT has shown weight distinction. LT has both light and heavy syllables. Lim (2018) has offered examples of heavy syllables with CV: shape in LT from his field data. DT also exhibits the same weight pattern in terms of syllabic weight distinction.

The following two lists feature monosyllabic DT words with light and heavy syllables, respectively. Monosyllabic words are considered stressed by default (Gussenhoven, 2004, p. 14). However, the following words are not included in the statistical analysis of acoustic correlates of stress. As the mean difference in different syllable nuclei can only be measured and compared in words with at least two syllables, only bisyllabic, trisyllabic and quadrisyllabic DT words are measured. Since such comparison is not possible in the case of monosyllabic words, they are not included in the analysis.

(5) Monosyllabic DT words

(a) /tʰib/	'dark'	(d) /ŋa/	'I'
(b) /tʰang/	'simple'	(e) /kʰam/	'Kham area of Tibet'
(c) /ke/	'language'	(f) /tso/	'a hybrid animal'

(6) Bimoraic DT words

(a) /pʰo:/	'Tibet'	(c) /ma:/	'red'
(b) /pu:/	'hair'	(d) /ʈa:/	'horse'

2.3.2 Stimuli for the experiment on DT lexical tone

A list of 32 monosyllabic words (CV and CVC structures) with two-way and three-way minimal pairs and triplets (13 minimal pairs and 2 triplets) was carefully constructed. The participants were asked to produce the target word within the frame sentence. Multiple iterations of the tokens are used as the data for the production experiment on DT tones later on.

(7) DT minimal triplets and minimal pairs

Meaning 1		*Meaning 2*		*Meaning 3*	
(a) /lá/	'rent'	/lā/	'pass'	/là/	'honorific'
(b) /tʃʰá/	'pair'	/tʃʰā/	'bird'	/tʃʰà/	'tea'
(c) /séɾ/	'gold'	/sèɾ/	'what'		

(d) /tʰáŋ/ ‘empty’ /tʰàŋ/ ‘and’

(e) /tsí/ ‘life’ /tsì/ ‘top’

(f) /tʃʰáŋ/ ‘beer’ /tʃʰàŋ/ ‘north’

(g) /ŋá/ ‘five’ /ŋā/ ‘I’

(h) /máɾ/ ‘butter’ /māɾ/ ‘low’

(i) /pʰú/ ‘gorge’ /pʰū/ ‘son’

(j) /páɾ/ ‘lit’ /pāɾ/ ‘picture’

(k) /kʰāŋ/ ‘snow’ /kʰàŋ/ ‘only’

(l) /ʃū/ ‘strong’ /ʃù/ ‘sofa’

(m) /tʰā/ ‘end’ /tʰà/ ‘now’

(n) /kō/ ‘hard skin’ /kò/ ‘head’

(o) /tsē/ ‘top’ /tsè/ ‘life’

2.4 Acoustic correlates of word stress in DT

The current section offers a comprehensive account of a production examination regarding the acoustic correlates of word stress to supplement the initial hypothesis that DT word stress patterns primarily consist of left-headed and recurring stress, along with a few minute exceptions. Intensity, fundamental frequency (f0) and duration of the vowels in existing syllables have been studied with the help of one-way repeated measure Analysis of Variance (ANOVA) in both left-headed and right-headed DT words.

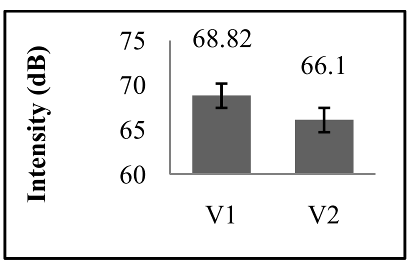
2.4.1 Acoustic Correlates of word stress in DT bisyllabic words

In the case of bisyllabic words, the nucleus of the stressed syllable should ideally receive the highest value in terms of the three acoustic correlates mentioned above. In the case of words with more than two syllables, the nucleus in the syllable with the primary stress is likely to carry the highest value in terms of the acoustic correlates. Additionally, the nucleus in the syllable carrying the secondary stress should receive the second highest value. Other syllables in between the stressed syllables occupy unstressed positions. As a result, in case of the DT words with more than two syllables, stress should ideally be recurring.

Twelve DT bisyllabic words are used as the target words in this subsection. The five best utterances of each word from each speaker are selected for extracting the required information of the acoustic correlates. Therefore, the number of tokens for bisyllabic words used in this study is 12 words*2 syllables*9 participants*5 repetitions= 1080. The upcoming subsections offer the details of the ANOVA test along with the posthoc analysis wherever it is applicable.

2.4.1.1 Intensity

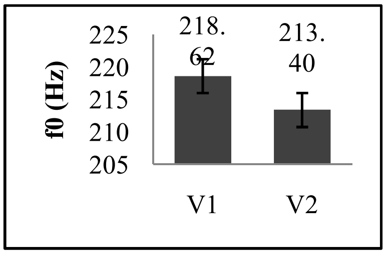
(8) Figure 1: Mean intensity of the two vowel groups (V1 and V2) in the DT bisyllabic words with the standard error (SE)



A one-way repeated measure ANOVA shows that there is a significant difference between the two syllables in terms of intensity between two vowel groups, V1 and V2 ($F(1, 539) = 270.14$, $p<.001$). Since there are only two syllables, it is evident that V1 has a higher value in terms of intensity ($M= 68.82$, $SD= 4.87$) than V2 ($M= 66.10$, $SD= 5.87$).

2.4.1.2 Fundamental frequency (f0)

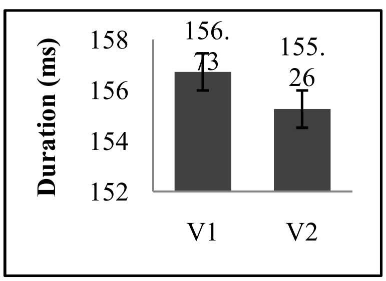
(9) Figure 2: Mean f0 of V1 and V2 of the DT bisyllabic words with SE



A one-way repeated measure ANOVA is conducted to reveal that there is a significant difference between V1 and V2 f0 values (F(1, 538) = 6.77, p<.01). As there are only two syllables, it is easily visible that V1 has the greater value (M= 218. 62, SD= 45.27), than V2 (M= 213.40, SD= 45.08).

2.4.1.3 Duration

(10) Figure 3: Mean duration of V1 and V2 of bisyllabic words with SE



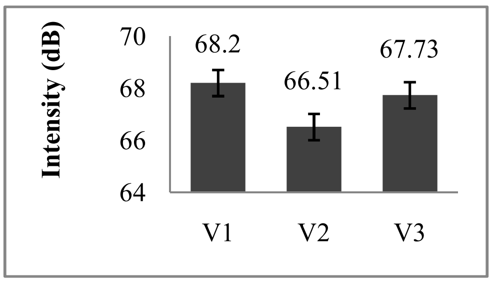
A one-way repeated measure ANOVA shows that a significant difference exists in the case of duration between two consecutive vowel groups, V1 and V2 (F(1,539)= 5.75, p<.05). V1 carries a higher durational value (M= 156.73, SD= 49.25) than V2 (M= 155.26, SD= 49.55).

2.4.2 Acoustics Correlates of word stress in DT trisyllabic words

In the case of trisyllabic words, six DT words are used as the target words. The five best iterations are picked for extracting information regarding acoustic correlates. In the case of trisyllabic words, the number of tokens is 6*3*9*5= 810.

2.4.2.1 Intensity

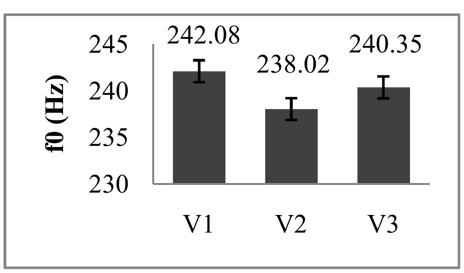
(11) Figure 4: Mean intensity in V1, V2 and V3 of the DT trisyllabic words with SE



A one-way repeated measure ANOVA indicates that the intensity value is significantly different, at least in one group of vowels ($F (2, 538) = 14.23$, and $p< .001$). An LSD (Least Significant Difference) posthoc analysis reveals that the V1 group has the highest mean intensity value (M=68.20, SD=5.63), whereas the V2 has a lesser mean intensity (M= 66.51, SD = 7.63). The last group, V3, has a greater mean intensity than V2 but less than V1 (M= 67.73, SD= 6.67).

2.4.2.2 Fundamental frequency (f0)

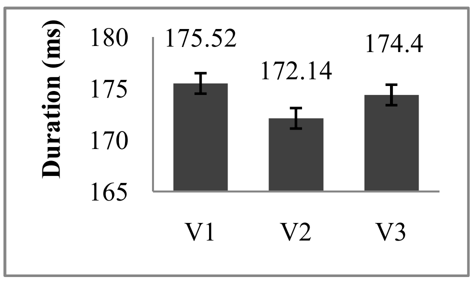
(12) Figure 5: Mean f0 in V1, V2 and V3 of the trisyllabic words with SE



A one-way repeated measure ANOVA reveals that the f0 value is significantly different, at least in one group of vowels ($F(2, 448) = 6.63$, $p < .001$). A posthoc LSD test further confirms that the f0 value of V1 is the highest (M= 242.08, SD= 51.87), whereas it is V2 that carries the lowest f0 value (M= 238.02, SD= 49.28). The f0 value of V3 is lower than V1, but higher than V2 (M = 240.35, SD = 50.24).

2.4.2.3 Duration

(13) Figure 6: Mean duration in V1, V2 and V3 of trisyllabic word with SE



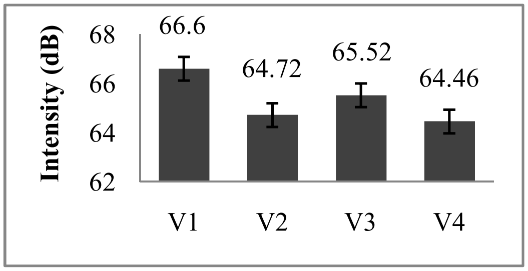
A one-way repeated measure ANOVA indicates that duration is significantly different, at least in one group of vowels ($F(2, 538) = 6.12$, $p<.01$). A posthoc LSD test further reveals that it is the V1 group that has the highest durational value (M= 175.52, SD= 46.83). The last vowel, V3, on the other hand, carries a lesser value than V1 (M=174.40, SD= 48.07). The durational value of V2 is the least in the group (M= 172.14, SD= 48.75).

2.4.3 Acoustics correlates of word stress in DT quadrisyllabic words

The current subsection offers the last statistical analysis of the bisyllabic words as DT words with maximum of four syllables are chosen for this study due to availability issues. In the case of the quadrisyllabic words, four DT words are used as target words. The five best iterations are picked for extracting information regarding acoustic correlates. Therefore, the number of tokens for quadrisyllabic words used in this study is 4*4* 9*5= 720.

2.4.3.1 Intensity

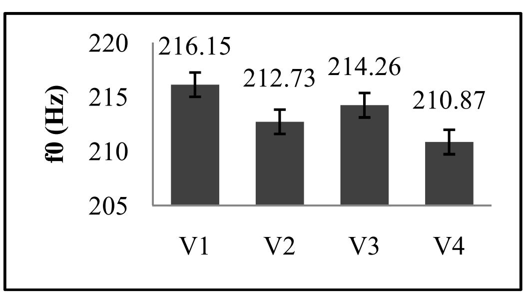
(14) Figure 7: Mean intensity in V1, V2, V3 and V4 of DT quadrisyllabic words with SE



A one-way repeated measure ANOVA is used, and it reveals that intensity is significantly different in at least one of the vowel groups (F (3,402)= 5.49, $p<.001$). An LSD posthoc test shows that V1 has the highest intensity value (M= 66.60, SD= 6.96), whereas V3 has the second highest intensity value (M=65.52, SD= 6.92).V2 intensity value lies in between V1 and V3 (M= 64.72, SD= 8.39). V4 has the lowest intensity value (M= 64.46, SD= 9.17).

2.4.3.2 Fundamental frequency (f0)

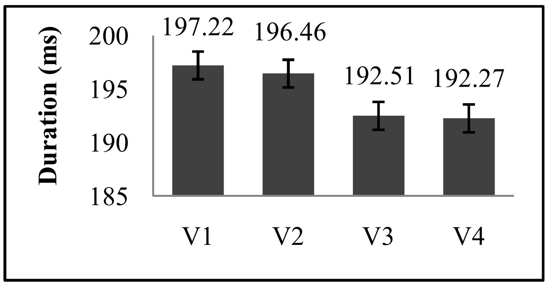
(15) Figure 8: Mean f0 in V1, V2, V3 and V4 of quadrisyllabic words with SE



A repeated measure one-way ANOVA reveals that in the case of DT quadrisyllabic words, the f0 value of at least one of the vowel groups is significantly different (F (3,402)= 5.10, $p<.01$). A posthoc LSD test explains further that it is the V1 that carries the highest f0 value (M= 216.15, SD= 44.36), whereas V3 carries the second highest f0 value (M= 214.26, SD= 46.04).V2 has the third highest f0 value (M= 212.73, SD= 42.64), whereas it is V4 that scores the lowest (M= 210.87, SD= 44.63) in terms of f0.

2.4.3.3 Duration

(16) Figure 9: Mean duration in V1, V2, V3 and V4 of quadrisyllabic words with SE



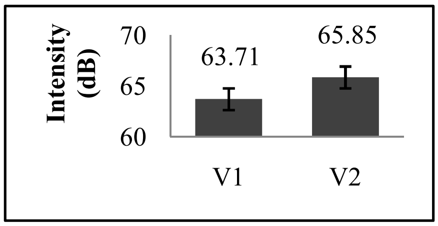
A repeated measure one-way ANOVA confirms that at least one of the vowel groups is significantly different in terms of duration in the quadrisyllabic DT words with four vowel groups (F (3, 402)= 5.25, p< .001). A posthoc LSD test proves that V1 contains the highest value in terms of duration (M= 197.22, SD= 49.64), whereas V2 has the second highest duration value (M= 196.46, SD=50.12).V3 carries the third highest duration value (M= 192.51, SD= 50.18), and V4 carries the lowest value (M= 192.27, SD= 49.15).

2.4.4 Acoustics correlates of word stress in DT right-headed words

As only two words have been consistently found to be exhibiting right-headed Iambic stress, these two words are also examined by studying the syllables' intensity, f0 and duration. One of the words is bisyllabic, whereas the other is trisyllabic. The number of tokens for the bisyllabic word is 1*2*9*5= 90. The number of tokens for trisyllabic words is 1*3*9*5= 135. The next subsections offer the statistical analysis of the word stress of these two right-headed DT words.

2.4.4.1 Intensity

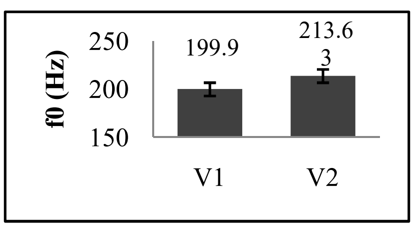
(17) Figure 10: Mean intensity of V1 and V2 of bisyllabic word with SE



A one-way repeated measure ANOVA shows that there is a significant difference between these two syllables in terms of intensity (F (1,44)= 11.42, p<.01). The second vowel contains a higher intensity value (M= 65.85, SD= 7.50), whereas the first syllable has a lower value (M= 63.71, SD=7.67).

2.4.4.2 Fundamental frequency (f0)

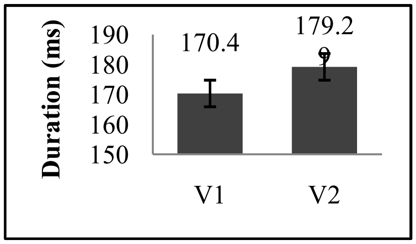
(18) Figure 11: Mean f0 of V1 and V2 of the bisyllabic word with SE



The difference is significant in terms of f0 between V1 and V2 (F (1, 44)= 9.63, p<.01). V2 carries the higher f0 value (M=213.63, SD= 47.45), whereas V1 has a lower value (M= 199.90, SD= 35.40).

2.4.4.3 Duration

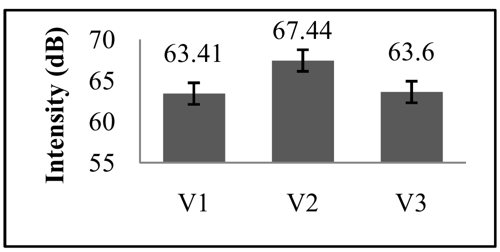
(19) Figure 12: Mean duration of V1 and V2 of bisyllabic word with SE



A significant difference exists between the V1 and V2 duration values (F(1, 44)= 7.34, p<.01). V2 has a higher value in terms of duration (M= 179.29, SD= 25.94), whereas V1 has a lower value (M= 170.40, SD= 24.22).

2.4.4.4 Intensity

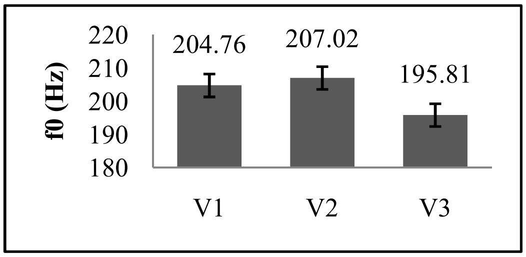
(20) Figure 13: Mean intensity of V1, V2 and V3 of the trisyllabic word with SE



A one-way repeated measure ANOVA indicates that the intensity value is significantly different, at least in one group of vowels (F (2, 88) = 6.72, p<.01). A post hoc LSD test ensures V2 contains the highest intensity value (M= 63.41, SD= 8.66).V3 intensity value (M= 63.60, SD= 10.48) is lower than V2, but slightly higher than V1 (M= 63.41, SD= 10.38).

2.4.4.5 Fundamental frequency (f0)

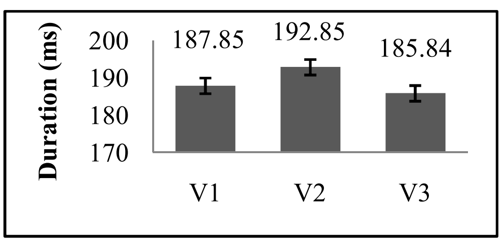
(21) Figure 14: Mean f0 ofV1, V2 and V3 of trisyllabic word with SE



A one-way repeated measure ANOVA indicates that the f0 value is significantly different, at least in one group of vowels (F (2, 88)= 5.77, p<.01). A post hoc LSD test proves V2 contains the highest f0 (M= 207.02, SD= 48.53).V1 has a lesser f0 than V2 (M= 204.76, SD= 44. 43), but higher than V3 (M= 195.81, SD= 44. 02).

2.4.4.6 Duration

(22) Figure 15: Mean duration of V1, V2 and V3 of trisyllabic word with SE



A one-way repeated measure ANOVA indicates that duration is significantly different, at least in one of the vowel groups (F= (2, 88)= 3.81, p< .05). A posthoc LST test ascertains that V2 has the highest durational value (M= 192.85, SD= 49. 09). In contrast, the duration of V1 is lesser than V2 (M= 187. 85, SD= 42. 08).V3 has the lowest duration value among the three (M= 185. 84, SD= 39. 41).

2.4.5 Discussion

DT words with left-headed stress patterns have intensity as the most reliable acoustic correlate of word stress, followed by fundamental frequency f0. This is true for DT left-headed words which might include two, three or four syllables. Duration is an important correlate to ascertain a stressed syllable for the bisyllabic and trisyllabic words. However, it is found to be inconsistent in the case of quadrisyllabic words. This is true for two different reasons. Firstly, the durational mean difference among the four vowel groups namely, V1, V2, V3 and V4 is also negligible. Secondly, V1 and V3 should ideally receive the highest mean durational value, respectively, as the primary and secondary stress holders. However, as V2 receives the second highest value for duration instead of V3, duration is not an effective correlate of stress in the case of DT quadrisyllabic words.

In the case of trisyllabic words, the difference in values of the correlates is higher between the first and second syllables. For the, DT quadrisyllabic words, the difference in values of the correlates is highest between the first and third syllables, apart from duration. In the case of the right-headed stress pattern, mean duration is found to be more consistent, along with intensity and f0.

2.5 Statistical analysis, model generation, and data representation for acoustic correlates of lexical tone

The visual observation of the raw values generated for each acoustic dimension offers a clue about the possible tonal contrasts in DT. To ensure the validity of the visual observations, a one-way repeated measure ANOVA (RM ANOVA) was conducted to examine the effect of dependent variables on the independent variable (tone types). The R (Version 3.6.3, Team, (2013)) embedded with R studio (Version 1.2.1335, RStudio, Inc., Boston, MA, USA) is used to conduct statistical analyses. In the RM ANOVA, the *lmer(y ~ x + (1|speaker)* function in R is used, where y is one of the dependent variables (viz., the acoustic dimensions such as f0 height, f0 directions, duration, intensity, etc.), and x is the independent variable, i.e., the number of possible tonal contrasts in DT.

However, it must be noted that the raw values generated for each acoustic dimension could be somewhat biased due to different factors (uneven number of tokens for each contrastive pair per speaker or any other hidden covariance). Furthermore, the range of f0 also depends on the size of the glottis and vibration of the glottis. The size of the glottis, on the other hand, may vary for different genders and ages. The vocal cords which are larger and thicker tend to have slower vibration. This tendency is generally visible in the case of the adult males. Slower vibration leads to lower rate of f0 (80-180 Hz). For smaller and thinner vocal cords, it is easier to vibrate faster. Such vocal cords are generally found in the case of the adult females. It might lead to a higher f0 rate than adult males, sometimes crossing 250Hz. F0 value might be affected in both males and females in the different age groups.

A simple generalised linear regression modelling (GLM) is used to account for the intra-speaker and inter-speaker anomalies (or any other hidden covariance) across all the tokens produced by all the speakers. *R*'s lm(y ~ x) function fits a basic linear model, where the dependent variable is y, viz., f0, intensity, duration, and x is the independent variable, viz., the possible tonal contrasts. However, the *lm(y ~ x)* function is modified to lm(y ~ x* Time) to examine if there is any interaction between tone and the f0 direction calculated over 11 timepoints.

Finally, type II analysis of variance (ANOVA) is incorporated in this study to explore the best model. The anova() function from the car package in R is adopted to generate the results. A pairwise comparison with Tukey's test examines the interaction levels between tone types. The emmeans package calculates the Estimated Marginal Means (henceforth EMMs) to better interpret the models for each dependent variable. It is calculated as *emmeans(lm, specs = ~Tone + Time, by = "Time", trans = "log", type =*

"response"). It is to be noted that different interpretations can be drawn while dealing with the transformations. Therefore, a ref_grid(lm) is also computed.

A pairwise comparison of the contrastive tonemes is also made using the *pairs()* function. The plot (estimates vs. contrastive tonal pairs) is formalised using the pairs() function applied to the emmeans object for f0. It must be noted that the EMMs are also calculated for every subject who participated in the production experiment to examine the f0 directionality. To do so, the function lm(f0 ~ Tone + Time + speaker) is used, and the EMM is calculated as *emmeans(lm, specs = ~Tone + Time +speaker, by = "speaker," trans = "log," type = "response")*. The EMM values were also estimated for the height of f0 (mean f0), intensity, and duration for visual observations. The details of the generation of this model can be found in Gope (2021). The threshold $p < 0.05$ is considered a significant difference for all the statistical analyses and modelling incorporated in this study.

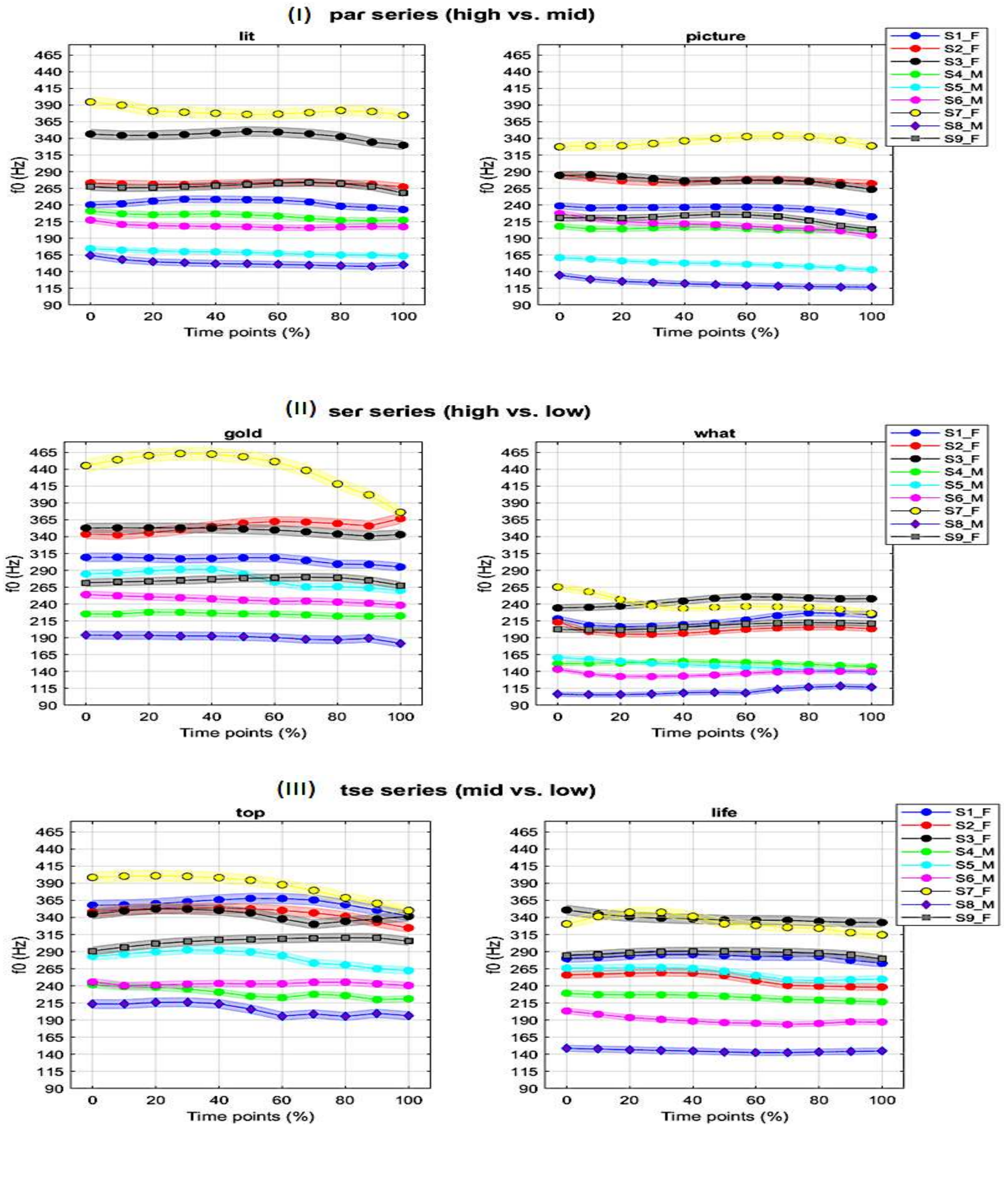
2.6 Acoustics correlates of lexical tone in DT

2.6.1 f0 directionality

The f0 direction contains 15,840 tokens (32 words * 9 subjects * 5 repetitions *11 time points). The raw f0 values of each contrastive pair were first visually examined over 11 time points- starting with the onset of the f0 labelled as 0%, till the offset of the f0, labelled as 100%. The f0 direction values are time-normalised for each token produced by each speaker.

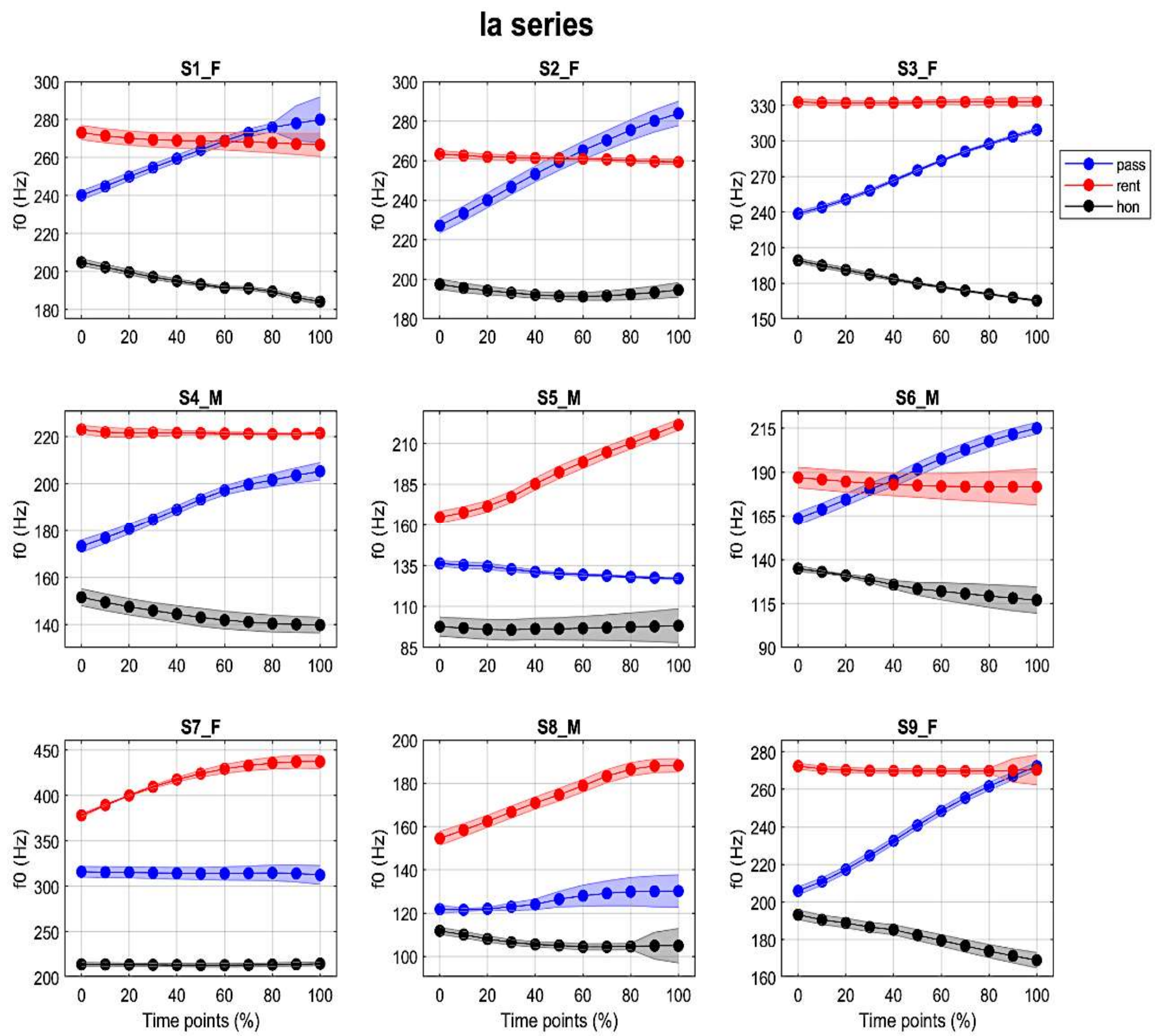
Figures 16, 17, and 18 show the raw f0 tracks of the contrastive tonemes produced by all the speakers who participated in the production experiments. The f0 tracks are generated by averaging the f0 measured at 11 equally spaced timepoints across the duration. It must be noted that each subject repeated the target tonemes six to seven times each. The best five iterations are used for the calculation. Figure 16 shows the f0 tracks of 3 toneme sets with two-way meaning contrasts.

(23) Figure 16: Raw f0 tracks (normalised across time for each speaker) and SE (the shaded part) of the /paɾ/, /seɾ/, and /tse/ series

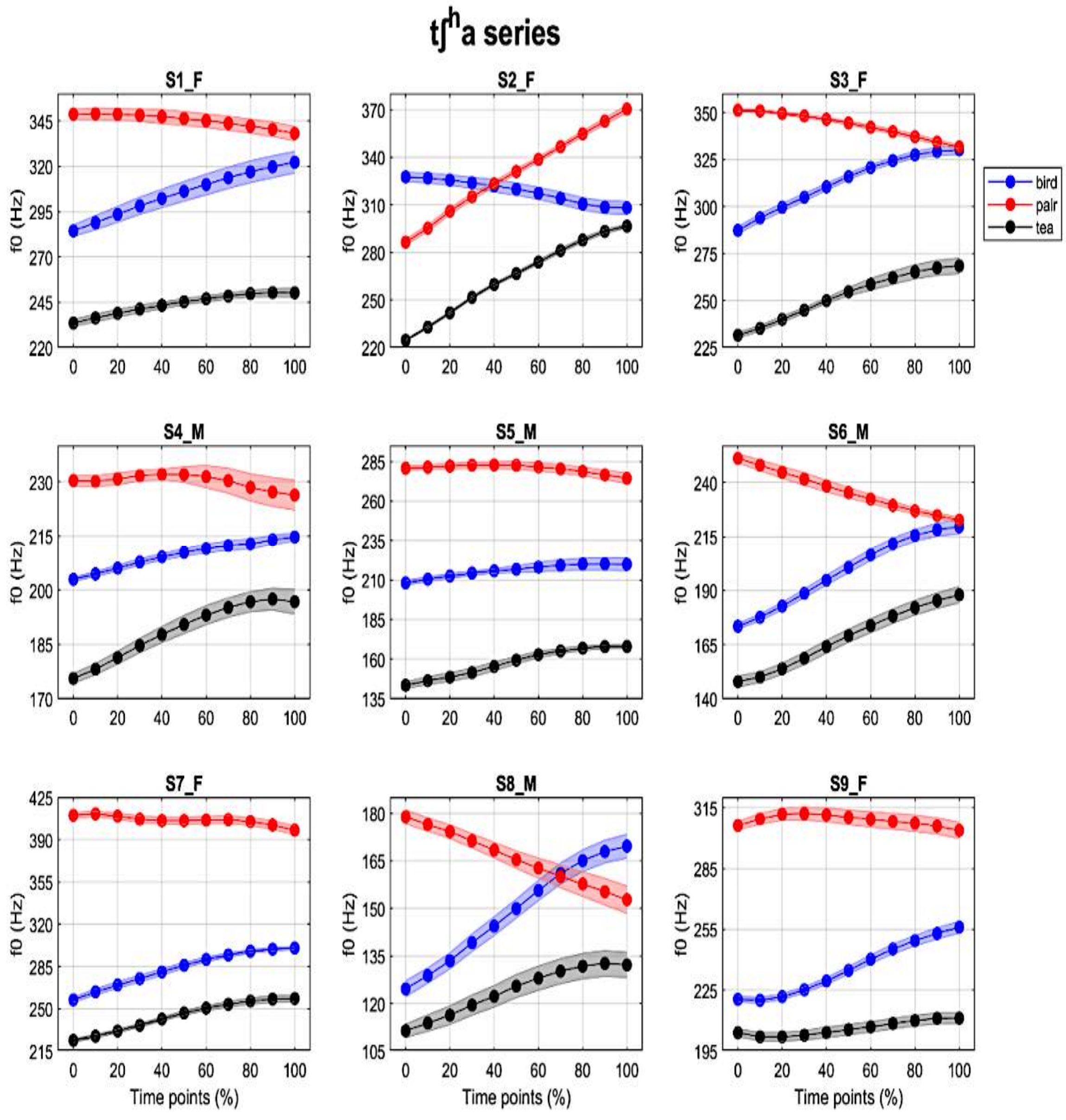


Figures 17 and 18 depict two triplets with three-way meaning contrasts, /la/ and /tʃʰa/, respectively. The tracks' visual observation indicates three-way tonal contrasts in this language. However, the directionality of f0 tracks is inconsistent. As a result, it is only possible to say there is a three-way tone contrast available in the DT, however, the quality of the said tones are yet to be decided. It can further be observed that almost all the participants maintained considerable f0 differences between each toneme.

(24) Figure 17: Raw f0 tracks (normalised across time for each speaker) and SE of the /la/ series produced by each participant



(25) Figure 18: Raw f0 tracks (normalised across time for each speaker) and SE of the /tʃʰa/ series produced by each participant

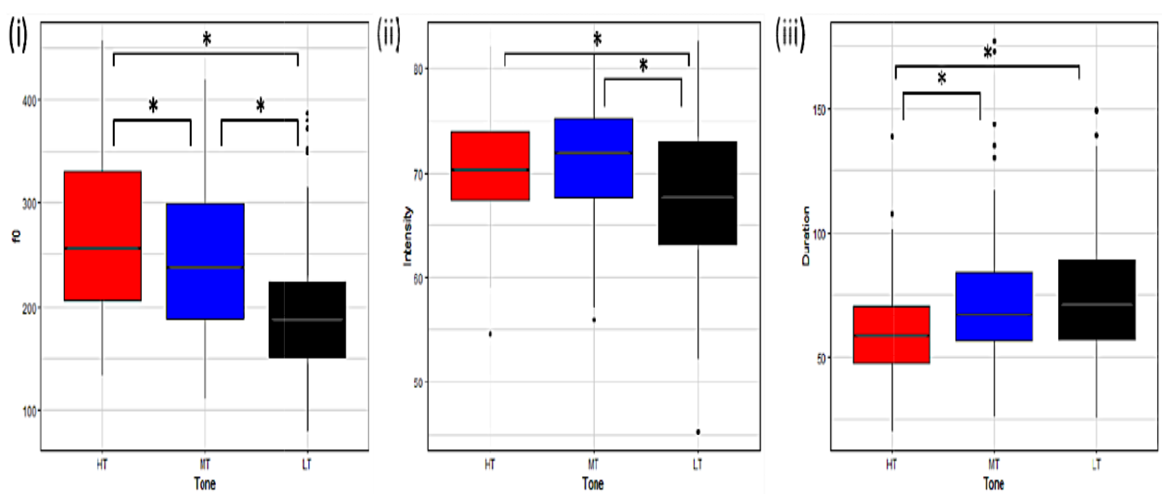


The visual observation of all the tokens considered in this study confirms an average of around 40 Hz difference between low tone and mid-tone, around 50 Hz between mid-tone and high tone, and around 75 Hz between high and low tone. However, the directionality of the f0 tracks in each series is inconsistent. It is tricky to assume the tones' quality (viz. level vs. contours) only by looking at the f0 tracks. Furthermore, researchers often prefer to measure the final velocity (generally, it represents the f0 calculated at 30ms before syllable offset time). However, the entire f0 track of each toneme carries irregular patterns. Thus, merely averaging all the tokens or looking at only the final velocity might be misleading in this context. To overcome this, measuring the estimated marginal means (EMMs) in this study is conducted.

2.6.2 Statistical analysis: mean f0, intensity, and duration

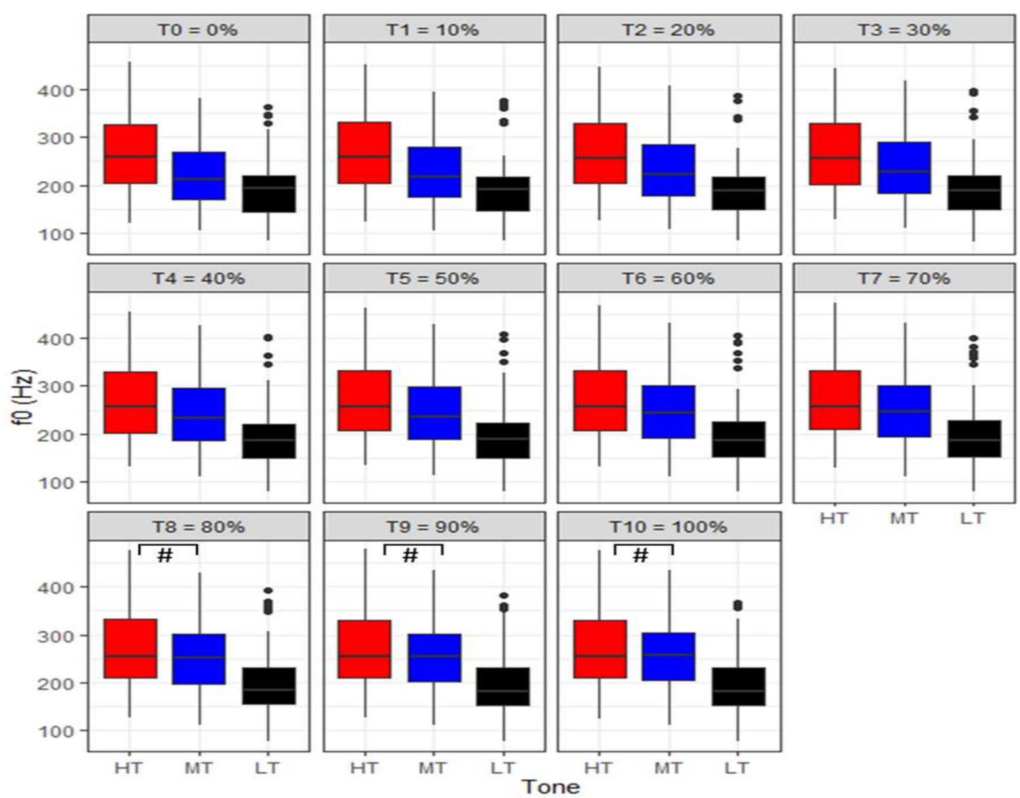
A repeated measure one-way ANOVA is conducted to validate the visual observations of the f0 tracks observed in figures 16, 17, and 18. The results confirm that the lexical tones are significantly different in terms of mean f0 (f0 height) (F[2, 324] = 11.26, p< 0.0001), intensity (F[2, 324] = 11.69, p< 0.0001), and duration (F[2, 324] = 11.26, p=<0.0001). Based on the height difference, the tonemes are considered high, mid, and low for further reference.

(26) Figure 19: Pairwise comparison of the contrastive tones using the post-hoc Tukey HSD



In order to determine the interactions between each tone type from the acoustic measurements mentioned above, a post-hoc Tukey test was conducted. The pairwise Tukey HSD shows that the three tones are significantly different in terms of f0 height (mean f0) [Figure 19 (i)]. However, the post-hoc analyses with a Tukey HSD revealed an interesting pattern for intensity and duration. A significant interaction was observed between high and low tones and mid- and low tones based on their intensity values. However, no significant interaction was observed between high and mid-tones [Figure 19 (ii)]. Similarly, the duration indicated a significant interaction between high and low tones and between high and mid tones. However, no significant difference between mid and low tones was observed in their duration values [Figure 19 (iii)]. The non-significant pairs are marked with a hash [#] (T8 to T10, between high-tone and mid-tone).

(27) Figure 20: Boxplots exhibiting f0 contours of the tonemes and their pairwise comparison



The repeated measure one-way ANOVA was also conducted on the f0 tracks (measured at 11 equidistant duration points, averaged across all the participants' repetitions) of the contrastive tones. The results are observed to be significant at all the 11 timepoints, viz., T0 (start pitch) $F[2, 324] = 36.02$, $p<0.0001$, T1 $F[2, 324] = 34.14$, p= <0.0001, T2 $F[2, 324] = 32.22$, $p<0.001$, T3 $F[2, 324] = 30.34$, p= <0.0001, T4 $F[2, 324] = 30.34$, $p<0.0001$, T5 $F[2, 324] = 28.03$, $p<0.0001$, T6 $F[2, 324] = 27.71$, $p<0.0001$, T7 $F[2, 324] = 27.71$, p= <0.0001, T8 $F[2, 324] = 28.25$, $p< 0.0001$*, T9 $F[2, 324] = 29.41$, p= <0.0001, and T10 $F[2, 324] = 30.51$, $p< 0.0001$. A pairwise comparison between the contrastive tonemes was also conducted using the post-hoc Tukey HSD. The results reveal a significant interaction amongst the three tones from T0 to T7 ($p< 0.05$). In contrast, the high-tone and mid-tone pairs returned a non-significant interaction near the end of the duration, viz., T8 to T10. This trend further indicates that the observation of the final velocity might not be sufficient to understand the quality of the contrastive tones.

2.7 Generalized linear regression and the generation of estimated marginal means (EMMs)

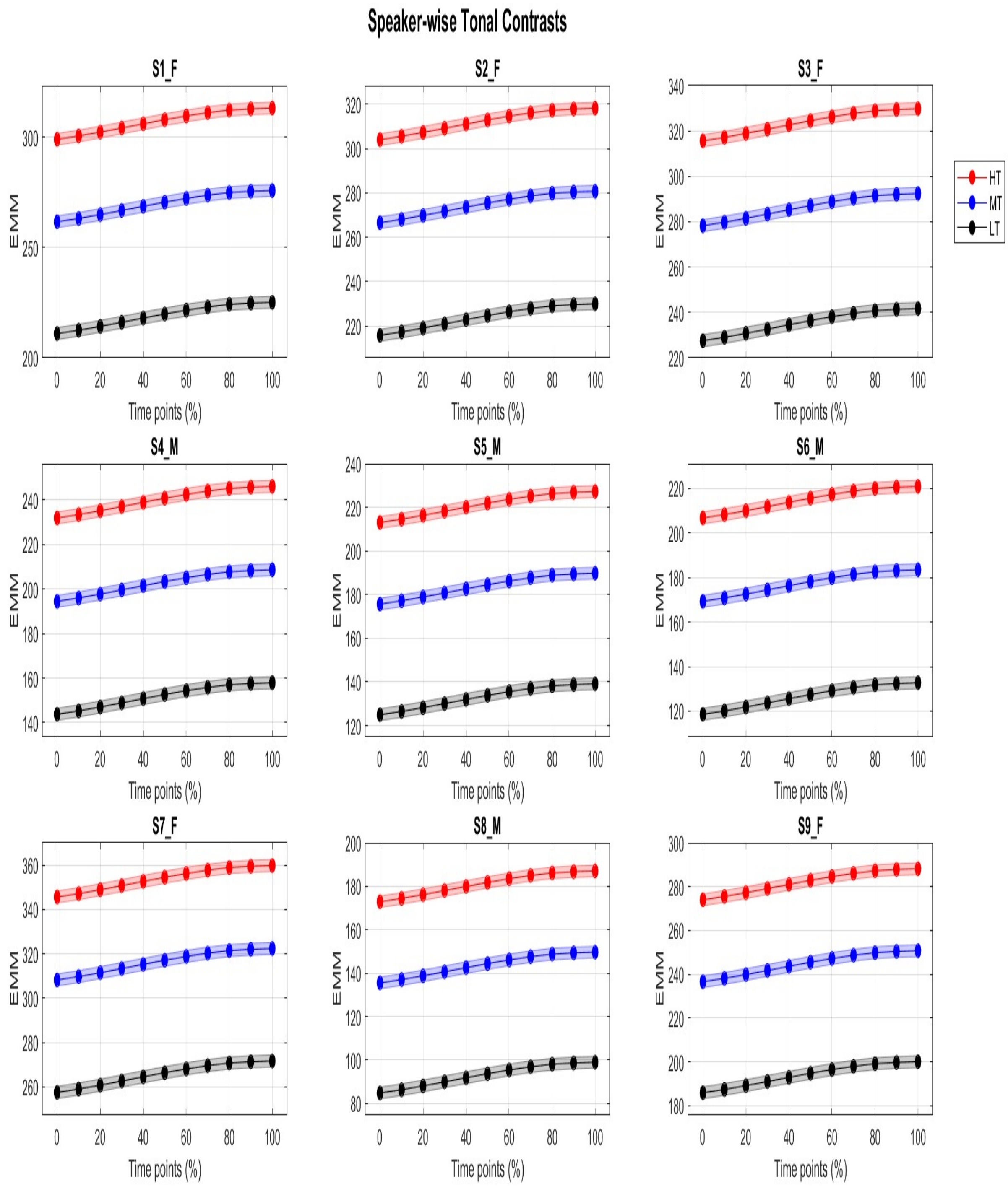
The results of the repeated measures ANOVA discussed above confirmed three-way tonal contrasts in DT. However, the quality of the contrastive tones is yet to be confirmed. Therefore, a generalised linear regression model was conducted on all the acoustic components, viz., f0 height, f0 at each time point (T0 to T10), intensity, and duration. In this context, two possible models, *lm1 = (f0 ~ Tone + Time) and lm2 = lm(f0 ~ Tone * Time),* are considered and computed to explore the significant interactions between tone types and the time points based on f0.

The ANOVA type II test is used to compare the better model. In the case of lm1, it is observed that the response of f0 with respect to (henceforth, w.r.t) tone and f0 w.r.t time show a significant level of interaction [$F (4084480, 2) = 480.49$, $p<0.0001$, and, $F(83652, 10) = 1.96$ $p = 0.032$, respectively]. The significant interactions indicate that the response f0 w.r.t. time or tone has an independent effect and must be included in this model. In case of the second model (lm2), f0 w.r.t. the interaction term, tone*time generates a non-significant outcome, $F(56786, 20) = 0.67$, $p = 0.86$. Therefore, the model, lm2, is discarded from further analysis. The raw values of the dependent variables, viz, f0 height, f0 directionality, intensity, and duration, are log-transformed. The transformed values are used to calculate the estimated marginal means (EMMs).

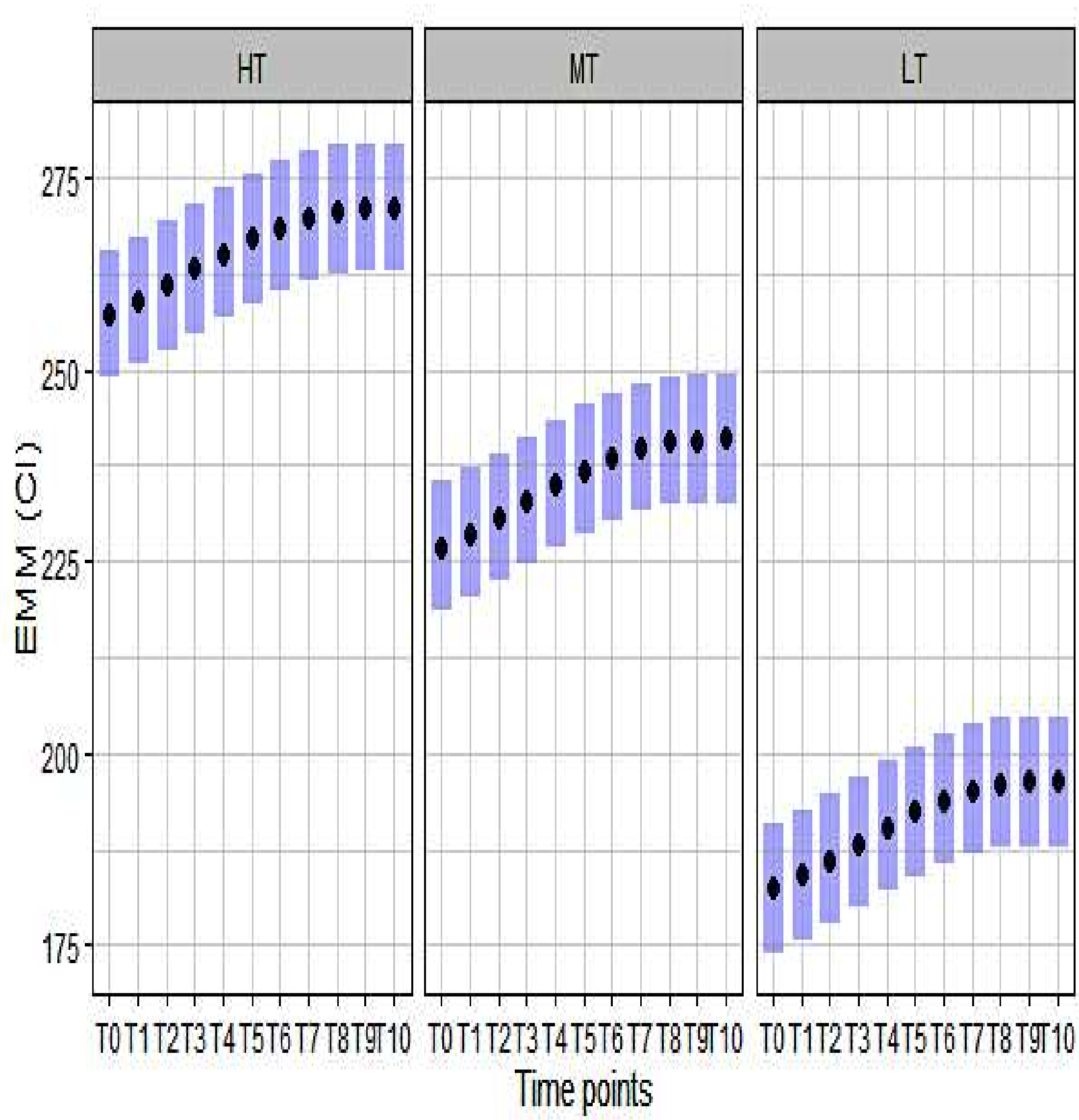
The speaker-wise linear regression modelling is conducted by adding the level "speaker" as one of the independent variables in the modelling. The updated modelling equation, thus, *becomes lm1 = (f0 ~ Tone + Time+ speaker).* The average pitch tracks of the contrastive tonemes produced by the individual speaker are generated using the converted EMM values. The values are averaged across each participant's repetitions for each toneme. These EMMs are calculated as the linear combinations of the regression coefficients. The generated EMMs show consistent contours for each participant's contrastive tones.

Figure 21 shows the representations of the contrastive tones, drawn using the converted mean EMM values, averaged across all the speakers' repetitions for each toneme. The regenerated contours using the EMMs confirm the quality of the contrastive tones in DT, viz., high, mid, and low tones. A pairwise comparison (at each time point) using the converted EMMS has been conducted to examine the interaction level of each toneme at each time point. The post-hoc Tukey HSD confirmed significant interactions at each timepoint between each toneme (including the timepoints T8 to T10 between high tone and mid tone, which were otherwise non-significant when the raw f0 values were considered). EMMs are derived from the f0 directionality (T0 to T10), as it is shown in the figure 21. They account for each speaker, all repetitions and all the contrastive toneme pairs. The redistributions of the f0 contours (in EMM values) facilitate the identification of the contrastive tones, viz., high, mid, and low. Figure 22 illustrates this point.

(28) Figure 21: Estimated marginal means (EMMs) and the confidence intervals (shaded area)

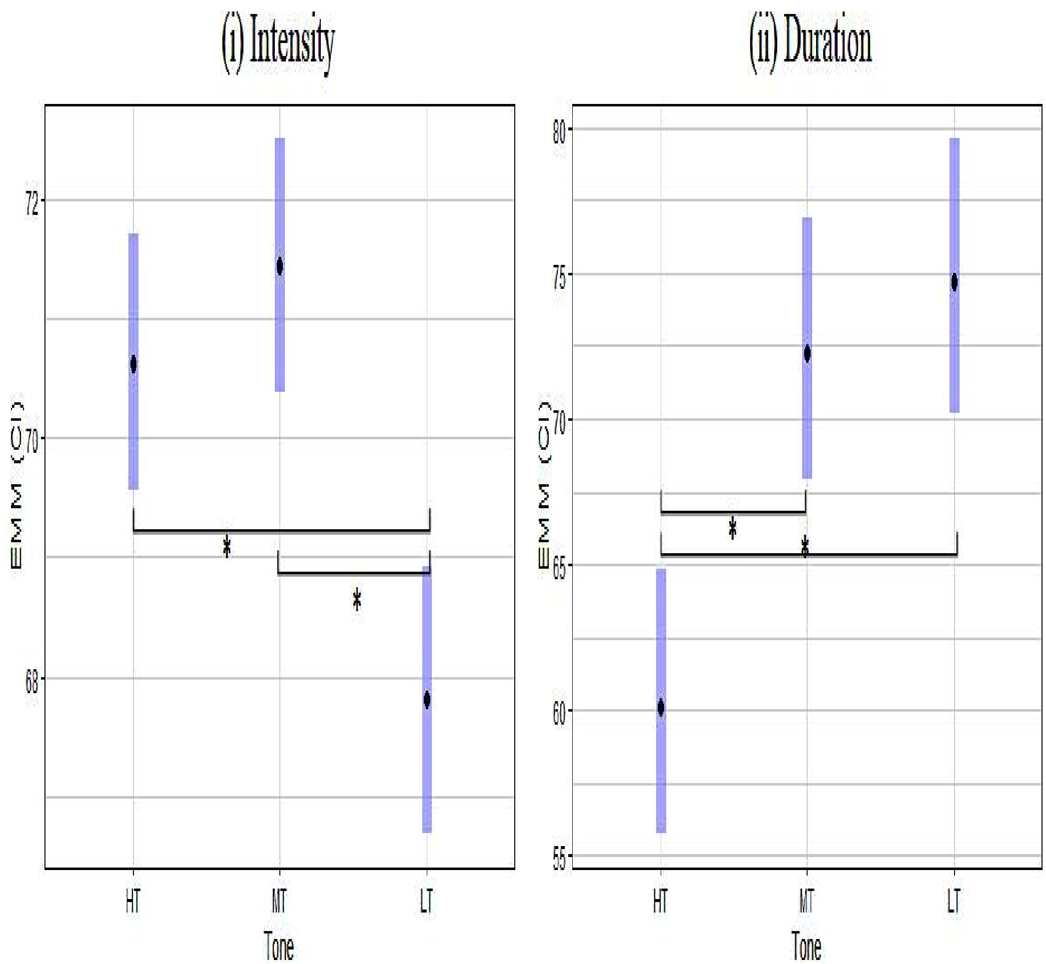


(29) Figure 22: Mean EMMs (derived from f0 directionality, i.e., 11 equidistant timepoints, T0 to T10) and the confidence intervals (blue bars)



The raw intensity and duration values are also converted to EMM values, and the converted values are used to compare the level of significance between each tone type. The results of post-hoc Tukey HSD show a non-significant interaction between high tone and mid tone for intensity, and between mid tone and low tone for the duration; a trend that is similar to the observations made with the raw f0 data. The results suggest that intensity and duration might not be the primary acoustic cues to distinguish each tone type. Figure 23 shows the results of the post-hoc Tukey HSD using a pairwise comparison (using the EMM values) of the contrastive tones. An (*) indicates the significant pairs; (i) shows the trend for the intensity, and (ii) shows the trend for the duration.

(30) Figure 23: post-hoc Tukey HSD showing a pairwise comparison (using the EMM values) of the contrastive tones



So far, the findings of the production experiment and the subsequent statistical modelling confirmed three-way tonal contrasts (viz., high, mid, and low tone) in DT. The overall f0 fluctuations (both height and direction) are the most salient indications leading to the tonal contrasts. Intensity and duration can be regarded as the secondary cues to the DT tonal contrasts. We concur with Lim (2018) that, like the Lhasa Tibetan, the DT variety of India also maintains three-way tonal contrasts; albeit the tones in DT are all level tones, the LH contour of Lhasa Tibetan (LT) is realised as a mid-tone in the DT variety.

2.8 Conclusion

DT stress system is predominantly left-headed and left-to-right oriented. The secondary stress rests on the third syllable if a word has more than two syllables. As the last syllable of a trisyllabic word can carry stress, degenerate foot is allowed in DT. The heavy syllables are stressed by default if a DT word contains it. Intensity and f0 are the most consistent acoustic correlates of DT stress in order to differentiate between stressed and unstressed syllables. In the case of duration, some degree of fluctuation is involved in the case of the longer words.

The results of the production experiment and the subsequent statistical modelling (GLM) confirmed the presence of three contrastive level tones in DT. The use of EMM-converted values confirmed the quality of the contrastive tones, viz., high, mid, and low. f0 directionality and f0 height are the most salient acoustic components, leading to tonal contrasts in this language. DT, at present, maintains a reduced number of stop sounds and an overall simplified phoneme inventory due to the loss of complex consonant clusters.

The tonal contrasts in DT are observed to be an essential component even though Dharamshala is geographically far away from the area of origin of the Tibetan language. Furthermore, the relatively small Tibetan speech community has to interact on a daily basis with the locals who predominantly speak Hindi in this region. English is the medium of instruction in high schools run by the community. These languages, viz., Hindi and English, are non-tonal. However, it can be assumed that the tonal contrasts observed in DT are likely to remain an integral part of this language's phonology, considering that most of the subjects who participated in the production experiment primarily represent the younger generation.

Chapter 3

Word stress pattern in Dharamshala Tibetan: an Optimality Theoretic formalisation

3.1 Introduction

Word stress has been one of the recurrent themes in the study of phonology. This supposedly generic statement makes further sense when we consider that word stress was once looked at as a feature with binary values which can be attributed to a segment (Chomsky & Halle, 1968, p. 66). It is no longer considered a feature rather a rhythmic property of increased prominence assigned to certain syllables in a particular domain. This domain might be a word or a phrase (Kager, 1999, p. 143). Metrical phonology concerns itself with rhythmic characteristics of speech. Liberman (1975) first conceptualised the notion of metrical theory, and the framework was further consolidated by Liberman and Prince (1977). In contrast to Chomskian idea of stress, metrical theory posited that the phenomenon of stress should be understood in terms of hierarchical and rhythmic organisation of different layers like syllables, feet, words and phrases. Hayes(1995, p. 25)has rightly suggested that word stress has a rhythmic structure with a strong and weak relationship between different syllables or morae. The prominence of one syllable is calculated in terms of that of the other syllable. The current chapter intends to offer an Optimality theoretic (Prince & Smolensky, 1993) reasoning of the word stress system in the Dharamshala variety of Tibetan.

The lack of comprehensive work on Dharamshala Tibetan (DT) word stress works as one of the motivations behind the current study. As DT is a subtype of LT, the present literature on LT stress might indicate the probable DT stress pattern. As mentioned in chapter 1, section (1.3), Lhasa Tibetan stress is primarily considered a left-headed system (Dawson, 1980; Monich, 2011; Tournadre & Dorje, 2003). Additionally, the postulation of Denwood (1999) regarding progressive vowel harmony in LT is a strong indicator of the existence of left-headed or trochaic stress. However, Lim (2018) considers that Denwood's understanding regarding the correlation between LT progressive vowel harmony and left-headed stress is inconclusive as LT also has instances of regressive vowel harmony.

The Tibetan speaking population in Dharamshala is in no way limited to only people whose ancestors came to India from Lhasa and nearby areas. Tibetan people from the Amdo and Kham geographical and dialect groups of Tibet are also included in the Tibetan speaking population of Dharamshala. As previously mentioned, the limited number of works on different varieties of Amdo and Kham dialect groups stress show that stress is mostly right-headed in these language groups (Caplow, 2017; Suzuki, 2017).

Even though DT can be termed a variety of LT, with close proximity to Tibetan speakers whose ancestors were originally from Amdo and Kham, the DT lexicon may contain both left-headed and right-headed stress. The statistical analysis of the three acoustics correlates, i.e., intensity, duration and f0 in chapter 2, section (4), of the firsthand Tibetan data from Dharamshala has proven that DT stress is largely left-headed. It is rhythmic, and has a left-to-right directionality. Only two words containing right-headed stress were found. DT data regarding words with right-headed stress does not include bimoraic syllables, such as the quantity-insensitive stress in Osage (Altshuler, 2009). A few monosyllabic DT words that are bimoraic are found.

Optimality Theory (OT) (Prince & Smolensky, 1993) is the chosen framework in this study to theorise the DT stress patterns. The conflict between the different markedness constraints decides the surface forms of stress in DT. OT constraints concerning word stress are based on the notions of culminativity, foot dominance and hierarchy, directionality of parsing, rhythmic nature and iterativity, quantity sensitivity, etc. Additionally, topics like extrametricality and degenerate foot are also covered. It has already been stated that DT stress is divided into three types. The DT data for both left-headed and right-headed patterns are quantity insensitive, whereas the heavy monosyllabic bimoraic words are automatically stressed. As three categories of stress patterns are available in the DT data, and the present literature on word stress of three Tibetan dialect groups offers an indication towards the possibility of both left and right-headed stress, this study treats DT stress in three different domains following the core peripheral model of the lexicon (Itô & Mester, 1995).

Section 2 includes a brief description of the syllable structure of DT. It also includes a list of DT words used in this chapter. Section 3 describes the universal characteristics of word stress in relation to DT word stress. Section 4 discusses DT stress patterns following the traditional generative framework. It also mentions why the Optimality Theoretic framework is suitable for theorising the word stress phenomena. Section 5 covers different aspects of the DT word stress phenomena through the OT framework. Section 6 finally presents a conclusion to the current study.

3.2 Few words regarding the syllable structure of DT

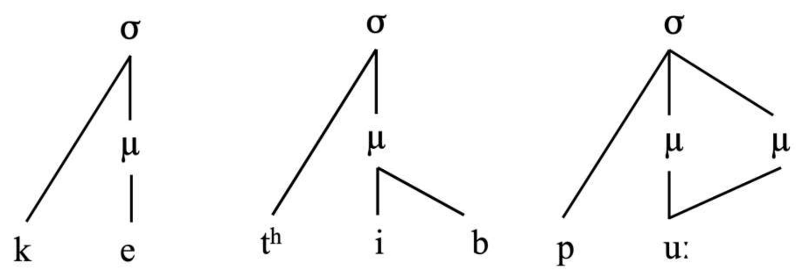
The basic DT syllable structure is (C)V(C). Like LT, DT has shown weight distinction. LT has both light and heavy syllables. Lim (2018) has offered examples of heavy syllables with CV: shapes in LT from his field data. DT also exhibits the same weight pattern in terms of syllabic weight distinction. The following list features some monosyllabic, bisyllabic, trisyllabic and quadrisyllabic DT words. The initial two monosyllabic words are bimoraic, whereas the other two are monomoraic. These words were already introduced once in chapter 2, section (3.1). However, as the current study offers an analysis of DT stress, the following words are used throughout the current chapter.

(1) List of words from the Dharamshala Tibetan

(a) /puː/	'hair'	(g) /ˈtʃʰo.mo/	'lake
(b) /maː/	'red'	(h) /ˈmen.si.ˌkʰaŋ/	'hospital'
(c) /ke/	'language'	(i) /ˈpin.ga.ˌbʰu.mo/	'cousin sister'
(d) /tʰib/	'dark'	(j) /po.ˈta/.la	'Potala palace'

(e) /ŋa/	‘I’	(k) /ʧʰi.ˈwa/	‘death’
(f) /ˈpugu/	‘child’	(l) /ˈʈʰɔŋmo/	‘female friend’

(2) Figure 1: Moraic structures of DT monomoraic words /ke/ ‘language’ and /tʰib/ ‘dark’ and bimoraic word /pu:/ ‘hair’



According to Gordon (2006, pp. 37-38), Lhasa Tibetan is a type two, weight-sensitive language. A language belonging to this category considers only CVV syllables as heavy. Syllables with CVC shape are not regarded as strong syllables as they cannot attract stress in these languages. A DT word is only stressed when a heavy syllable with a long vowel is involved. Both DT and LT adhere to the same criterion regarding weight sensitivity.

3.3 Universal word stress features of DT

It is essential to include the universal features of stress and how their interplay dominates the stress types and patterns of Dharamshala Tibetan in the present analysis. As the previous part has asserted, DT has both left-headed (trochaic) and right-headed (iambic) stress patterns. Both primary and secondary stresses are available in the word samples collected from the field data. Instances of the degenerate foot are also present.

3.3.1 Culminativity

Stress requires a prosodic head in a morphological or syntactic domain. It needs words, phrases, etc, to contain at least one stressed syllable. It is essential for the content words to include a minimum of one stressed syllable each. The grammatical words do not have this need. This feature indirectly distinguishes between a domain's head and non-head parts, as the syllable with primary stress is the head in the word. This requirement also refers to the prosodic hierarchy (Selkirk, 1980, 1984). Culminativity can be better represented if explained through different layers in this hierarchy. A prosodic word contains at least one foot, and it is the head of the PrWd. If a foot contains one unstressed and one stressed syllable, the stressed syllable becomes the head of the said foot. Every higher category contains its head in the next lower-level domain.

(3) Figure 2: Prosodic hierarchy (Selkirk, 1980)

PrWd (ω)	Prosodic/phonological word
|	
FT	Foot
|	
σ	Syllable
|	
μ	Mora

If there is more than one foot in a word, multiple heads might exist at the foot level. There can be only one primary stressed syllable at the prosodic word level. Consequently, it becomes the head of the word. Kager (1999, p. 142) discussed this issue with the help of breaking down the word Alabama into three different levels.

(4) Metrical analysis of the English word /ˌæ.lə.ˈbæ.mə/ 'a US state' (Kager, 1999, p. 142)

(. *)	Prosodic word level (ω)
(* .) (* .)	Foot level (FT)
ˌæ.lə. ˈbæ.mə	Syllable level (σ)

If we need a head within a foot, it would require either two syllables or a long syllable. So, culminativity also sets an indirect criterion on the size of a word (Hayes, 1995, p. 29). However, this requirement is not absolute. In some languages, a minimum of two syllables is required to create a word. A monosyllabic word does not exist in such languages. This limit is further visible when the epenthesis process is employed in some languages to meet the minimum size requirement. Iraqi Arabic uses epenthesis to add an extra syllable to meet the minimal syllable requirement if the word has only one syllable (Broselow, 1992). As a result, the word /drus/ 'study' turns into /idrus/ in Iraqi Arabic. Similarly, monosyllabic words with a light syllable are permitted in some languages. In this situation, the exhaustiveness requirement of word stress comes to the front. It ensures every syllable in a content word is parsed into feet. In such languages, the non-ideal foot is acceptable. DT does not have the phonological requirement to have at least two syllables in a word, as monosyllabic words with a light syllable are available in this variety.

In the case of the bisyllabic word /ˈʈʰɔŋmo/ 'female friend', the stress falls on the first syllable, making it a trochaic foot. It also creates an ideal foot with two syllables distinct for being stressed and unstressed.

(5) Metrical analysis of the word /ˈʈʰɔŋmo/ 'female friend'

(* .)	Prosodic word level (ω)
(* .)	Foot level (FT)
ˈʈʰɔŋ.mo	Syllable level (σ)

If a segment is strong at the foot level, it does not always mean it is also strong at the prosodic word level if more than one foot is present. The last example has the syllable /ʈʰɔŋ/ as the strong segment in both the higher levels (PrWd and FT). The disparity becomes evident in the following word /ˈmen.si.ˌkʰaŋ/ 'hospital'.

(6) Metrical analysis of the word /ˈmen.si.ˌkʰaŋ/ 'hospital'

(* .)	Prosodic word level (ω)
(* .) (*)	Foot level (FT)
ˈmen.si.ˌkʰaŋ	Syllable level (σ)

In this example, both syllables /ˈmen/ and /ˌkʰaŋ/ are stressed or strong at the foot level. Only /ˈmen/is considered strong at the prosodic word level. The foot level displays both primary and secondary stress, whereas the prosodic word level only displays the primary stress. The same observation is reflected in the following example /ˈpin.ga.ˌb^{h}u.mo/ ‘female cousin’.

(7) Metrical analysis of the word /ˈpin.ga.ˌb^{h}u.mo/ ‘female cousin’

(* .)	Prosodic word level (ω)
(* .) (* .)	Foot level (FT)
ˈpin.ga.ˌb^{h}u.mo	Syllable level (σ)

3.3.2 Demarcative property

Stress placement tends to coincide with the edges of grammatical domains like stems, words, phrases, etc. This feature is linked to the perceptual operation of the grammatical units by the human brain. Some specific positions of stress placement are preferred in accordance with the demarcative function, such as initial, penultimate, final, pen-initial, etc. (Kager, 1999, pp. 144–145). Among these positions of stress placements, the initial position is the most popular one, and the rest share a decreasing range of popularity. In DT, all the words with trochaic stress contain the primary stress in the first syllable of the word. The analysis of the field data of DT reveals that the number of words with first and penultimate stress placement surpasses the pen-initial and final types in terms of quantity. Thus, the universal tendency in the range popularity in the case of stress placement is reflected in the DT data.

Addressing the concepts of extrametricality and degenerate foot is required in the context of the demarcative property of stress. Extrametricality makes parts of the words invisible to the stress rule. Pintupi language contains secondary stress in every uneven syllable unless it is the last syllable (Hayes, 1995, p. 62). The third syllable gets secondary stress only if a fourth syllable is present. If the third syllable is the last in a word, it is extrametrical. The position of the extrametrical syllables or a degenerate foot is an indication of the directionality of the stress rule placement. If a syllable is extrametrical at the word’s right-hand side, the stress assignment's directionality is likely to be left to right.

A degenerate foot has only one light syllable. It carries marked status typologically (Kager, 1999, p. 162). It is located on the edge of a word. If a language does not allow a degenerate foot, it becomes extrametrical. In the languages that would allow it, the foot can get stressed. The DT trisyllabic words permit degenerate foot.

DT lexicon contains several monosyllabic words with a single light syllable. It indicates that DT does not require a minimal word containing at least two syllables. Hence, a degenerate foot with a single syllable becomes possible in DT.

3.3.3 Rule governedness and boundedness

Some word stress patterns are predictable as they follow a set of formal rules. Some languages do not follow any such rule. A few exceptional patterns of stress placement might exist in a language with a set of predictable rules on stress placement. Such languages combine both rule-governed and free systems. Both Osage and Pintupi have rule-governed stress placements (Altshuler, 2009; Gordon, 2011, p. 142). German combines both regular and exceptional stress rules (Féry, 1998). DT stress pattern falls in the rule-governed stress category.

Bounded stress-patterned languages have a foot with a maximum of two syllables. The stress placement occurs within a regular gap both from edges and from each other. Unbounded systems do not follow these requirements. DT follows a bounded stress pattern. All the DT words presented in this paper follow boundedness.

3.3.4 Foot dominance and hierarchy

Foot dominance refers to the edge of the foot on which the head is located. The head is called the dominant, and the non-head part of a foot is called recessive. The left dominant foot is called a trochee, and the right dominant foot is called an iamb. If a word contains more than one stress placement, only one is the primary stress. It carries the most prominence inside that word. The rest of them are secondary ones. So, a hierarchy is present between the primary and secondary stresses. The word /ˈʈ^{h}ɔŋmo/‘female friend’ has a left dominant foot with no stress hierarchy. In the case of /ˈmen.si.ˌkʰaŋ/ ‘hospital’, the head is located at the left edge. The secondary stress is present in the third syllable. It is a word with two left-dominant feet and a stress hierarchy.

3.3.5 Directionality of foot and iterativity

Directionality indicates in which direction the foot is parsed. If a stress pattern is iterative, the directionality can be either left-to-right or right-to-left in every alternative syllable. In the case of non-iterative patterns, there is only one foot at either of the edges. Pintupi has a left-to-right and iterative directionality except in the last syllable in case of an uneven number of syllables (Gordon, 2011, p. 142). In Osage, the stress directionality is towards the right and iterative (Altshuler, 2009).

In the case of words with an even number of syllables, it can be challenging to ascertain the directionality of parsing of the stress rule. The side where the shape of the feet remains unchanged is generally considered the start of the stress rule parsing. DT has left-to-right feet in both the trochaic and iambic categories. DT trisyllabic words show that the first foot consists of two syllables, and the degenerate foot is placed at the end. However, in the case of a quadrisyllabic word, the foot consists of two syllables in the case of the second foot as well, which is located towards the right edge. The foot’s shape at the left edge is always intact in DT.

(8) List of DT words with stress pattern directionality

(a)	ˈtʃʰomo →	‘lake’
(b)	ˈmen.si.ˌkʰaŋ →	‘hospital’
(c)	ˈpiŋ.ga.ˌbʰu. mo →	‘cousin sister’
(d)	tʃʰi.ˈwa →	‘death’
(e)	po.ˈta.la →	‘Potala palace’

In the examples above, the initial three cases have trochaic and left-to-right directional feet. The last two words follow an iambic stress pattern with left-to-right directionality.

3.3.6 Rhythmic pattern and quantity sensitivity

The universal pattern of word stress is to have a rhythmic pattern of strong and weak syllables. This pattern is followed in the case of languages with bounded stress patterns. In the unbounded stress pattern, there might be a single stress per word with stress lapses in other syllables. While DT avoids stress clash and lapse, it allows the rhyming of stressed and unstressed syllables, visible in all of the trisyllabic and longer DT words.

If a language carries syllabic weight distinction, the heavy syllable in the word is the likely candidate to attract stress (Gordon, 2011, pp. 151-152). A syllable with a long vowel, diphthong, or closed syllable might be a heavy syllable with shapes like CVV, CVC, VV, etc. CVC is considered light as it does not attract stress in some languages, while in some other languages, CVC is regarded as a heavy syllable as it attracts word stress.

Hyman (1985, pp. 9-10) and McCarthy & Prince (1996) have devised a different approach to describe syllable weight distinction. The concept of mora has been introduced for this reason. Mora can be defined as a unit of time. A long vowel or a diphthong needs a longer time to be pronounced, whereas a short vowel or a consonant takes less time. Moraic theory formulates that the group of sounds is bimoraic, whereas the latter group is monomoraic. The moraic structure can vary from one language to another. For instance, CVC can be both mono and bimoraic, depending on whether it attracts stress in that specific language.

According to Gordon (2006, pp. 37-38), Lhasa Tibetan is a type two, weight-sensitive language. A language belonging to this category considers only CVV syllables as heavy. Syllables with CVC shape are not regarded as strong syllables as they cannot attract stress in these languages. Dharamshala Tibetan can also be categorised as a type two language in terms of syllabic weight sensitivity.

3.4 Word stress through the lens of the generative grammar

The DT word (ˈmen.si).(ˌk^{h}aŋ)‘hospital’ has two left-headed trochaic feet. The feet are parsed from left to right. It has both primary and secondary stress in the first and second foot successively. The secondary foot is a degenerate foot. The stress placement is rhythmic and iterative. It is a quantity-insensitive instance of stress in DT.

If the route of the standard generative grammar is considered, according to Kager (1999, p. 149), the stress assignment rules of DT can be stated as follows.

(9) Steps of stress assignment rules following the generative framework

Rule 1: Syllabify the words.

Rule 2: Assign left-headed feet onto the syllables in an iterative manner from left to right.

Rule 3: Accept a degenerate foot if the word contains an uneven number of syllables.

Rule 4: Assign the primary stress on the leftmost syllable. The first foot contains the primary stress.

Rule 5: Assign secondary stress in the subsequent feet.

Following the rules mentioned above, stress assignment is shown in the word (ˈmen.si).(ˌk^{h}aŋ) ‘hospital’. The derivation takes place in five steps.

(10) Stress assignment in the word /ˈmensiˌkʰaŋ/ ‘hospital’ following the generative framework

/mensikʰaŋ/

Rule 1: men.si.kʰaŋ

Rule 2: (ˈmen.si).kʰaŋ

Rule 3: (ˈmen.si).(ˌkʰaŋ)

Rule 4 (ˈmen.si).(ˌkʰaŋ)

Rule 5: (ˈmen.si).(ˌkʰaŋ)

The rule that assigns feet (rule 2), and the rules that assign primary and secondary stresses (rule 4 and rule 5) are three different rules. However, all of them work towards creating left-headed and left-to-right oriented rhythmic stress. The rule-based framework does not explain the functional unity of the process that exists in these three different rewrite rules to attain the same output. This issue has been referred to as conspiracy by Kisseberth (1970).

During derivation, phonological structures may come into existence which are not permitted in the surface forms of that specific language. In generative grammar, the rewrite rules work through linear ordering, not parallel ordering. Inputs go through rewrite rules serially through a process of derivation to reach the output. In the case of the DT rewrite rules on word stress, it is unclear what happens after the rule in rule 2 is employed to assign feet in the DT words. The first foot is easily assigned. However, in the case of the second foot, which happens to be a degenerate foot, it is not regarded as a foot before the assignment of rule 3. The second foot is extrametrical at this stage. During the derivation process, temporarily, a structure which is not allowed in DT becomes allowed in the generative framework.

True to the universal phenomenon of edge marking (Kager, 1999, p. 144), the primary stress is assigned to the left most syllable in rule 4. The rule 5 assigns secondary stress to the other foot. There is an intermediate juncture before rules 4 and 5 are assigned when both of the stresses are treated equally. During the derivation stages, these two stresses share equal status.

Optimality Theory (OT), a framework born out of generative grammar, shares the concepts of input-output mechanism, underlying specification etc, with the traditional model. It deals with an actual output and a set of probable output forms. The optimal candidate is selected based on a list of conflicting, parallel and violable constraints and their ranking in that specific language instead of the serial application of rewrite rules. This framework offers an explanation free from the theoretical issues related to conspiracy and the existence of phonological representations in the middle of the derivation process, which are not permitted in the surface structure of a specific language. The following section will analyse DT word stress using the OT framework.

3.5 DT word stress in OT framework

It has already been stated that DT word stress can be roughly divided into three categories. Most words belong to the trochaic category, whereas few words with iambic stress have been found. Both of these types are quantity-insensitive in DT. Lastly, there are also a few DT words with heavy syllables that automatically carry stress. The core-periphery model of the lexicon (Itô & Mester, 1995, p. 182) can be extended when describing the stress types available in DT. The trochaic category belongs to the core because most words carry it, whereas the iambic and words with heavy syllables belong to the peripheral level. The previous discussion regarding the cross-linguistic universal stress parameters in section 3 is relevant in the current section, as the same parameters get formalised as competing constraints. The metrical constraints used for theorising word stress are formalisations deduced from the parameters of culminativity, demarcativeness, headedness, rhythmic quality, directionality, and quantity sensitivity.

Culminativity not only ensures the presence of at least one stress in a phonological domain but also indirectly creates the requirement of a word minima (Hayes, 1995, p. 29). DT contains monosyllabic words with light syllables. It is an indication of the possibility that a degenerate foot can exist in the DT metrical system along with the default binary foot. If DT only allowed binary foot, the constraint FT-BIN. Prince & Smolensky (1993, p. 92) would have been high-ranked.

(11) FT-BIN (Prince & Smolensky, 1993, p. 92)
Feet are binary in the moraic or syllabic level.

The high ranking of FT-BIN ensures the exclusive legitimacy of the bisyllabic or bimoraic feet. At this stage, it is required to establish whether all the syllables in a word are required to be parsed in feet. The constraint PARSE-σ (Prince & Smolensky, 1993, p. 92) is fulfilled when all the existing syllables are parsed into feet.

(12) PARSE-σ (Prince & Smolensky, 1993, p. 92)
Syllables are parsed by feet.

Stress placements tend to have few preferable spots in the constituents. The greater majority of words in DT have primary stress in the first syllable. This category of words in DT follows a left-headed trochaic stress pattern. The constraint RH TYPE=T (Trochaic) formalises the requirement of having the feet left-headed. Few DT words have consistently exhibited a right-headed stress pattern. RH TYPE=I (Iambic) ensures a foot is right-headed. Both of these constraints have been used in the discussion of word stress by Kager (1999, pp. 72–73).

(13) RH TYPE=T (Kager, 1999, pp. 72–73)
Feet have initial prominence.

(14) RH TYPE=I (Kager, 1999, pp. 72–73)
Feet have final prominence.

The word /ˈpugu/ ‘child’ has bisyllabic, quantity insensitive, and left-headed stress. Since a bisyllabic word has only one position for stress assignment, the directionality of stress assignment is left at this stage.

(15) Tableau 1:/ˈpugu/ ‘child’ (bisyllabic, left-headed)

/pu.gu/	RH TYPE=T	FT-BIN	PARSE-σ
(a) ☞ (ˈpu.gu)			
(b) (pu.ˈgu)	*!		
(c) (ˈpu).gu	*!	*	*
(d) pu.(ˈgu)	*!	*	*

The tableau in (15), the optimal candidate (a) satisfies all the constraints. The only difference between candidates (a) and (b) is the headedness of the stress placement. Candidate (b) violates the RH TYPE=T constraint as the stress placement is not left-headed. Until a word with three syllables is introduced, the ranking between FT-BIN and PARSE-σ will not emerge since the optimal candidate automatically satisfies both constraints in the case of a bisyllabic word. Any shuffling of the ranking among these three constraints would produce the same optimal candidate at this stage. Candidate (c) violates the highest ranked constraint RH TYPE=T. This constraint would require a foot with two syllables with initial stress to be fulfilled as it is quantity-insensitive stress. As the second syllable of the word is left unparsed, PARSE-σ is violated. Since the foot contains only one light syllable, FT-BIN is also violated. Candidate (d) also incurs similar violations.

As the next tableau concerns itself with a trisyllabic word, a more precise and detailed ranking emerges. A left-headed trisyllabic word /men.si.k^haŋ/ ‘hospital’ has two left-headed stress positions. The first foot is binary, whereas the second is a degenerate foot consisting of only one light syllable. Since the degenerate foot is located on the right side, the directionality of the stress assignment in DT is left-to-right.

The alignment constraint, ALL-FT-LEFT (McCarthy & Prince, 1993, p. 94), demarcates the left edge of PrWd in DT. It needs all feet in a word to coincide with the left edge of the PrWd.

(16) ALL-FT-L (McCarthy & Prince, 1993, p. 94)
Align (Ft, Left, PrWd, Left).

This markedness constraint is not violated only in two cases. ALL-FT-L is automatically satisfied if the PrWd has only one foot with two syllables. Apart from that, ALL-FT-L is satisfied when a word includes more than two syllables but has only one foot at the left edge. In the latter scenario, this constraint is not dominated in the said language, creating a non-iterative pattern. However, if multiple stresses can exist in a prosodic word at regular intervals, ALL-FT-L is a lower-ranked constraint in that language. DT word stress is rhythmic; hence, ALL-FT-L is only fulfilled in the case of the initial foot. From the second foot onwards, ALL-FT-L incurs a violation. It is a gradient constraint. Rhythmic stress is the default in DT, starting from the left edge. Hence, DT has left-to-right directionality of word stress.

In DT, since it is of greater importance to parse all existing syllables in feet in a PrWd, PARSE-σ dominates ALL-FT-L.

(17) PARSE-σ≫ALL-FT-L

Subsequently, both binary and degenerate foot exist in the DT word stress pattern. Hence, it has become evident that the constraint Parse σ ranks higher than FT-BIN.

(18) PARSE-σ≫FT-BIN

The next tableau reflects both of the previously mentioned constraint rankings. Since the parsing takes place from the left to right direction, the directionality of stress placement in DT is left-to-right. The next tableau discusses the constraint ranking of the stress placement of a trisyllabic word /ˈmen.si.ˌkʰaŋ/ ‘hospital.’

(19) Tableau 2: /ˈmen.si.ˌkʰaŋ/‘hospital’ (trisyllabic, left-headed)

/men.si.kʰaŋ/	RH TYPE=T	PARSE-σ	FT-BIN	ALL-FT-L
(a)☞(ˈmen.si).(ˌkʰaŋ)			*	**
(b) (ˈmen.si).kʰaŋ		*!		
(c) (men.ˈsi).kʰaŋ	*!	*		

In the tableau in (19), candidate (a), the optimal candidate, violates FT-BIN as there is a monosyllabic degenerate foot where the secondary stress is located. It also violates ALL-FT-L two times. Since the optimal candidate needs to parse all the syllables in feet rather than construct only binary feet, it is evident that PARSE-σ ranks higher than FT-BIN. Since there are two violations of ALL-FT-L, it proves that the requirement of having all the syllables parsed is higher in the DT stress system than having one foot on the left edge. Therefore, Parse σ also outranks ALL-FT-L. The ranking between FT-BIN and ALL-FT-L is unclear.

In the same way, there is no conclusive proof of any domination relationship between RH TYPE=T and PARSE-σ. Candidate (b) incurs one fatal violation of PARSE-σ. As it is one of the higher-ranked constraints, this candidate gets out of the competition. Candidate (c) violates both RH TYPE=T and PARSE-σ.

Till this point, the discussion was focused on the constraint requirements regarding feet type, parsing of syllables in feet, headedness, rhythmic quality, and directionality of word stress. However, the said constraints do not differentiate between the primary and secondary stresses. A finer-grained theorisation of word stress deserves a constraint-based mechanism to address this issue. The idea that primary stress should be assigned before the secondary ones is a step in that direction (Goedemans & van der

Hulst, 2011). In most languages, the first foot carries the primary stress. According to Staubs (2014), the directionality of stress is directly related to the placement of primary stress. Since DT has both trochaic and iambic stress patterns and a left-to-right directionality, the placement of primary and secondary stress in DT words should look like the following.

(20) Placements of primary and secondary stress in different stress patterns in DT

(a) (ˈσ.σ)
(b) (ˈσ.σ).(ˌσ)
(c) (ˈσ.σ).(ˌσ.σ)
(d) (σ.ˈσ)
(e) (σ.ˈσ).σ

Staubs (2014) further opines that the placement of primary stress is independent of secondary stress. The placement of primary stress in the initial foot of the PrWd has both typological and perceptual bearings. The constraint LEFTMOST (Kager, 1999, p. 167)places the primary stress on the left edge of the word in unidirectional stress systems like DT.

(21) LEFTMOST (Kager, 1999, p. 167)
Align (Hd-Ft, Left, PrWd, Left).

This constraint is derived from the EDGEMOST (Prince & Smolensky, 1993, p. 93) constraint. It is also another edge marking alignment constraint. However, unlike ALL-FT-L, LEFTMOST is never violated in the case of trisyllabic or quadrisyllabic DT words, as the latter constraint ensures the presence of primary stress. The monosyllabic degenerate foot carries the secondary stress in the case of a trisyllabic word. Leftmost automatically receives a higher ranking in the DT stress system than ALL-FT-L.

(22) LEFTMOST≫ALL-FT-L

The constraint Leftmost ensures that primary stress is assigned to the left edge of the word. The optimal candidate always satisfies RH TYPE=T, PARSE-σ, and

LEFTMOST. These constraints do not have any domination relationship among them. On the other hand, FT-BIN and ALL-FT-Lcan be dominated by the optimal candidate. The initial group of constraints can dominate both of them. Tableau 17 is reintroduced as tableau 21, maintaining the same ranking but with the addition of the markedness constraint LEFTMOST. Here, the same candidate turns out to be the optimal one, like the last tableau. However, candidate (d) violates the high-ranked constraint LEFTMOST. It violates LEFTMOST because the first foot at the left edge does not start with primary stress. It also violates FT-BIN and ALL-FT-L.

(23) Tableau 3: /ˈmen.si.ˌkʰaŋ/ ‘hospital’ (trisyllabic, left-headed)

/ˈmen.si.ˌkʰaŋ/	RH TYPE=T	PARSE-σ	LEFTMOST	FT-BIN	ALL-FT-L
(a) ☞ (ˈmen.si).(ˌkʰaŋ)				*	**
(b) (ˈmen.si).kʰaŋ		*!			
(c) (men.ˈsi).kʰaŋ	*!	*			
(d) (ˌmen.si).(ˈkʰaŋ)			*!	*	**

The tableau in (23) contains the constraint ranking for left-headed stress in DT. The metrical pattern of the quadrisyllabic word /ˈpiŋgaˌbʰumo/ ‘a female cousin’ also maintains the constraint ranking of the last tableau.

(24) Tableau 4: /ˈpiŋgaˌbʰumo/ ‘a female cousin’ (quadrisyllabic, left-headed)

/piŋ.ga.bʰu.mo/	RH TYPE= T	LEFTMOST	PARSE-σ	FT-BIN	ALL-FT-L
(a) ☞ (ˈpiŋ.ga).(ˌbʰu.mo)					**
(b) (ˈpiŋ.ga). bʰu.mo			*!*		
(c) (piŋ.ˈga).(bʰu.ˌmo)	*!*				**
(d) (ˌpiŋ.ga).(ˈbʰu.mo)		*!			**
(e) (ˈpiŋ.ga).(ˌbʰu).mo			*!	*	**

In the tableau in (22), candidate (a) is the optimal output and only violates ALL-FT-L, the lowest-ranked constraint, two times. Candidate (b) fatally violates PARSE-σ twice, creating only one foot at the left edge. Candidate (c) incurs a fatal violation of the highest ranked constraint RH TYPE=T by having two right-headed feet. It also violates ALL-FT-L twice. In candidate (d), the initial foot does not carry the primary stress; thus, it violates another high-ranked candidate, LEFTMOST. Candidate (e) has a degenerate foot. It also leaves a syllable unparsed. It violates both FT-BIN and PARSE-σ, in addition to the double violation of ALL-FT-L.

The tableau 22 has established the constraint hierarchy of the left-headed stress pattern of DT. The factorial typology in DT in the trochaic segment is proposed as follows.

(25) RH TYPE=T, LEFTMOST, PARSE-σ≫ FT-BIN, ALL-FT-L

All the aforementioned tableaux have exhibited the mechanism of a left-headed, rhythmic and quantity-insensitive stress pattern with a left-to-right directionality. This is the default stress pattern of DT, as this constraint hierarchy can be employed for a set of DT words, which can be bisyllabic, trisyllabic or quadrisyllabic. However, two rather narrow groups of DT words cannot be theorised with the present hierarchy. Only two words with iambic stress pattern, and a few monosyllabic words with heavy syllables have been found. These two groups act as the exceptions to DT's otherwise default stress pattern.

Kager (1999, p. 4) has stated that languages vary based on the difference in constraint ranking as it causes cross-linguistic variation. Only quantity-insensitive stress patterns contain fixed stress locations (Goedemans, 2011, p. 650). In a system with quantity-sensitive stress, the stress should be assigned to the heavy syllable, which might be located anywhere in the word. In languages with quantity-insensitive systems, stress plays a demarcation function as it signals the beginning or end of the words. Considering the claims made by both Kager (1999) and Goedemans (2011), DT should be a free-stress language. However, the present work considers the stress patterns of DT not in terms of fixed and free stress but rather in terms of core and peripheral patterns. Also, in languages like Rotuman (McCarthy, 1995), German (Féry, 1998), Turkish (Inkelas, 1999), Spanish (Hammond, 2000), etc, both default and peripheral stress patterns are available.

In the case of the default and exceptional patterns in English stress, two different domains have been theorised within the same language as it contains both native English words and borrowed words (Pater, 1994).This work deploys a constraint ranking activation mechanism to explain the exceptional light penultimate stress phenomenon and the default stress pattern in the English language. English words classified as nouns containing a heavy penultimate syllable are stressed in that specific syllable. In case of the absence of a heavy penult, the antepenult is stressed. However, a set of words gets stressed in the penultimate syllable despite being light as an exception to the initial two default rules. Pater considers the first two categories of stress assignment belonging to the more generalised or core, whereas the last category holds a peripheral position following the core-peripheral model of lexicon (Itô & Mester 1995).

(26) Three types of English word stress patterns[1]

(a) XˈHX: aˈgenda, uˈtensil, aˈroma, etc.

(b) ˈXLX: ˈCanada, ˈcinema, anˈalysis, etc

(c) XˈLX: vaˈnilla, conˈfetti, Phiˈlippa, etc.

Pater (1994) has used the constraint Align-right (McCarthy & Prince, 1993).The English words with different stress types include patterns which are either right-oriented and those which are not.

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[1]These words are written using default English spelling instead of IPA, following Pater's method in his paper.

(27) ALIGN-RIGHT (McCarthy & Prince, 1993)

Align the right edge of a prosodic word with the right edge of a foot.

Pater (1994) further introduces the constraint *ALIGN-RIGHT, which has the opposite function of ALIGN-RIGHT.

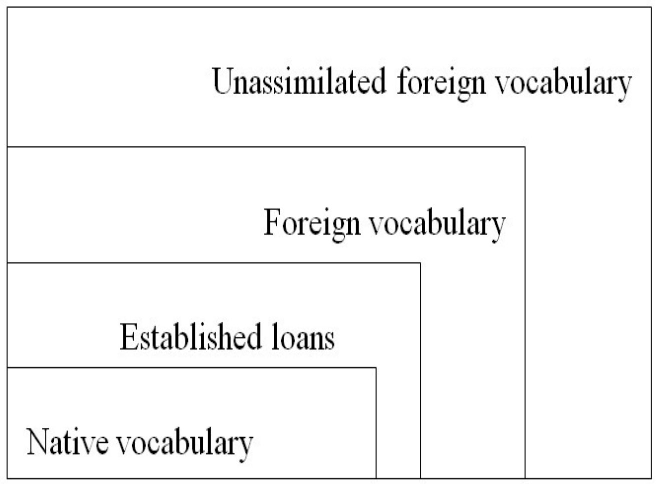
(28) *ALIGN-RIGHT

Do not align the right edge of a prosodic word with the right edge of a foot.

In the case of the English words following the default stress rule, the ranking *ALIGN-RIGHT≫ALIGN-RIGHT gets activated. In the case of the peripheral stress rule, the ranking ALIGN-RIGHT≫*ALIGN-RIGHT is activated. In both cases, all the other constraints are the same, and maintain the same ranking.

Itô & Mester (1995) have observed the difference in constraint rankings in native Japanese lexical data and in the borrowed words that might still keep some phonological and morphological traits of the source language even after phonological adaptations. Hence, having a core and a few peripheral lexical strata in the same language is possible in the OT framework. As explained in chapter 1 (section 1.2), DT contains linguistic variations born out of the admixture of the linguistic features from the Amdo and Kham dialect groups into the Lhasa group. Apart from the segmental variations, the suprasegmental variation in DT might also owe its origin to the linguistically composite characteristics it embodies. Tibetan speaking group in Dharamshala also constitutes people whose ancestors came from Amdo and Kham dialect groups. Different studies on word stress conducted on these two dialect groups show that stress is often right-headed (Caplow, 2017; Suzuki, 2017; Watters, 2002). DT has been their lingua franca through the last few generations. With the generations of Tibetan people living in a close-knit community, it is possible for DT to have the main stress pattern of LT, which is left-headed, and also include the right-headed stress patterns of Amdo and Kham dialect groups. As a result, the core-peripheral model of lexicon (Itô & Mester, 1995) acts as an appropriate means to explain the presence of more than one stress patterns in DT.

(29) Figure 3: Core-peripheral model of lexicon of Japanese (Itô & Mester, 1995)



In order to resolve the conflict between the default and exceptional stress patterns in DT, a similar path following Pater (1994) has been adopted. A novel constraint *RH TYPE=T is brought into the equation.

(30) *RH TYPE=T

Feet have non-initial prominence.

In this way, different rankings of the same constraints can account for the core and peripheral stress patterns of the DT stress. In the case of the DT, words following the dominant stress pattern are of the left-headed or trochaic category. Both the exceptions, including the words with right-headed stress and the monosyllabic words with heavy syllables, fall into the category of stress patterns, which are not left-headed or non-trochee. As a result, in the core stress pattern of DT, the ranking RH TYPE=T≫* RH TYPE=T is functional. The tableau in (24) is restructured in (31) in the next paragraph with the new ranking. *RH TYPE=T is dominated by RH TYPE=T.

(31) Tableau 5 /ˈpiŋgaˌbʰumo/ 'a female cousin' (quadrisyllabic, left-headed)

/piŋ.ga.bʰu.mo/		RH TYPE =T	LEFTMOST	PARSE -σ	FT-BIN	ALL-FT-L	*RH TYPE=T
(a)	☞(ˈpiŋ.ga). (ˌbʰu.mo)					**	**
(b)	(ˈpiŋ.ga). bʰu.mo			*!*			*
(c)	(piŋ.ˈga). (bʰu.ˌmo)	*!*				**	
(d)	(ˌpiŋ.ga). (ˈbʰu.mo)		*!			**	**
(e)	(ˈpiŋ.ga). (ˌbʰu).mo			*!	*	**	**

As a new constraint is added in the ranking, it needs to be updated. The new constraint ranking for trochaic stress pattern in DT would look like the following.

(32) RH TYPE=T, LEFTMOST, PARSE-σ≫ FT-BIN, ALL-FT-L≫* RH TYPE=T

The iambic counterpart of the DT stress system is discussed in this section. The words with iambic stress have right-headed feet and left-to-right directionality. Iambic feet in DT are quantity insensitive, like the Osage stress system (Altshuler, 2009). Hence, in the case of a bisyllabic word, the previous ranking of PARSE-σ≫FT-BIN is maintained for the bisyllabic, right-headed word.

(33) Tableau 6: /tʃʰi.ˈwa/ 'death' (bisyllabic, right-headed)

/tʃʰi.wa/		RH TYPE =I	PARSE-σ	FT-BIN
(a)	☞(tʃʰi.ˈwa)			
(b)	(ˈtʃʰi.wa)	*!		
(c)	tʃʰi.(ˈwa)	*!	*	*

The tableau in (33) presents the metrical constraint ranking of the word /tʃʰi.ˈwa/ 'death.' As it is a bisyllabic word, the optimal candidate should satisfy both FT-BIN and PARSE-σ. Additionally, it needs to be an iambic foot. Candidate (a) satisfies all these constraints. Candidate (b) fatally violates RH TYPE =I as it has a trochaic foot. Since it is a quantity-insensitive iamb, candidate (c) violates FT-BIN. It also violates RH TYPE =I and PARSE-σ.

As the bisyllabic optimal candidate fulfils all the constraints, it is difficult to rank the constraints in this context. If the constraint ranking of PARSE-σ≫FT-BIN is employed in the case of a trisyllabic word /poˈtala/ 'Potala palace', the optimal candidate (po.ˈta).la would go out of the competition as the higher ranked constraint PARSE-σ would be violated in this case. Hence, a different ranking is needed. Instead of having a degenerate foot at the rightmost side of a right-headed word, having an extrametrical syllable is a better option to avoid a clash between two adjacent stressed syllables. As a result, a right-headed word like /poˈtala/ with an uneven number of words can only have one binary foot. The last syllable /la/ is extrametrical in the iambic domain of DT. The same ranking is automatically valid for right-headed words with an even number of syllables. The ranking must change between FT-BIN and PARSE-σ for the right-headed stress pattern. Since only one stress position is available, the primary stress-defining constraint LEFTMOST is not included in the next tableau.

(34) FT-BIN ≫PARSE-σ

As the directionality of stress assignment is still left-to-right-oriented, PARSE-σ still ranks higher than ALL-FT-L.

(35) PARSE-σ≫ALL-FT-L

RH TYPE =I and FT-BIN are kept in the same group as the optimal candidate, never violates these constraints. The optimal candidate in tableau (34) proves this point.

Since the foot is right-headed in this domain, *RH TYPE=T≫RH TYPE=T ranking is activated. Additionally, the ranking FT-BIN≫ PARSE-σ is also active in this domain.

(36) Tableau 7: /poˈtala/ 'Potala palace' (trisyllabic, right-headed)

/po.ta.la/		*RH TYPE=T	RH TYPE =I	FT BIN	PARSE-σ	ALL-FT-L	RH TYPE=T
(a) ☞	(poˈta).la				*		*
(b)	(ˈpo.ta).(ˌla)	*!*	**	*		**	
(c)	po.(ta.ˈla)				*!	**	*
(d)	po.(ˈta.la)	*!	*		*	*	

In tableau (36), candidate (a) is the optimal candidate. It violates a lower ranked constraint, PARSE-σ, as the syllable /la/ is not parsed into a foot. Additionally, it also violates RH TYPE=T. Candidate (b) violates three high-ranked constraints, *RH TYPE=T, RH TYPE =I and FT-BIN, because of having two trochaic feet and for the existence of a degenerate foot, respectively. It also violates a lower ranked constraint, ALL-FT-L. Candidate (c) has three violations. It fatally violates PARSE-σ as the first syllable is left unparsed. It also violates ALL-FT-L and RH TYPE=T. Candidate (d) fatally violates * RH TYPE=T. It also violates RH TYPE =I and PARSE-σ.

With this, the discussion regarding the right-headed stress in DT comes to an end. The factorial typology for right-headed stress would be as follows.

(37) * RH TYPE=T, RH TYPE =I, FT-BIN≫PARSE-σ≫ALL-FT-L≫RH TYPE=T

It should be observed that for left-headed and right-headed stress domains, the ranking of RH TYPE=T and *RH TYPE=T changes. Additionally, the ranking of PARSE-σ and FT-BIN also shifts.It is not pertinent to end this discussion without raising the issue of words with heavy syllables. The heavy syllable gets stressed if a word has two or more syllables. The constraint WSP (Weight to stress principle) ensures that heavy syllables get stressed (Kager, 1999, p. 155).

(38) WSP (Kager, 1999, p. 155)
(Weight to stress principle)
Heavy syllables are stressed.

Nonetheless, as it was previously mentioned the DT words collected from the fieldwork having heavy syllables are monosyllabic. However, if a tableau is constructed on the stress pattern of a heavily stressed DT monosyllabic and bimoraic word, it would look like the following. The word /pu:/ 'hair'.

(39) Tableau 8: /pu:/'hair'

/pu:/	*RH TYPE=T	WSP	FT-BIN	PARSE-σ	ALL-FT-L	RH TYPE=T
(a) ☞ ˈpu:						*
(b) ˈpu		*!	*			*

In the tableau in (3) candidate (a) /ˈpu:/ satisfies WSP as it automatically gets stressed for having a heavy syllable. As this word is bimoraic, it also satisfies FT-BIN. Similarly, candidate (a) satisfies both PARSE-σ and ALL-FT-L. It violates the lowest ranking constraint RH TYPE=T as there is no trochaic foot. On the other hand, candidate (b) fatally violates the highest ranked constraint WSP as it contains a light syllable. It also violates FT-BIN as it is both monosyllabic and monomoraic. Additionally, it violates RH TYPE=T. So, candidate (a) is the optimal choice in this case.

In the case of the stress situation mentioned in tableau (42), and if there are hypothetical DT words with one heavy and at least one light syllable, the factorial typology would be as follows.

(40) * RH TYPE=T, WSP, FT-BIN ≫PARSE-σ ≫ALL-FT-L≫RH TYPE=T

3.6 Conclusion

The primary data collected in Dharamshala (India) ensures that the trochaic, quantity-insensitive feet with left-to-right directionality is the pattern that applies to over ninety per cent of the DT words containing two syllables and more. The first foot contains the primary stress in DT if more than one foot is present. DT word stress pattern accepts a degenerate foot in the case of a left-headed trisyllabic word where there is no possibility of stress clash. Additionally, two words with iambic pattern have been found which are bisyllabic and trisyllabic respectively. As it is seen in the only right-headed trisyllabic word, the last syllable is extrametrical to prevent stress clash. Both extrametricality and degenerate foot exist in DT in two different contexts. Having both trochaic and iambic stress makes DT a typologically unique language. DT contains monosyllabic words which are either monomoraic or bimoraic. Both types receive stress by default. An existing body of literature on the stress of the standard Lhasa Tibetan has provided exciting insights into the probable forms of word stress in the DT variety. It offered a strong indication towards the existence of trochaic feet in DT. Simultaneously, a few earlier studies hinted at the possibility of some words with right-headed stress. In this context, a systematic analysis of word stress in the Dharamshala variety of the Tibetan language has been long overdue.

The OT framework is used to offer insight into the intricate yet highly systematic forces that make the existence of surface-level word stress possible in DT. DT stress patterns can be analysed as an interplay of the markedness constraints. An attempt to theorise both dominant and exceptional stress patterns of DT has been made with the same set of constraints in two different hierarchies. The objective to offer a theoretical understanding of DT stress has been, thus, attempted to be fulfilled.

Chapter 4

Tone sandhi and surface tonal realisations in the Dharamshala Tibetan

4.1 Introduction

Tonal languages generally contain a number of level or register tones and, in some cases, few contour tones in their citation forms. However, when multiple words with the same or different citation tones are in use in the domain of compound words, phrases and sentences, the surface form of the same tones might act differently. There are few distinct possibilities regarding the probable tonal behaviour in such context. Four possibilities are highlighted at present.

The citation tones might maintain their underlined forms even during the interaction with the other tones in the vicinity. Mandarin tones often behave in this manner with few exceptions like tone 3 sandhi (Yip, 2002, p. 187). Secondly, tone deletion and spreading of the remaining tone might take place. It is known to be a common occurrence in the Lhasa Tibetan (Duanmu, 1992). Thirdly, tone sandhi might occur. Tone sandhi refers to the alternations of tonal citation forms through phonological processes like the change of the category of the local tones under the influence of a neighbouring tone, long distance spreading, and lastly, both of the aforementioned processes might take place together. Tonal shift and spread is widely visible in the siSwati, a Bantu language (Malambe, 2017). Tonal change might take place in the form of assimilation or dissimilation. Tone based assimilation and dissimilation are found in the Cantonese and Tianjin languages respectively (Yip, 2002, p. 195).

As it was found in the chapter 2, Dharamshala Tibetan contains three level tones, namely, high, mid and low. In the current chapter, a few DT compounds and phrases have been listed for analysing and studying the behaviour of the tone associated with the tone bearing units. Simultaneously, the tonal behaviour of the individual words which are the building blocks of the aforementioned compounds and phrases is also studied. The tonal change can be only studied if the tone categories of the citation tones and their surface forms are studied and analysed.

It is essential to have an idea regarding the tone bearing unit (TBU) prevalent in one language. Mora and syllable are regarded as TBUs in general. A tone is associated with a TBU. DT contains words with both heavy and light syllables. Ideally, if a language contains both, and the number of tones a word can carry varies based on syllable weight, that language would contain mora as TBU. However, if the number of tones carried by a syllable does not depend on whether it is monomoraic or bimoraic, syllable is the TBU in that language. DT belongs to the second category.

To theorise DT surface tonal behaviour, Optimality Theory (Prince & Smolensky, 1993) is deployed as the phonological framework for this study. The wellformedness conditions of tone, propagated by Goldsmith (1976), have been turned into markedness constraints (Yip, 2002, pp. 79–80). A tonal language also might contain faithfulness constraints which would require the citation tone and the surface tone to be the same in terms of some features. Both binary and gradient constraints are useful to offer a theoretical justification of tonal systems (Yip, 2002, p. 83).

Considering all the points mentioned above, there are two goals this chapter aims to achieve.

A. To study the DT tones both in the citation forms and surface forms by analysing the stimuli.

B. To provide an OT justification of the tonal behavioural patterns found through the analysis of the DT tones both in citation and surface forms.

The organisation of the current chapter is stated as follows. Section 2 is divided into two subsections. Section 2.1 mentions the way the data was collected in brief. Section 2.2 lists the tonal stimuli on which the notions conveyed in this study are based on. Section 3 incorporates the main features of autosegmental phonology, and how this framework explains and theorises tone. Section 4 contains a discussion on tone sandhi. Section 5 adds a much needed discussion regarding how the tone based constraints of the Optimality theory evolved from the tenets of the autosegmental framework. Section 6 contains the OT justification of DT tone sandhi. Finally, the chapter ends with a conclusion in section 7.

4.2 Data collection and Stimuli

4.2.1 Data collection

The conditions described in section 2.1 of the chapter 2, regarding the venue of data collection are the same. The same set of protocols regarding the selection of the participants of the experiment is followed. All the conditions regarding the recorder and microphone set up are the same as before. A list of stimuli was prepared by a Tibetan L1 speaking consultant, and it was written in the Tibetan script. The participants were given a list of single words, compound words and small phrases to read. A Tibetan frame sentence /*ne X lab in*/ 'I will say X' is used to elicit the target content. The software PRAAT (Boersma & Weenink, 2010) is used for post-recording manual segmentation, and the script written by Gope (2016) is used to elicit the f0 data. The stimuli are presented in the following subsection.

4.2.2 List of stimuli

The current study uses compound words and phrases to examine the tone change patterns in DT. As these two domains are formed by concatenating different words, they present a valid way to study tone sandhi. The words, compounds and phrases used in this chapter as stimuli are presented in this section.

(1) List of stimuli for tone sandhi in DT

(a) /t͡ʃó/ 'ten'+/ŋā/ 'five'=/t͡ʃóŋá/ 'fifteen'

(b) /t͡ʃóŋá/ 'fifteen'+/pà/ (Ordinal Number Marker)= /t͡ʃóŋápā/ 'fifteenth'

(c) /níʃù/ 'twenty'+ /sā/ 'connector'+ /t͡ʃī/ 'one'=/níʃùsāt͡ʃī/ 'twenty one'

(d) /níʃùsāt͡ʃī/+/pà/ 'ONM'=/níʃùsāt͡ʃīpā/ 'twentieth'

(e) /ʈʰɔ́ŋmō/ 'friend'+ /là/ 'honorific' = /ʈʰɔ́ŋmōlā/ 'female friend (hon.)'

(f) /ŋé/ 'my'+/ʈʰɔ́ŋmō/ 'friend' = /ŋé ʈʰɔ̄ŋmó/ 'my female friend'

(g) /ʈʰɔ́kpō/ 'friend'+ /là/ 'hon.' = /ʈhɔ́kpōlā/ 'male friend (hon.)'

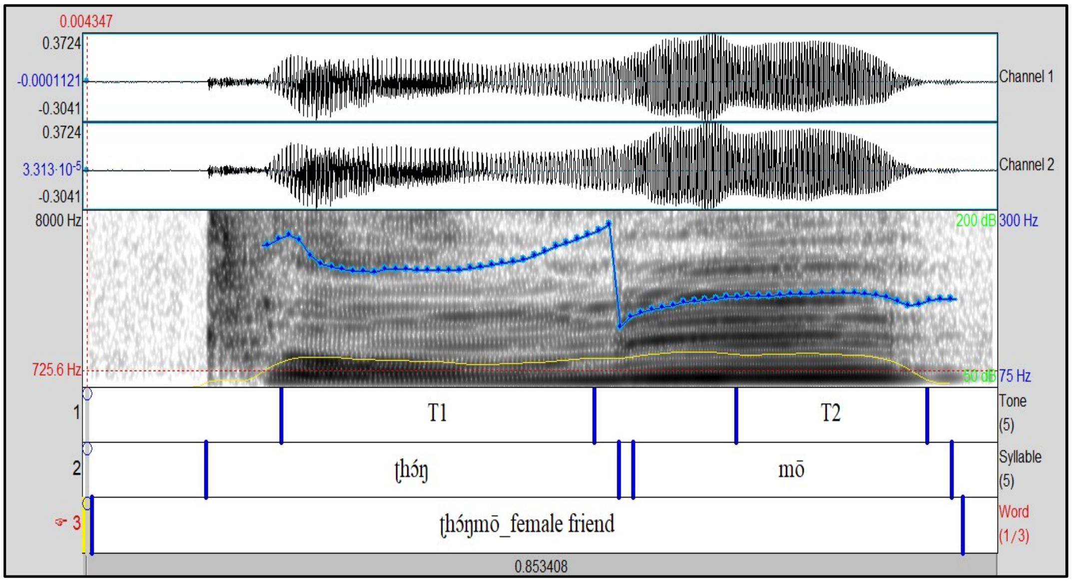
(h) /ŋá/ 'I'+ /là/ 'hon.' = /ŋálā/ 'I' (formal)

In the example (1a), the words /t͡ʃó/ 'ten' and /ŋā/ 'five' have high and mid tones in the citation forms. The tonal pattern of the citation tone remains unchanged in the first word /t͡ʃó/. However, the second word /ŋā/ has a change of tonal value. It has turned to /ŋá/. In case of (1b), the ordinal number marking suffix /pà/ is added to the existing word. It has a low tone in its citation form. But when it gets added to the compound /t͡ʃóŋá/ (fifteen), the lows tone of /pà/ becomes a medium tone.

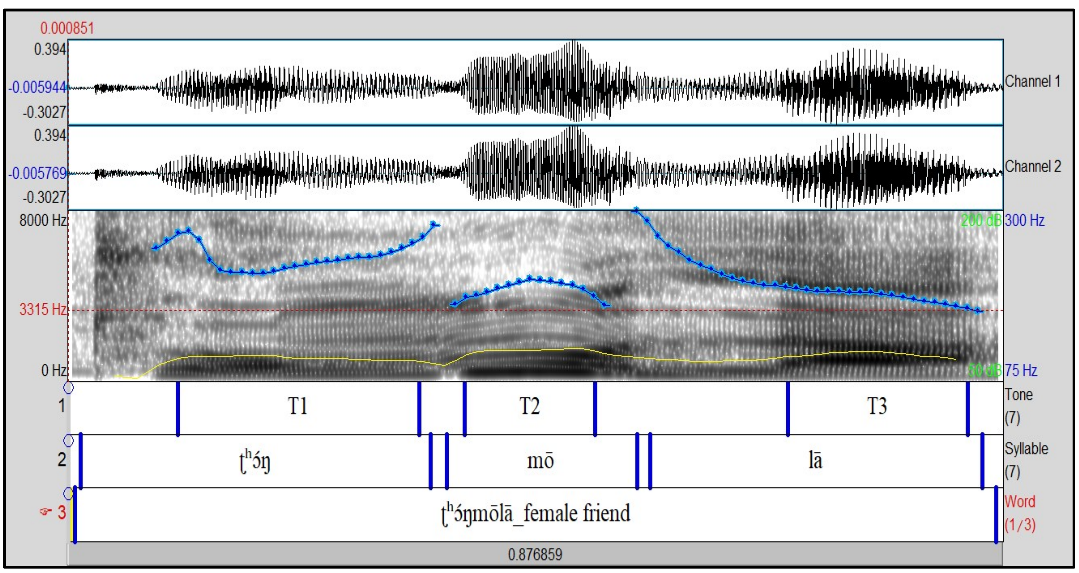
Similar tonal pattern is visible in case of the example (1d). A step by step study shows that how the f0 value of the last word /t͡ʃī/ 'one' drops in the influence of the connector particle /sā/. The connector particle roughly translates to 'and' semantically. It adds two cardinal numbers twenty and one to create twenty one in Tibetan. However, the tonal category of /sā/ did not change.

The word /là/ is used as an honorific after names, pronouns and in some cases it is added after place names as well in Tibetan. In its citation form, /là/ carries a low tone. However, based on the tonal environment, its surface form can see greater f0 value as a result of tonal assimilatory effect. The DT words in (1e), (1g) and (1h) prove this point. In all the DT examples listed in this section, tonal categories either go up or down. Praat impressions of the f0 tracks of few DT words are provided to elucidate the change of the citation tones in surface forms.

(2) Figure 1: f0 track of the DT word /ʈʰɔ́ŋmō/ 'friend'

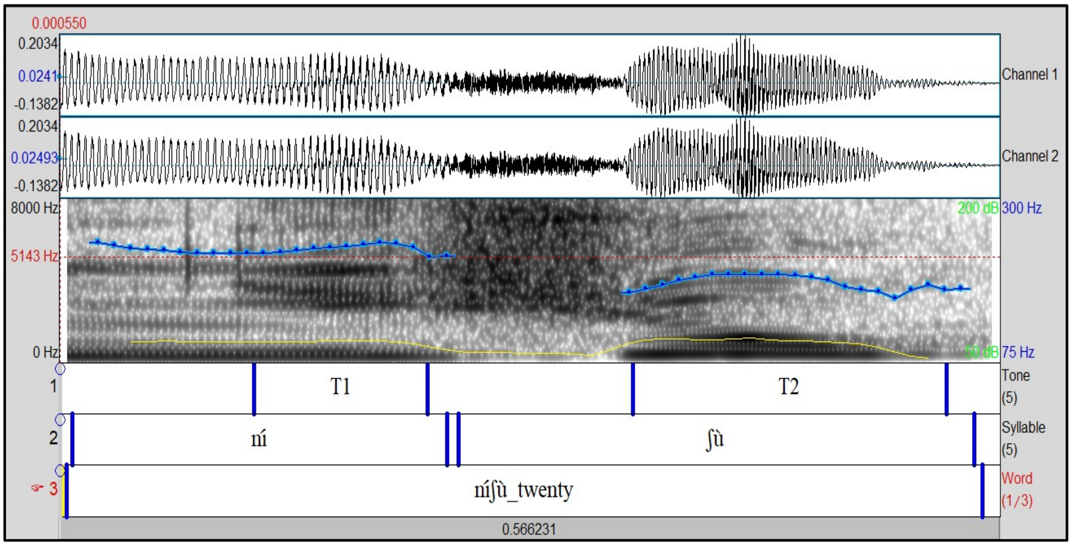


(3) Figure 2: f0 track of the DT word /ʈʰɔ́ŋmōlā/ 'female friend (formal)'

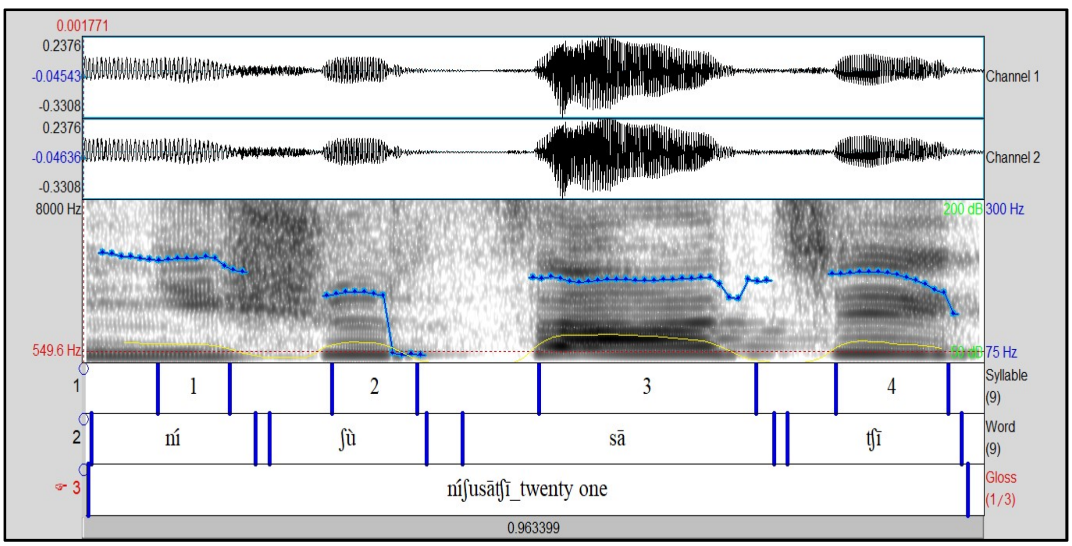


In the figure (1), it is seen that the DT word /ʈʰɔ́ŋmō/ 'friend' contains a high tone in the first syllable, and a low tone in the second syllable. In figure (2), the suffix /là/ is added with /ʈʰɔ́ŋmō/, and the low tone of /là/ becomes a mid tone in /ʈʰɔ́ŋmōlā/ in the influence of the preceding tone.

(4) Figure 3: f0 track of the DT word /níʃù/ 'twenty'



(5) Figure 4: f0 track of the DT word /níʃùsāt͡ʃī/ 'twenty one'



The word /níʃù/ 'twenty' has a high tone in the first syllable and a low tone in the second syllable. Figure 30 highlights this. When the numerical connector /sā/ is added with /níʃù/, it does not go through any change; however, the mid tone associated with the connector changes the high citation tone of /t͡ʃí/ to a mid one. In all these cases, the category of tone has either gone up or down. In short, qualitative change has taken place.

However, the leftmost syllable can keep its citation form intact during the process of tone sandhi.

4.3 Autosegmental representation

Autosegmental phonology is a non-linear framework that assumes linguistic representations to be a combination of multiple independent and parallel tiers, interconnected via association lines (Goldsmith, 1976). The segments and the suprasegments like stress and tone exist on different tiers. The suprasegments are not the property of individual segments, rather the word. Autosegmental framework has its origin in the works of Leben (1973) and Williams (1976), which employed a model that proposed the idea of tones existing in a separate tier from the vowels and consonants. The crux of autosegmental phonology can be summed up through the wellformedness conditions.

(6) Wellformedness conditions of the autosegmental framework (Goldsmith, 1976)

(a) All TBU are connected to minimum one tone.
(b) All tones are associated with minimum one TBU.
(c) Association lines are independent; they don’t cross each other.
(d) Association between the segments and tone progress from left to right direction.

However, these tenets are not absolute. In tonal languages, it is often seen that there are some syllables which are atonal. On the other hand, after the deletion of a TBU, the tone might still exist in the form of a floating tone with its own morphological and semantic content. In case of Mende, when the toneless suffix /ma/ ‘on’ is added to the word /mbǔ/ ‘owl’, the low tone gets transferred to the toneless syllable (Keffala, 2007). In this language, the requirement to fulfil the first wellformedness condition is strong.

(7) Figure 5: Tonal representation of the Mende word /mbùmà/ 'on the owl' in two steps following the autosegmental framework (Keffala, 2007)

(a) H L — Tonal tier

mbǔ — Segmental tier

(b) H L — Tonal tier

mbù má — Segmental tier

In the first stage, both H and L are associated with /mbǔ/. Both of the association lines are connected to the nucleus of /mbǔ/. However, when the tone shifting takes place with the addition of the toneless suffix /ma/, the L tone gets attached with the suffix. There are two separate association lines at this point.

(8) Figure 6: Tonal representation of the DT numerical compound /t͡ʃúʃī/ 'fourteen' in two steps

(a) H L — Tonal tier

t͡ʃú ʃì — Segmental tier

(b) H M — Tonal tier

t͡ʃú ʃī — Segmental tier

In this case, only tonal category of the second word /ʃì/ 'four' has changed in the impact of the tone in the preceding word /t͡ʃú/ 'ten'. L tone in the citation form gets changed to M, in the impact of the preceding H tone.

(9) Figure 7: Tonal representation of the DT numerical compound /níʃùsāt͡ʃīpā/ 'twenty first' in four steps

(a) H L M H — Tonal tier

ní ʃù sā t͡ʃī — Segmental tier

(b) H L M M — Tonal tier

ní ʃù sā t͡ʃī — Segmental tier

(c) H L M M L — Tonal tier

ní ʃù sā t͡ʃī pá — Segmental tier

(d) H L M M M — Tonal tier

ní ʃù sā t͡ʃī pā — Segmental tier

In this context, the numerical connector has a fixed tone value, and yet it influences the other tones to change quality. /pa/ acts as the morphological element that converts a DT cardinal number to an ordinal number. This particle adheres to the common rules of DT tone sandhi.

4.4 Tone Sandhi

Tone sandhi is a process of tonal alternations in the presence of contextually determined factors like the impact of other tones. Tones which are associated with different words or morphemes undergo change in this phonological process in the influence of tones in the neighbouring words or morphemes. Tone sandhi is a ubiquitous tonal mechanism present in different extent in all the tonal languages. However, in case of different dialects of Chinese, it is widely reported as the presence of contour tones creates a fertile ground for tone sandhi. If tone 3 exists in the adjacent words in Mandarin, tonal alternation takes place (Chen, 2000, p. 20; Yin, 2017). Tone 3 is a HLH or 214 tone. The first tone 3 becomes tone 2 in this context, whereas the last tone 3 remains intact. The following rule shows this tonal alteration.

(10) 3→ [2] /___3

The following example is a Mandarin phrase which consists of two words. This example highlights the aforementioned rule of sandhi of tone 3 in Mandarin.

(11) mai3 jiu3→mai [2] jiu3

buy wine

However, this specific tone sandhi in Mandarin is not only applicable in case of two adjacent words with tone 3. If more than two words are involved, and they carry tone 3, apart from the right most one, all the other tone 3 would turn to tone 2. The following example highlights this issue.

(12) mai3 hao3 jiu3→ mai [2] hao[2] jiu3

buy good wine

In case of the Mandarin tone 3, the tone sandhi is dissimilatory in nature. Ample instances of assimilatory tone sandhi also exist in different tonal languages. In Nanjing Mandarin, both assimilatory and dissimilatory instances of tone sandhi are available (Li & Kager, 2018). Apart from this classification, this phonological process can take place between the adjacent words or morphemes as well as in the non adjacent contexts. Mandarin tone sandhi is local. Tone sandhi is also local in case of Taiwanese. However, in Sanghai Chinese, tone sandhi occurs in the form of long distance spreading (Yip, 2002, p. 99).

As the examples of Mandarin tone sandhi suggests, the only tone 3 that does not undergo any change in the presence of other tone 3 is the rightmost one. The justification of this phonological detail reveals important information, not just about Mandarin tone 3, but also about the phenomena of tone sandhi itself. Mandarin tone 3 has a right dominant system. That is why the rightmost tone can keep its citation form intact even in the context of tone sandhi. Similarly, left dominant systems of tone sandhi exist. In Chengdu, a southwestern Mandarin dialect spoken in Sichuan, the directionality of tone sandhi is left to right (Lin, 2006).

A discussion on tone sandhi is incomplete without raising the topic of tonal coarticulation. The difference between these two processes related to tonal change might be blurred. However, there are few rules to distinguish them. Sandhi, in general, is a process of fusion which can take place both in the segmental and tonal domains. Coarticulation is a process where the shape of a segment or a tone gets influenced by a preceding or following segment or tone. In case of tone sandhi, the tone that undergoes the tonal change, acquires a new tonal category. This is evident in the case of the above mentioned two Mandarin examples. However, the tonal change in case of tonal coarticulation is not categorical, it is allophonic (Xu, 1993). In case a language contains contour tones, tonal coarticulation cannot affect the tonal contour (Li & Chen, 2016). Tone sandhi, on the contrary, can change the contours to a great extent.

4.5 Optimality Theory and tone

The current chapter explores the tonal behaviour in DT through the lens of Optimality theory (Prince & Smolensky, 1993). This constraint based approach is well equipped to handle not only different segmental phenomena; it is also robust enough to handle tonal behaviours in different contexts. This is a non-derivational framework which has been utilized by phonologists to theorise tones in different languages (Chen et al., 2008; Chen, 2008; Gomez-Imbert & Kenstowicz, 2000; Gruber, 2009; Morén & Zsiga, 2001, 2006; Mtenje, 2006). It is essential to appreciate how different theories of language that came before OT have contributed some great insights into the functioning of OT framework. This is true in the context of tone as well. For instance, constraints are one of the central components of OT, and some of a tone based constraints are derived from the wellformedness conditions of the Autosegmental phonology (Goldsmith, 1976).

The idea of different layers to accommodate autosegments like segments and tone became necessary because tones do not behave like segments. The first and foremost difference between the SPE model (Chomsky & Halle, 1968) and autosegmental model is the notions regarding the levels of representations. Unlike the SPE model, autosegmental framework posited phonological representation as a collection of independent layers. When it comes to the study of tone, having a tonal layer, independent of the segmental layer, can easily explain different tonal behaviours like tone spreading, survival of a tone when its TBU is deleted and so on.

In the same way ideas which are included in the wellformedness conditions can be turned into constraints. The condition every tone bearing unit (TBU) must be associated with a tone is not only about how there should be one tone associated with one TBU, it also is an indirect prohibition of the floating tone. A floating tone is phonemic (Yip, 2002, p. 76). It exists after the TBU it was associated with gets deleted. It also impacts the neighbouring tonal behaviour. As it is easily understandable that the wellformedness conditions are not absolute, it gets more convenient to translate a wellformedness condition into an OT constraint. The following constraint *FLOAT(Yip, 2002, p. 83) expresses this idea with further directness and clarity.

(13) *FLOAT (Yip, 2002, p. 83)
A tone must be associated with a TBU.

This constraint mentioned in the previous paragraph is an instance of a tonal markedness constraint. So are the following ones.

(14) NoContour (Yip, 2002, p. 86)

No contour tone is allowed.

(15) *LongTone (Yip, 2002, p. 87)

A tone may be associated with at most one TBU.

(16) One-T/μ (Yip, 2002, p. 198)

There should be one tone per mora.

(17) NoFusion (Yip, 2002, p. 102)

Separate underlying tones must stay separate.

Apart from a wide range of markedness constraints, a set of faithfulness constraints also exists in the tonal context. The following two constraints belong to the category of faithfulness constraints.

(18) Head-Max-Tone (Yip, 2002, p. 183)

Preserve the underlying tones of head syllables.

(19) Max-Tone (Yip, 2002, p. 183)

Preserve all underlying tones.

4.6 Optimality theory and DT tonal system

As it was said in section 2, DT has two types of tonal behaviour when two or more tones congregate. Firstly, a left to right oriented change in terms of tone sandhi might occur, where the qualitative values of the citation tones change. However, the leftmost tone does not change. Secondly, in the context of the numerical compound words, a morphological element might display different tonal behaviour, and be immune to the influence of the tones present in the domain. This morphological element has a fixed tonal value that remains unaltered. All the other tones in the same domain may undergo tone sandhi except this element and the leftmost tone. The first type of tonal behaviour would be dealt with initially.

However, as DT can be considered a variation of LT, it is essential to see what patterns of tonal behavior occur in LT before delving into the discussion of DT tone pattern. Duanmu (1992) came up with a set of rules to encapsulate the tonal alternation patterns of LT. He considered that LT contains three citation tones namely, H, L and LH. The Lhasa Tone rules propagated by Duanmu (1992) are as follows.

(20) Lhasa tone rules (Duanmu, 1992)

(a) Delete all tones except the initial one.

(b) Tone and syllables are to be associated in one to one manner, maintaining a left to right directionality.

(c) If there are more syllables, the last tone should be spread to the excess syllables.

(d) If there are excess tones, these tones should be linked to the last syllable.

(e) If an L tone precedes a long syllable with H tone in the final position, L should be spread to the latter.

In the Tibetan word /námǎ/ 'bride', high and rising are the two citation tones. Following the aforementioned Lhasa tone rules, only the high tone of the first syllable should survive as it is the initial tone. Then the same high tone should be spread to the last syllable, creating the surface tone pattern /námá/.

However, deletion followed by spreading of the initial tone to the non-initial positions does not occur in DT tonal system. The number of tones associated with the words in the phrasal domain or compound remains the same in the case of the optimal candidate. However, the quality of the tones undergoes change.

As there is no addition or deletion visible in such tonal interactions, it is evident that the faithfulness constraints are high ranking. The constraint MAX-TONE is derived from the faithfulness constraint MAX-IO (Kager, 1999, p. 67), and this constraint was already introduced in the section 5. The constraint DEP-TONE (Yip, 2002, p. 83) has its origin in the constraint DEP-IO (Kager, 1999, p. 68), which prevents any new addition in the surface form. DEP-TONE also has similar function, but in the context of tone.

(21) DEP-TONE (Yip, 2002, p. 83)
No addition of tones.

The faithfulness constraint IDENT-IO (Kager, 1999, p. 250) demands the quality of the segment in the input would be the same in the output regarding a certain feature. IDENT-TONE has the similar function in the context of tone (Yip, 2002, p. 79).

(22) IDENT-TONE (Yip, 2002, p. 79)
The value of tone associated with a TBU would be the same in both input and output.

If a feature of a segment is kept in its surface form or optimal form, that feature is high ranked in that language. The constraint IDENT-TONE is high ranked in a system in which the category of the tones remains unchanged in the surface forms. However, if the tones undergo qualitative change in the output, IDENT-TONE is a lower ranking constraint in that specific language. Since DT tones change in the surface form, IDENT-TONE can be regarded as a lower ranking constraint in DT.

In order to show the surface tonal forms in DT, a constraint is needed which would dominate IDENT-TONE. If we recall the example in (1h) /ŋā/+ /là/= /ŋālā/, the second tone goes up from low to mid. The difference in the value of f0 becomes one step higher in the second syllable in the impact of the high tone of the first syllable. It can be termed as an instance of progressive assimilation.

(23) L→ M/ M __

Similarly, the example in (1e) shows the tone sandhi of the word /ʈʰɔ́ŋmō/ + /là/ (female friend). When the honorific là is added, the low tone becomes a mid tone in the influence of the mid tone preceding it.

Both of these examples show that tone in DT gets impacted by the previous tone. If the tone which is lower in value than the one preceding it, it would climb up a step. A low tone would become a mid tone in the influence of the preceding high or mid tone. This is a specific situation that demands change of tone value due to the contextual requirement. A new constraint TONE VALUE UPWARDS is proposed to convey this information. Even though this type of constraints compares the input and output, but it requires a change in the output to not cause a violation. This is the reason why TONE VALUE UPWARDS is different from a faithfulness constraint. Alderete (1999) came up with the notion of anti-faithfulness constraint for certain situations in which change is expected in the output. An anti-faithfulness constraint is violated if change has not occurred in the output. TONE VALUE UPWARDS can be regarded as an anti-faithfulness constraint for this reason.

(24) TONE VALUE UPWARDS

A low or mid tone would become mid or high tones respectively if preceded by a mid or high tone.

This constraint is intended to create the opposite structural requirement of IDENT-TONE. It requires an uplifting of the value of tone in a specific context. An upliftment of tonal category constitutes a change. If the former constraint requires no change, the latter constraint does, but only for the tones with a preceding tone with higher qualitative value. The ranking between these two constraints is as follows.

(25) TONE VALUE UPWARDS ≫ IDENT-TONE

The following tableau attempts to provide an Optimality theoratic explanation regarding the above mentioned phenomenon. As there is no tonal addition or deletion, both MAX-TONE and DEP-TONE are automatically fulfilled by the optimal candidate.

(26) Tableau 1: Tone sandhi of the DT word /ŋālā/ (I in the formal context)

ŋā + là	MAX-TONE	DEP-TONE	TONE VALUE $^{\text{UPWARDS}}$	IDENT-TONE
(a)☞ŋālā				*
(b) ŋālà			*!	
(c) ŋāla	*!		*	
(d) ŋālǎ		*!		*

In the tableau in (26), the optimal candidate (a) /ŋālā/ fulfils all the higher ranking constraints. It violates the lowest ranking constraint IDENT-TONE as the low tone on /la/ has changed to mid. Candidate (b) violates the constraint TONE VALUE $^{\text{UPWARDS}}$ by not changing the low tone to mid tone in /la/. As it is a high ranking constraint, and candidate (b) has fatally violated it, it has gone out of the competition. Candidate (c) has no tone on la, and as a result of tonal deletion, it fatally violates a high ranking constraint Max-Tone. It also violates TONE VALUE $^{\text{UPWARDS}}$. Candidate (d) has violated DEP-TONE by adding one extra tone in /la/, and thus, has got eliminated.

The former tableau only explained the basic mechanism of DT tone sandhi. However, one essential factor regarding DT tone sandhi is yet to be explained. DT tone sandhi takes place from the left to right side, but the leftmost tone in the domain remains unchanged. This fact reveals that DT tone sandhi is left headed. The constraint IDENT-IO-TONE-LEFT is added to address this issue (Lin, 2006).

(27) IDENT-IO-TONE-LEFT (Lin, 2006)

The leftmost tone of an utterance is identical to its input.

All the optimal candidates fulfill this constraint, thus, making it a high ranking constraint. The tableau in (19) is repurposed as tableau (21) with a new candidate (e).

(28) Tableau 2: Tone sandhi of the DT word /ŋālā/ 'I in formal context'

ŋā + là	MAX-T	DEP-T	IDENT-IO-T-L	ToneValue $^{\text{Upwards}}$	IDENT-T
(a)☞ŋālā					*
(b) ŋālà				*!	
(c) ŋāla	*!			*	
(d) ŋālǎ		*!			
(e) ŋàlà			*!	*	*

In the tableau of (28) candidate (e) also undergoes tone sandhi. However, it does not keep the leftmost tone untouched, and thus, it violates IDENT-IO-T-L, a high ranking constraint. It also violates Tone Value $^{\text{Upwards}}$ and IDENT-TONE. The surface tones automatically fulfil both MAX-TONE and DEP-TONE in DT. As a result, the next tableaux would not contain these two constraints.

The tone pattern in the example /ʈʰɔ́ŋmō/ 'female friend' starts with a high tone, whereas it has a mid tone in the second syllable. If the word /ŋé/ 'my' is added before /ʈʰɔ́ŋmō/, the phrase in the example (1f) /ŋé ʈhɔ̄ŋmó/ 'my female friend' would be found.It suggests that the first syllable of a compound word or a phrase can only keep its citation tone if it is the leftmost in that domain.

(29) H→ M/ H _

As the value of tone has decreased one degree below after two high tones are juxtaposed, the following anti-faithfulness constraint is proposed to express this notion.

(30) TONE VALUE $^{\text{DOWNWARDS}}$

A high tone would go one step down if preceded by a high or mid tone. A mid tone would go one step down if it ispreceded by a mid or low tone in the latter case.

Tone Value $^{\text{Downwards}}$ and Tone Value $^{\text{Upwards}}$ constitute the pair of constraints that act as the opposition of the constraint IDENT-TONE. The former two constraints are markedness constraints. The constraint TONE VALUE $^{\text{DOWNWARDS}}$ is used in the following tableau. In the tableau in (31), candidate (a) is the optimal candidate as it violates IDENT-TONE, the lowest ranking constraints two times. Candidate (b) fatally violates TONE VALUE $^{\text{DOWNWARDS}}$ two times, and gets eliminated as it is a higher-ranking constraint. The high tone in /ʈhɔ́ŋ/ should have become a mid tone, and the mid tone in /mō/ should have become a low tone. In the case of candidate (c), the directionality of tone sandhi is right to left. As a result, the citation tone of /ŋe/ gets changed. Candidate (c) fatally violates the highest-ranking constraint IDENT-IO-T-L. It also violates IDENT -TONE.

(31) Tableau 3: Tone sandhi of the DT phrase /ŋé ʈhɔ̄gmó/ ‘my female friend’

ŋé+ ʈʰɔ́ŋmō	IDENT-IO-T-L	TONE VALUE$^{\text{DOWNWARDS}}$	IDENT -TONE
(a)☞ŋé ʈhɔ̄ŋmó			**
(b) ŋé ʈʰɔ́ŋmō		*!*	
(c) ŋè ʈʰɔ́ŋmō	*!		*

The last two tableaux (1 and 2) have established the basic tone sandhi constraint ranking in DT. Change of tone category is more preferred than keeping the citation values, except in one case. The factorial typology of DT tone sandhi is as follows.

(32) IDENT-IO-T-L≫TONE VALUE $^{\text{UPWARDS}}$, TONE VALUE $^{\text{DOWNWARDS}}$≫ IDENT-TONE

Example (4) /níʃùsāt͡ʃī/ 'twenty one' shows that not all tones go through tone sandhi in DT. The connecting particle /sā/ carries a mid tone in the citation form, and keeps it when accompanied by other tones in the same domain. As a result, the constraint ranking that was formulated previously, is insufficient to accommodate this tonal behavior. Hence, a new constraint is proposed.

(33) IDENT-IO-T-NC
(IDENT-IO-TONE-NUMERICAL CONNECTOR)
The value of the input tone of the numerical connector is the same in the output.

A numerical compound word with a connector in DT fulfills this constraint, along with the IDENT-IO-T-Lconstraint. As a result, they share the same ranking, and would dominate other constraints. Tableaux (34) and (35) illustrate this point.

(34) Tableau 4: Tone sandhi of the DT compound /níʃùsāt͡ʃī/ 'twenty one'

níʃù+sā +t͡ʃi	IDENT-IO-T-L	IDENT-IO-T-NC	TONE VALUE^{DOWNWARDS}	IDENT- T
(a) ☞níʃùsāt͡ʃī			*	*
(b) níʃùsāt͡ʃí			*!*	
(c) níʃùsàt͡ʃī		*!		**
(d) nìʃùsāt͡ʃi	*!			*

In the tableau in (34), the candidate (a) is the optimal candidate as it has one lower ranking violation of TONE VALUE ^{DOWNWARDS}. It also violates the lowest ranking constraint IDENT-TONE as there is only one change of the value of tone. Candidate (b) violates TONE VALUE ^{DOWNWARDS} twice, and thus gets eliminated. Candidate (c) has a fatal violation of the high ranking constraint IDENT-IO-T-NC. It also violates IDENT-TONE twice. Candidate (d) fatally violates the highest ranking constraint IDENT-IO-T-L as the high tone associated with the leftmost syllable gets changed to a low tone. It also has a violation of the constraint IDENT- TONE as only one change of tone value took place.

(35) Tableau 5: Tone sandhi of the DT compound word /níʃùsāt͡ʃīpā/ 'twenty first'

níʃùsāt͡ʃī+pà	IDENT-IO-T-L	IDENT-IO-T-NC	TONE VALUE UPWARDS	IDENT-T
(a)☞níʃùsāt͡ʃīpā				
(b) níʃùsāt͡ʃīpà			*!	
(c) nīʃūsàt͡ʃīpà	*!	*		****
(d) nīʃūsāt͡ʃīpà	*!			***

In the tableau (35), candidate (a) is the optimal candidate, and it has one violation of IDENT-TONE, as the low tone associated with /pa/ gets changed to a mid tone. Candidate (b) has one fatal violation of the constraint TONE VALUE UPWARDS, as the citation low tone in /pà/ has not become a mid tone. Candidate (c) is a candidate which has a right headed tone pattern. As a result, only /pà/ keeps its citation tone, and the rest of the words undergoes shift in tone value. It fatally violates IDENT-IO-T-L. It also violates IDENT-IO-T-NC once. It has four violations of IDENT-TONE. Candidate (d) is similar to candidate (c) only except, it maintains the citation form of sā. It fatally violates IDENT-IO-T-L. It violates TONE VALUE DOWNWARDS once. It has three violations of IDENT-TONE.

The discussion on tone sandhi in DT has reached towards its end with the inclusion of the numerical compound words and their tone pattern. The factorial typology of DT tone sandhi of numerical compounds is as follows.

(36) IDENT-IO-T-L, IDENT-IO-T-NC≫ TONE VALUE UPWARDS, TONE VALUE DOWNWARDS≫ IDENT –TONE

4.7 Conclusion

Tone sandhi has displayed two different patterns in Dharamshala Tibetan so far. In the first pattern, tonal category changes in the influence of the tone preceding it. It might be an upward or a downward change, depending upon the preceding tone. However, the leftmost tone can keep its citation form even when it is in the company of other tones in the same domain as DT has a left dominant tone system. Apart from this pattern, we have also found a pattern of tonal behaviour in which citation tone of a certain morphological element remains intact, even when it is in the same domain with other tones. Though this specific type of tone does not get affected by the presence of the neighbouring tones, it can impact the tonal category of the tone following it. It is required to conduct an in depth examination of DT compounds, and phrases in different contexts to see if there are other types of tonal behaviour that takes place in this language. Both faithfulness and markedness constraints have been essential to theorise the tone sandhi patterns in DT.

Chapter 5

Word Stress and tone in the context of reduplication in the Dharamshala Tibetan

5.1 Introduction

Reduplication is a word formation process, widely pervasive in languages all over the world. It is a morphophonological phenomenon involving either complete or partial repetition of a word in order to create a new word with novel semantic as well as grammatical content (Rubino, 2011; Urbanczyk, 2017). Base is the part of a reduplicative expression that offers the source material for the part, which would be repeated. The repeated part is called reduplicant (RED). The reduplicative expressions generally refer to a sense of pluralisation, repetition, continuity, greater degree of intensity, etc. It can also generate a sense of diminution.

Morphologically, reduplication can be defined as affixation. The RED can be attached to the base in the forms of prefix, suffix, and infix. Phonologically, reduplication is a linguistic phenomenon regarding phonological identity between the base and the reduplicant. Phonological segments and suprasegments of the RED are copied from the base, though advanced phonological theories regarding reduplication do not treat it as a mere copying mechanism.

Full reduplication involves repetition of the complete root, stem, word, and in some cases, phrases. In case of the partial reduplication, generally syllable or foot sized repetitions are involved. Full reduplication in Vietnamese contains repetition of the root, whereas partial reduplication in Vietnamese may contain alternative vowels in the nucleus or different consonants in the coda of the base and RED (Phuong et al., 2009). Indonesian plural reduplication is an instance of repetition of whole words (Cohn, 1989). Samoan and Diyari contain syllable sized and foot sized reduplicants respectively (Broselow & McCarthy, 1983; Poser, 1989). Nguyen & Ingram (2006) have worked on two different types of reduplication processes in Vietnamese. In the first one, both segmental and tonal properties are fully reduplicated from the base to the RED. In the other type, segments are fully copied. However, the tones go through the process of tone sandhi. In both these two cases, the stress lies with the base, which falls at the right hand side.

As it is already mentioned, RED can be prefixal, suffixal and in relatively less number of languages, infixal. Both Samoan and Diyari contain prefixal reduplication, whereas Vietnamese includes both prefixal and suffixal reduplication. On the other hand, Cantonese and Mandarin contain instances of infixation (Samuels, 2010). In all these languages, the base and RED are positioned side by side. However, RED and base are not always juxtaposed together. When some linguistic material is intervening between RED and base, it is called discontinuous reduplication. Tshobdun, Malay, Maithili are some of the languages that include instances of discontinuous reduplication (Mattiola & Masini, 2022).

The current chapter concerns itself with how word stress and tone work in the domain of the reduplicative process in the Dharamshala variety of Tibetan. Few descriptive works on Lhasa Tibetan reduplication exist (Vollmann, 2010; Vollmann & Wagner, 2006). The formulations in this study are based on the firsthand data collected from the fieldwork in Dharamshala, Himachal Pradesh, India. Word stress and tone in DT have been individually studied in the previous chapters, both from the phonetic and phonological perspectives.

Optimality Theory (OT) (Prince & Smolensky, 1993) is utilised in this chapter to offer the reasoning behind how stress and tone function in the context of DT reduplication patterns through a set of constraints which are violable and universal. These specific constraints regarding reduplication have their foundation in the principles of identity, shape invariance and the emergence of the unmarked (TETU). Different reduplication patterns arise due to the conflict among three types of violable constraints namely, wellformedness, faithfulness, and base-reduplicant identity (McCarthy & Prince, 1999).

The next sections would be divided into the following. Section 2 offers a brief description on how DT data on reduplication was collected. It also contains the examples of different types of DT reduplicative words. Section 3 includes a discussion of shape invariance and the emergence of the unmarked (TETU) in the context of word stress and tone. Section 4 contains a rather brief description on how different frameworks tackle the challenge of reduplication. Section 5 concerns with theorisation of word stress in the context of DT reduplication using OT framework. Section 6 deals with tone in the context of DT reduplication. The paper ends with a conclusion at section 7.

5.2 Data collection and stimuli

5.2.1 Data collection

A list of reduplicative words was prepared by consulting with a local DT speaker. The data was collected from nine Tibetan L1 speakers, among them five were female and four were male. A set of Tibetan reduplicative words was prepared beforehand with the help of a Tibetan consultant. The list of reduplicative words was presented to them in the Tibetan font. They were instructed to reiterate the words within the frame sentence /*ŋa* X lab in/ 'I will say X.' The details concerning instrument, venue of recording, sampling frequency, post-recording data segmentation and extraction are same as the previous chapters.

5.2.2 A brief discussion on the stimuli and type of reduplication patterns available in DT

DT reduplications are of both full and partial types (Simon & Hill, 2015; Vollmann, 2010). The base for reduplication in DT can be either monosyllabic or bisyllabic. DT reduplicants are suffixal. Instances of echo formations are also available in DT. The first list features instances of DT reduplications with monosyllabic bases. It also shows how tone and stress behaves in the base and the reduplicant. DT contains three tones, namely, high, mid and low. In case of monosyllabic bases, the tone of the base is changed in the reduplicant. Even though same tones occur side by side in DT tonology in general, in case of reduplication, OCP is prioritised. The dominant stress pattern is left-headed, maintaining a left to right directionality.

(1) Tone and stress patterns in full reduplication with monosyllabic bases in DT

(a) (ˈtʰūk.tʰùk) ‘very short’

(b) (ˈtʰíb.tʰìb) ‘very dark’

(c) (ˈtʰùŋ.tʰúŋ) ‘very young’

(d) (ˈpó.pò) ‘grandfather’

(e) (ˈʧó.ʧò) ‘brother’

(f) (ˈní.nì) ‘two two’

(g) (ˈsù.sū) ‘who who’

(h) (ˈtsí.tsī) ‘mountain rat’

(i) (ˈyá.yà) ‘as good as possible’

In case of the bisyllabic bases, the stress and tone patterns of the base can get reduplicated in almost the same form. The following list features instances of DT complete reduplications with tonal patterns. In case H and L tones are available in the base, the H of the reduplicant undergoes downstepping in the RED.

(2) Tone and stress pattern in full reduplication with bisyllabic bases

(a) (ˈkʰá.lè) (ˌkʰá.lè) ‘slowly slowly’

(b) (ˈʧʰē.táb) (ˌʧʰē.táb) ‘open open (in the process of opening)’

(c) (ˈgyòk.tú) (ˌgyòk.tú) ‘fast fast’

(d) (ˈkʰá.rè) (ˌkʰá.rè) ‘who who’

(e) (ˈŋīŋ.bà) (ˌŋīŋ.bà) ‘very old’

The third list features both monosyllabic and bisyllabic instances of DT echo words with the same tonal pattern mentioned in the last two lists.

(3) Tone and stress pattern in DT echo words with both monosyllabic and bisyllabic bases

(a) (ˈnām.nùŋ) ‘very experienced and so’

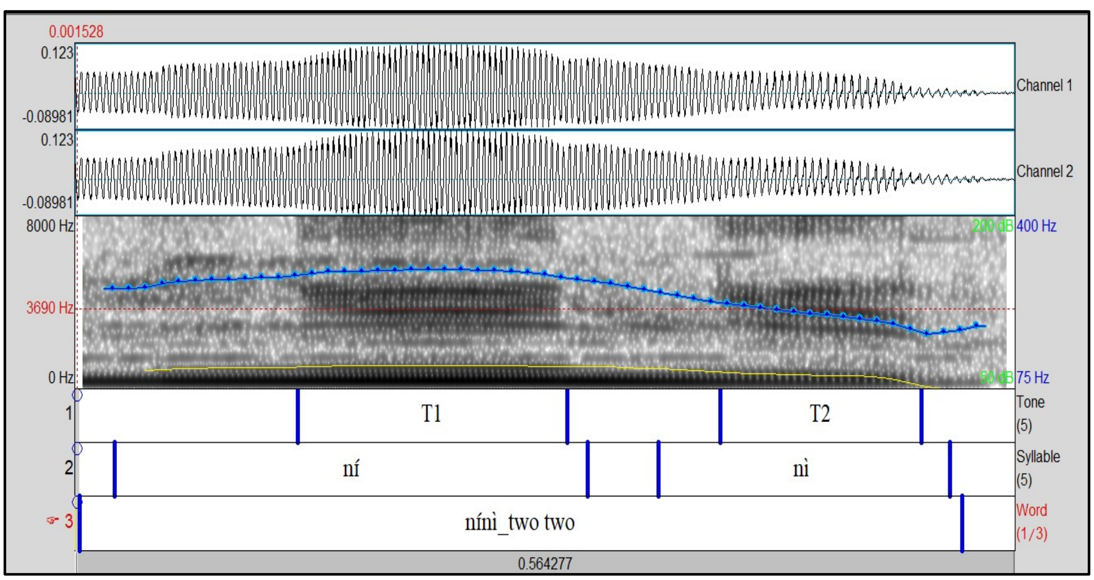
(b) (ˈkʰárg kʰrùg) ‘really disturbed and so’

(c) (ˈmí.tèn) (ˌgú.tèn) ‘disorganized and so’

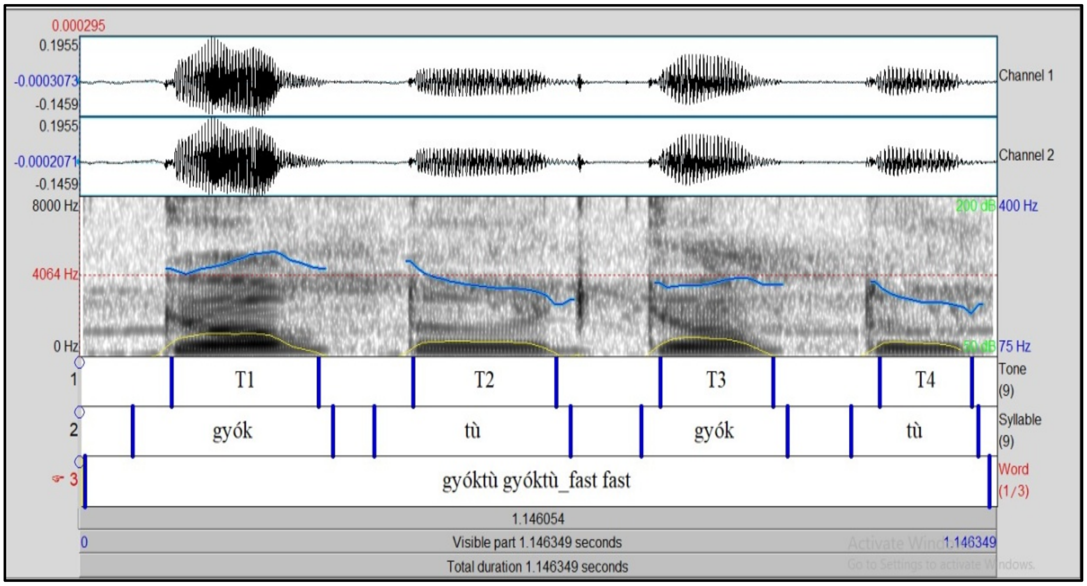
(d) (ˈkʰáŋ. ʧʰùŋ) (ˌmáŋ.ʧʰùŋ) ‘really honest and so’

The following two figures display the spectrograms of tone and stress patterns of the two DT reduplicated words. One of the words has a monosyllabic base, and the other has a bisyllabic base.

(4) Figure 1: f0 track and intensity of the DT reduplicated word /ˈní nì/‘two two’



(5) Figure 2: f0 track and intensity of the DT reduplicated word /ˈgyòktú ˈgyòktú/ ‘fast fast’



Both stress and tone are different in the reduplicated word with the monosyllabic base. However, stress and tone patterns are similar in the DT reduplicated word with bisyllabic base. However, downstepping is visible in the latter case.

5.3 Few distinct features of the reduplication process: Shape invariance and The Emergence of the Unmarked (TETU)

As it has been already mentioned, reduplication is concerned with the phonological identity between the base and the reduplicant. The reduplicant does not have an underlined representation as it acquires its segmental and suprasegmental forms from the base. The segmental and suprasegmental content of the base and reduplicant are the same for complete reduplication. It is easily evident in case of Indonesian reduplication (Cohn, 1989). The reduplicated forms indicate pluralisation in this language.

(6) wanita wanita ‘women’

A similar kind of complete reduplication pattern is visible in case of Chichewa, which is one of the tonal Bantu languages. Both segmental and tonal features of the base are reduplicated (Hyman & Mtenje, 1999). The reduplicated expression refers to the occurrence of an action repeatedly.

(7) tambalalá tambalalá 'stretch out your legs repeatedly'

Juba Arabic language contains a similar pattern in case of the full reduplication of adjective and adverb with bisyllabic bases (Miller, 2003). Bases with trisyllabic verbs also maintain this pattern.

(8) ˈkebir ˈkebir 'big'

The last two types of reduplication not only show full segmental identity between base and RED, but also full suprasegmental identity, as the tone and stress patterns of the base and RED are the same. However, in case of the partial reduplication, the reduplicant only copies a part of the base. It might be a syllable or a foot. In Diyari, it is the initial two syllables from the base that gets reduplicated in the form of prefixal reduplication in case of reduplication with bases containing more than two syllables (Austin, 1981). However, in case of bases containing two syllables, the entire base is copied. The RED forms a foot with the initial two syllables, and the first syllable is stressed. Diyari bans monosyllabic RED to not cause stress clash, and maintain the cyclic pattern of stress. Full identity is only maintained in case of the word with bisyllabic base.

(9) Diyari reduplication (Austin, 1981)

(a) ˈtʲilparku ˈtʲilpa ˈtʲilparku 'a species of bird'

(b) ˈwilha ˈwilhaˈwilha 'women'

In case of reduplication in Kirundi, another Bantu tonal language, high tone is not copied (Brassil, 2003). If one H tone is present, it has to be realized only at the base, located left hand side.

(10) ku-réga+rega 'to be unstable'

The instances of partial reduplication make it evident that reduplication is not a mere copying mechanism. Rather it involves different layers of complexities. Though reduplicant receives its segmental and suprasegmental properties from the base, how much of the content from the base the reduplicant would copy and in what format (e.g., complete reduplication or partial) shed light on the subject that reduplicant doesn't always share a one to one prosodic shape with the base. Rather the idea of shape invariance is at the crux of it (Kager, 1999, pp. 195–196).

Another integral aspect of this process involves the unmarkedness of the reduplicant. If a certain phonological structure is permitted in the phonotactic rules of a certain language, it might appear on the base. However, the reduplicant might forgo this structure in favour of a universally unmarked structure. Since the reduplicant has no underlined representation, it has no provision of faithfulness relationship between the underlined and surface representations, unlike the base. In a context like this, the unmarked structure surfaces. Non-transfer of H tone from base to RED in Kirundi happens as a result of the emergence of the unmarked (TETU) (Brassil, 2003). High tone is universally considered marked. As a result, it is not copied in the RED of the Kirundi reduplication. In case of Diyari, the prefixal RED creates a bisyllabic foot, thus, an unmarked structure is produced (Austin, 1981).

5.4 Theoretical frameworks of reduplication

Multiple models regarding different reduplication types have been theorised. Such theories of reduplication are either morphology based or phonology based. Morphological Doubling Theory (MDT) proposes that reduplication as a process falls into the domain of morphology (Inkelas & Zoll, 2005). Morphology of the language requires the copying of the semantic elements twice. It is the semantic features that get doubled in this process, not a word or a stem. The main theoretical outlook of the current work focuses on the phonology based theories. If these frameworks are clearly studied, it can be observed that these theories clearly set precedent to each other.

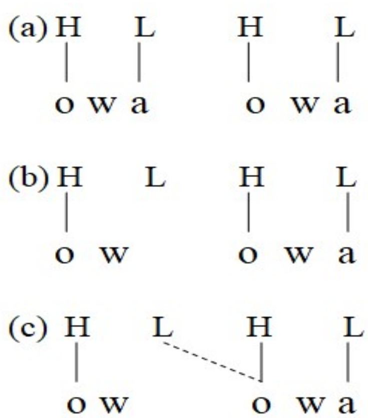
Autosegmental framework puts forward the idea that phonological representation consists of more than one independent tier (Goldsmith, 1976). A suprasegmental feature like tone or stress exists on a tier separate from the segmental tier. These tiers are connected to each other with the help of association lines. In this way, stress or tone is a property of a word, not individual segments.

Relatively limited number of works on reduplication has been done following the autosegmental phonology framework. The work of Indrawati (2008) on Indoneshian reduplication is one of them. In case of Etsako language from Nigeria, hiatus is disallowed (Fromkin, 2014, p. 243). If a word ends with a vowel and another word starts with a vowel, one of the vowels gets deleted, and a compound is formed using these two words. The same rule is applicable in case of reduplicated expressions as well.

(11) /ówà / ‘house’ $\longrightarrow$ /ówà ówà/ ‘every house’ $\longrightarrow$ [ówǒwà] ‘every house’

The low tone on the vowel a does not get deleted, though the segment did. L is existing, and it becomes LH tone due to the tonal stability factor (Yip 2002, 65). The following diagram shows an autosegmental representation of tonal reduplication in three steps.

(12) Figure 3: Autosegmental diagram on the tonal reduplication in Estako (Fromkin, 2014, p. 243)

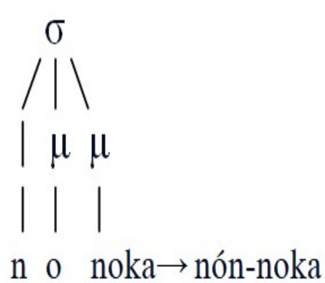


The association line was removed in the second stage after the segment was deleted. However, the tone associated with the segment still exists. The remaining L tone gets transferred to the next vowel /o/ due to the tonal mobility factor (Yip 2002, 65). The broken line represents a new association.

In Mayo, for the word /nón-noka/ 'know language', the stem /nóka/ is monomoraic (Hagberg, 1993). However, the prefixal RED is bimoraic. The extra mora is obtained through the process of leftward spread of the initial phoneme of the stem. The stress is transferred from the base to the RED.

(13) nóka→ nó( )-noka 'know language'

(14) Figure 4: An autosegmental representation of the reduplicative word /nón-noka/ 'know language' (Hagberg, 1993)



Both segmental and suprasegmental reduplication can be expressed through the multiple tier structure, though it does not shed light on the reasoning behind such reduplications. Therefore, seeking a phonological framework that provides an explicit reasoning regarding the shapes of the reduplicants is pertinent. Moravcsik (1978) was one of the first linguists to note how RED can take up different shape from the base in different ways even though the material of RED is taken from the base. This specific observation makes it apparent that reduplication is not a simple mechanism of copying rather something more complex. Moravcsik's ideas on shape invariance paved path for the template association theory (Clements, 1985; Marantz, 1982) which the reduplicant to a template. The classical version of this theory suggests the idea of a template which contains all the prosodic traits of the reduplicant. It predicts whether the RED would exist in the form of prefix or suffix, etc. A template contains C and V slots.

Generalized Templatic Theory offers an evolved version of the earlier templatic framework (McCarthy & Prince, 1986). It simply considers RED to be an affix. In order to explore the idea of shape invariance of the RED, it is more pragmatic to define the RED through prosodic categories than CV slots. The approach of Optimality theory towards the shape of the RED is a further attempt to offer an explicit reasoning regarding why RED can take varied shapes in terms of both segments and suprasegments. It can be rightfully suggested that the theoretical apparatus of the templatic model in the study of reduplication has found a further continuation with the advent of Optimality theoretic framework.

OT generally deals with two types of constraints, namely markedness and faithfulness constraints. The first set of constraints require the optimal output to fulfil a set of structural requirements permitted in the said language, whereas the latter set of constraints require the surface form and the underlined forms to be identical. A third set of constraints, Base Reduplicant (BR) identity constraints is required in case of reduplication.

The study of reduplication through the Correspondence theory is to study these three types of constraint interactions and rankings. Different rankings of the said constraint types can justify typologically varied reduplication structures available in the world languages.

(15) Figure 5: Basic model of reduplication (McCarthy & Prince, 1995)

Input: **/*Af* $_{\mathbf{RED}}$ + Stem/**

↑↓ ***IO Faithfulness***

Output: **R ↔ B**

BR- Identity

The model constitutes an input and an output level. The input includes a segmentally empty affix, *Af* $_{\text{RED}}$, which is adjoined to the base. The optimal candidate is generated through the conflict among the aforementioned three types of constraints. The notion of correspondence is an essential one in the study of reduplication. Correspondence is the relationship between the base and the reduplicant. Correspondence is born out of the interaction among different constraints present in a specific language.

(16) Idea of correspondence in the reduplication process (McCarthy & Prince, 1995, p. 262)

A. Correspondence. Given two strings S1 and S2, *correspondence* is a relation $\mathscr{R}$ from the elements of S1 to those of S2.

B. Correspondents. Elements $\alpha \in$ S1 and $\beta \in$ S2 are referred to as *correspondents* of one another when $\alpha \mathscr{R} \beta$.

5.5 Optimality theoretic representation of word stress in the context of DT reduplication

In DT reduplication, it is the first syllable that is stressed. In case of a base that happens to be a monosyllabic word, the RED does not get stressed to avoid a stress clash. However, the stress pattern of the base gets repeated in the RED if the base is bisyllabic as no stress clash is involved in that case. In case of stress in DT reduplication, adjacent stress is not allowed. As a result, the priority is to not have a situation where stress clash may occur. If this criterion is being fulfilled, stress can get reduplicated. Otherwise, RED does not copy stress of the base.

As the stress pattern is left headed in the DT reduplication data, the constraints associated with stress used in the chapter 3 are also useful in this context. Additionally, modified constraints like MAX-BR (STRESS), MAX-IO (STRESS) & IDENT-BR (STRESS) have been used. As the stress pattern of the base is repeated in the RED in case of the reduplicated words with bisyllabic base, there is no deletion of stress in RED. The constraint MAX-BR (Kager, 1999, p. 205) is used in such a context in case of the segmental copying.

(17) MAX-BR (Kager, 1999, p. 205)

Every element in B has a correspondent in R.

As this study is dealing with stress, a new constraint MAX-BR (STRESS) is derived from the previous constraint.

(18) MAX-BR (STRESS)

Every stressed syllable of B has a correspondent in R.

As the base is derived from an underlined representation, a faithfulness constraint MAX-IO is generally used in such context (Kager, 1999, p. 67).

(19) MAX-IO (Kager, 1999, p. 67)

Input segments must have output correspondents.

It ensures the segments in the underlined representation are present in the base. Since current discussion is regarding stress pattern and reduplication, a more suitable form of MAX-IO is introduced. In this way, the stress pattern of the base is subjected to the condition of input faithfulness.

(20) MAX-IO (STRESS)

The stress pattern of the input must be the same in the output.

The placement of the word stress in DT reduplication depends on the number of syllables the base carries. DT reduplicative words can be segmentally full or partial. This fact does not impact the positioning of word stress in case of reduplication. The goal is to not place two stressed syllables in the adjacent positions. The word stress of the base is copied to the RED in DT reduplication if this condition is fulfilled. The next two tableaux illustrate this point. Since both of the DT reduplicated words dealt in the next tableaux have only one syllable in the base, the constraints LEFTMOST (Kager, 1999, p. 167) & ALL-FT-L (McCarthy & Prince, 1993, p. 94) are left out at this point.

(21) Tableau 1: /ˈni ni/ ‘two two’

/ ni-RED/	RH TYPE=T	PARSE-σ	MAX - IO (STRESS)	FT-BIN	MAX-BR (STRESS)
(a) ☞(ˈni.ni)					*
(b) (ˈni) (ˈni)	*!			**	
(c) ni (ˈni)	*!	*	*	*	*

In the tableau in (21), candidate (a) is the optimal candidate as it only violates the lowest ranking constraint MAX-BR (STRESS) as the stress of the base is not repeated in the RED. In case of DT reduplication with a monosyllabic base, the optimal candidate always fulfils other constraints. The stress is placed at the left most syllable of the word. There is no stress clash involved. Candidate (b) gets out of the competition as the stress of the base is repeated in the RED, leading to stress clash. It also does not maintain trochaic foot structure. Candidate (c) commits the fatal violation of RH TYPE=T as there is no stress on the initial syllable. Additionally, it also violates MAX-IO (STRESS) as the base does not carry the stress of the input.

The tableau in (22) shows the constraint ranking of the word stress in another instance of DT reduplication with monosyllabic base. However, the nuclei of the base, and reduplicant are different. Segmental difference does not cause any issue in the stress pattern. The exact constraint ranking of tableau (21) can be applied in this case too. Stress is not reduplicated in this instance as well.

(22) Tableau 2: /ˈkʰarg kʰrug/ ‘really disturbed and so’

/ kʰrag -RED/	RH TYPE=T	PARSE-σ	MAX - IO (STRESS)	FT-BIN	MAX-BR (STRESS)
(a)☞(ˈkʰarg. kʰrug)					*
(b) (ˈkʰarg) (ˈkʰrug)	*!			**	
(c) kʰarg (ˈkʰrug)	*!	*	*	*	*

The next tableau deals with the Tibetan reduplicated expression /ˈʧʰetab ˌʧʰetab/ ‘open open’. As there is no scope for stress clash, the word stress in the base is reduplicated in this context. In this tableau, along with the constraints utilised in the previous tableaux, the constraints LEFTMOST and ALL-FT-L are used.

(23) Tableau 3: /ˈʧʰetab ˈʧʰetab/ ‘open open’

/ˈʧʰetab-RED/	RH TYPE=T	PARSE-σ	LEFTMOST	Max-IO (Stress)	FT-BIN	ALL-FT-L	Max-BR (Stress)
(a)☞(ˈʧʰe.tab)(ˌʧʰe.tab)						**	
(b) (ˈʧʰe.tab) ʧʰe.tab		*!*					*
(c) (ˈʧʰe.tab)(ˈʧʰe.tab)			*!			**	
(d) (ʧeʰ.ˈtab)(ʧʰe.ˈtab)	*!			*		**	*
(e) (ˈʧʰe.tab)(ˌʧʰe).tab	*!	*			*	**	

In the tableau in (23), candidate (a) is the optimal candidate as it has no constraint violation other than two violations of ALL-FT-L which happens to be a lower ranking constraint. Since there is no clash between two stressed syllables present in this case, the whole stress pattern gets copied to the RED, and MAX-BR (STRESS) is fulfilled. Candidate (b) has fatal violations of PARSE-σ. Apart from that, the constraint MAX-BR (STRESS) is violated as the stress of the base is not reduplicated. In case of candidate (c), a high ranking constraint LEFTMOST is fatally violated as the RED should carry the secondary stress. It also violates the constraint ALL-FT-L. Candidate (d) has multiple violations among which the violation of RH TYPE=T is fatal. Apart from that, this candidate has also violations of the constraints Max-IO (Stress), ALL-FT-L and Max-BR (Stress). Finally, candidate (e) has violated the constraints RH TYPE=T, PARSE-σ, FT-BIN & ALL-FT-L.

The base in DT reduplication contains the maximum of the two syllables. As a result, the discussion on stress in the context of DT reduplication has come to an end. The factorial typology for stress in DT reduplication is as follows.

(24) RH TYPE=T, PARSE-σ, LEFTMOST, MAX-IO (STRESS)≫ FT-BIN, ALL-FT-L, MAX-BR (STRESS)

5.6 Optimality theoretic representation of tone in the context of DT reduplication

In case of tonal reduplication of the instances with monosyllabic base, the suffixal reduplicant undergoes a change in tone in DT. For the instances with bisyllabic base, the reduplicant can copy the tone pattern of the base. In certain cases, the H tones in the reduplicant might undergo downstepping (Yip 2002, 9). It is proposed that Obligatory Contour Principle (OCP) (Leben, 1973) is the reason behind the tonal behavioral pattern of DT reduplication. Therefore, OCP is applicable in the tonal context as a constraint (Kager, 1999, p. 56). Copying the tone category of the base in the RED is an option, but not a priority in DT. Maintaining OCP is the main priority in case of DT tonal reduplication. When two identical tones are not side by side, TETU is maintained. Hence, only the RED of a bisyllabic base can copy its tone, monosyllabic RED undergoes a change in tone category.

It is a markedness constraint that prevents the occurrence of two high tones side by side. In the context of tone, OCP traditionally prevents occurrence of H tone in two adjacent syllables.

(25) OCP (Kager, 1999, p. 56)
Two identical elements are prohibited in the adjacent positions.

However, in the recent times, OCP has been used as a constraint that prevents other tones too in the adjacent positions (Utulu et al., 2023). A reduplicated word involves both base and the RED, and the tone pattern of the base is derived from the underlined representation. The constraint MAX-IO (TONE) is derived from the constraint MAX-IO (Kager, 1999, p. 67). This constraint demands the number of tones associated with the underlined representation is the same in the base.

(26) MAX-IO (TONE)

Every tone in the input will have a corresponding tone in the output.

Similarly, MAX-BR (TONE) constraint is derived from the MAX-BR constraint (Kager, 1999, p. 205). It needs the number of tones in the base is same in the RED.

(27) MAX-BR (TONE)

Every tonal element in B has a correspondent in R.

Similarly, IDENT-BR (TONE) is derived from the constraint IDENT-BR (Kager, 1999, p. 208).This constraint requires the quality of the tone in the input is maintained in the output.

(28) IDENT-BR (TONE)

Let α be a tone in B, and β be a correspondent of α in R.

The last three constraints are instances of faithfulness constraints. In DT, the tone in the base can be only copied to the RED when the overall tonal pattern does not violate OCP. The number of tone in the base and the RED is the same in DT. Change of tonal category in one of the syllables is the way DT tones do not clash in the reduplicative words in case of the words with monosyllabic base. Therefore, IDENT-BR (TONE) is dominated by OCP.

(29) OCP≫ IDENT-BR (TONE)

The optimal candidate also needs to have the same number of tone between the underlined representation and the base. Hence, Max-IO (Tone) and Max-BR (Tone) share the same ranking. Additionally, any domination relationship is not found among OCP, Max-IO (Tone) and Max-BR (Tone). Hence, they share the same ranking.

(30) OCP, Max-IO (Tone), Max-BR (Tone)

In this context, if OCP dominates IDENT-BR (TONE), the other two faithfulness constraints also dominate IDENT-BR (TONE).

(31) OCP, MAX-IO (TONE), MAX-BR (TONE)≫ IDENT-BR (TONE)

(32) Tableau 4: /ʧó. ʧò/'brother'

/ʧó .RED/	OCP	MAX-IO (TONE)	MAX-BR (TONE)	IDENT-BR (TONE)
(a)☞ʧó. ʧò				*
(b) ʧó. ʧó	*!			
(c) ʧó. ʧo			*!	
(d) ʧo. ʧó		*!	*	*

In the tableau in (32), the optimal candidate (a) violates one constraint, IDENT-BR (TONE) as the high tone of the base has changed into a low tone in RED in order to not violate OCP, a higher ranking constraint. The number of tone in the UR is the same as in the base. Hence, MAX-IO (TONE) is not violated. Additionally, there is no tonal deletion in the RED. As a result, MAX-BR (TONE) is not violated. Candidate (b) has an H tone in the adjacent base and reduplicant, thus, it fatally violates OCP. Candidate (c) fatally violates the high ranking MAX-BR (TONE) as the reduplicant is toneless. Candidate (d) fatally violates MAX-IO (TONE) as the tone in the base is absent.

A similar picture can be seen in case of /nám nùŋ/ 'very experienced or so', an instance of DT eco formation as the base is monosyllabic. Tonal configuration of the base can only be repeated in the reduplicant if there is no OCP violation. In case of /nám nùŋ/, change in tone value take place to satisfy OCP.

(33) Tableau 5: /nām nùŋ/ 'very experienced or so'

/nām-RED/	OCP	MAX-IO (TONE)	MAX-BR (TONE)	IDENT-BR (TONE)
(a)☞nām. nùŋ				*
(b) nām. nuŋ			*!	
(c) nām. nūŋ	*!*			
(d) nam. nùŋ		*!		

In the tableau in (33), candidate (a) is the optimal candidate as it violates only one constraint IDENT-BR (TONE), which is a low ranking constraint. Candidate (b) fatally violates the high ranking constraint MAX-BR (TONE) as the reduplicant does not have any tone. Candidate (c) fatally violates OCP as both base and reduplicant have the same mid tone. In candidate (d), tone is missing in the base, thus, violating MAX-IO (TONE).

The same constraint ranking is applicable in the case of bisyllabic bases. In case of the DT reduplications with bisyllabic bases, the same tone pattern can be copied to the reduplicant as OCP is not getting violated in this case. The following tableau depicts this point.

(34) Tableau 6: /mī ʈèn gū ʈèn/ ‘disorganized and so’

/ mī ʈèn-RED/	OCP	MAX-IO (TONE)	MAX-BR (TONE)	IDENT-BR (TONE)
(a)☞mī.ʈèn gū.ʈèn				
(b) mī.ʈèn gù.ʈèn	*!			*
(c) mī.ʈèn gū.ʈen			*!	
(d) mī.ʈen gū.ʈèn		*!		

In the tableau in (34), candidate (a) is the optimal candidate as it has no constraint violation. The candidate (b) has one fatal violations of OCP. It also violates IDENT-BR (TONE). Candidate (c) has a violation of MAX-BR (TONE) as the second syllable of the reduplicant has a tonal deletion. Candidate (d) fatally violates MAX-IO (TONE) as a tone is missing in the base. If the base contains a High and a Low tone in any order, the High tone of the reduplicant is downstepped in the RED in DT. The following constraint is proposed to address this issue.

(35) DOWNSTEP

If there are two high tones in the adjacent syllables, the second H is downstepped.

In the tableau in (36), Candidate (a) is the optimal candidate as it does not have any constraint violations. Candidate (b) has a fatal violation of IDENT-BR (TONE) as the value of a H in base have changed into M in RED. The first syllable of the reduplicant of Candidate C is missing a tone in RED, hence, fatally violating IDENT-BR (TONE). In case of candidate (d) two low tones are adjacent. It fatally violates OCP. Plus it also violates MAX-IO (TONE) as a tone is missing from the second syllable of the base. Candidate (e) has a violation of the constraint DOWNSTEP as the high tone of the RED has not undergone downstepping.

(36) Tableau 7: /kʰá. lè kʰá↓.lè/ ‘slowly slowly’

/ kʰá.lè-RED/	OCP	MAX-IO (T)	MAX-BR (T)	DOWNSTEP	IDENT-BR (T)
(a)☞kʰá.lè kʰá↓.lè					
(b) kʰá.lè kʰā. lé					*!
(c) kʰá.lè kʰa.lè			*!		
(d) kʰá.le kʰá.lé	*!	*			
(e) kʰá.lè kʰá.lè				*!	

As the constraint hierarchy of the tonal behaviour in DT reduplication is decided, the factorial typology can finally be offered. The constraint ranking of the last tableau offers the factorial typology of DT tonal reduplication in its final form.

(37) OCP, MAX-IO (TONE) MAX-BR (TONE), DOWNSTEP≫ IDENT-BR (TONE)

5.7 Conclusion

The current study has attempted to provide a brief description of how stress and tone operates in the context of DT reduplication, and provided a theoretical justification for it. As *CLASH is a strong deciding factor in the case of stress placement in DT reduplication, phonological identity regarding the stress pattern of the base is only maintained in the RED when there was no stress clash involved. It is only in case of the reduplication with monosyllabic base in which the stress of the base is not accepted in the RED to avoid stress clash. As there is no such possibility in case of a bisyllabic base, the stress pattern of base is repeated in the RED. A reduplicative word in DT starts with a stressed syllable, and it always maintains the identity between the underlined representation and the base.

DT data ensures that OCP is a deciding factor in case of the tone assignment in the RED. Based on that, the tones of the reduplicative expressions with monosyllabic bases change their value in the RED to escape two identical tones in the adjacent position. However, this change of value does not take place in case of the reduplicative words with bisyllabic bases as there is no scope of occurring of the two identical tones adjacently. Downstepping might take place if the required tonal prerequisites are present in the context of reduplication of tone in DT.

Bibliography

Alderete, J. D. (1999). *Morphologically Governed Accent in Optimality Theory.* [Doctoral Dissertation], University of Massachusetts.

Altshuler, D. (2009). Quantity-insensitive iambs in Osage. *International Journal of American Linguistics*, *75*(3), 365–398. https://doi.org/10.1086/605417

Austin, P. (1981). *A Grammar of Diyari, South Australia*. Cambridge University Press.

Benedict, P. K. (1972). *Sino-Tibetan: A conspectus*. University Press.

Bird, S., & Hyman, L. (Eds.). (1994). How to Study a Tone Language, with exemplification from Oku (Grassfields Bantu, Cameroon). *Language Documentation and Conservation*, *20*(3), 525–562.

Boersma, P., & Weenink, D. (2010). *Praat: Doing Phonetics by computer* [Computer software]. https://www.fon.hum.uva.nl/praat/

Bolton, T. L. (1894). Rhythm. *The American Journal of Psychology*, *6*(2), 145–238. https://doi.org/10.2307/1410948

Bradley, D. (1997). Tibeto-Burman languages and classification. In *Papers in Southeast Asian Linguistics 14: Tibeto-Burman Languages of the Himalayas* (Vol. 86, pp. 1–72). Australian National University.

Brassil, D. (2003). Patterns in Kirundi reduplication. *San Diego Linguistic Papers*, *1*, 43–82.

Broselow, E. (1992). Parametric variation in Arabic dialect phonology. *Perspectives on Arabic Linguistics IV. Amsterdam & Philadelphia: Benjamins*, 7–45.

Broselow, E., & McCarthy, J. J. (1983). A theory of internal reduplication. *The Linguistic Review*, *3*(1). https://doi.org/10.1515/tlir.1983.3.1.25

Caplow, N. J. (2009). *The role of stress in Tibetan tonogenesis: A study in historical comparative acoustics.* [Doctoral Dissertation]. Oklahoma State University.

Caplow, N. J. (2017). Reconstructing stress in Proto-Tibetan: Evidence from Balti and Rebkong Amdo. *Linguistics of the Tibeto-Burman Area.*, *39*(2), 180–221. https://doi.org/10.1075/ltba.39.2.01cap

Central Tibetan Relief Committee. (2002). *Tibetan settlements in India* [Map].

Chao, Y. R. (1930). A system of 'tone-letters'. *Le Maître Phonétique*, *8 (45)*(30), 24–27.

Chen, M. Y. (2000). *Tone Sandhi: Patterns across Chinese Dialects*. Cambridge University Press. https://doi.org/10.1017/CBO9780511486364

Chen, M. Y., Wee, L. H., & Yan, X. (2008). The Paradox of Hakka Tone Sandhi. In Y. E. Hsiao, H. C. Hsu, L. H. Wee, & D. A. Ho (Eds.), *Interfaces in Chinese phonology: Festschrift in honor of Matthew Y. Chen on his 70th birthday = 漢語音韻介面: 陳淵泉先生七秩壽慶論文集* (pp. 1–45). 中央研究院語言學研究所. https://www.ling.sinica.edu.tw/item/zh-tw?act=publish_book&code=view&bookID=117

Chen, Y. (2008). *Revisiting the phonetics and phonology of Shanghai tone sandhi*. 253–256. https://doi.org/10.21437/SpeechProsody.2008-55

Chomsky, N., & Halle, M. (1968). *The Sound Pattern of English*. Harper & Row.

Civera, M. B. (1970). *The distinctive phonology of Lhasa Central Tibetan: Results of a Field Trip to study the Himalayas as an Ethno-linguistics Area.* [Dissertation].

Clements, G. N. (1985). The Problem of Transfer in Nonlinear Phonology. *Cornell Working Papers in Linguistics*, *5*, 38–73.

Cohn, A. C. (1989). Stress in Indonesian and Bracketing Paradoxes. *Natural Language & Linguistic Theory*, *7*(2), 167–216.

Dawson, W. (1980). *Tibetan Phonology* [Doctoral Dissertation]. University of Washington.

de Lacy, P. (2002). The Interaction of tone and stress in Optimality Theory. *Phonology*, *19*(1), 1–32.

DeLancey, S. (2006a). Classical Tibetan. In G. Thurgood & R. J. LaPolla (Eds.), *The Sino-Tibetan Languages* (Vol. 3, pp. 255–269). Routledge.

DeLancey, S. (2006b). Lhasa Tibetan. In G. Thurgood & R. J. LaPolla (Eds.), *The Sino-Tibetan Languages* (Vol. 3, pp. 270–288). Routledge.

Denwood, P. (1999). Tibetan. In *Loall.3* (Vol. 3). John Benjamins Publishing Company. https://benjamins.com/catalog/loall.3

Derbyshire, D. C. (with Internet Archive). (1985). *Hixkaryana and linguistic typology*. Dallas, TX : Summer Institute of Linguistics ; [Arlington] : University of Texas at Arlington. http://archive.org/details/hixkaryanalingui0000derb

Dodsworth, R. (2017). Migration and dialect contact. *Annual Review of Linguistics*, *3*(1), 331–346. https://doi.org/10.1146/annurev-linguistics-011516-034108

Duanmu, S. (1992). An autosegmental analysis of tone in four Tibetan languages. *Linguistics of the Tibeto-Burman Area*, *15*(1), 65–91.

Duanmu, S. (2001). Stress in Chinese. In *Chinese Phonology in Generative Grammar* (pp. 117–138). https://doi.org/10.1016/B978-012767670-8/50006-5

Echeverrí-a, M. S., & Contreras, H. (1965). Araucanian phonemics. *International Journal of American Linguistics.*, *31*(2), 132–135.

Féry, C. (1998). German word stress in Optimality Theory. *Journal of Comparative Germanic Linguistics*, *2*(2), 101–142.

Fromkin, V. A. (2014). *Tone: A Linguistic Survey*. Academic Press.

Goedemans, R. (2011). A typology of stress patterns. In H. V. D. Hulst, R. Goedemans, & E. V. Zanten (Eds.), *A Survey of Word Accentual Patterns in the Languages of the World* (pp. 647–668). DE GRUYTER MOUTON.

https://doi.org/10.1515/9783110198966.1.647

Goedemans, R. W. N., & van der Hulst, H. (2011). The separation of accent and rhythm: Evidence from StressTyp. *Word Stress: Theoretical and Typological Issues.*, 119–146. https://doi.org/10.1017/CBO9781139600408.006

Goldsmith, J. A. (1976). *Autosegmental phonology* [Doctoral Dissertation]. Massachusetts Institute of Technology.

https://dspace.mit.edu/handle/1721.1/16388

Gomez-Imbert, E., & Kenstowicz, M. (2000). Barasana Tone and Accent. *International Journal of American Linguistics*, *66*(4), 419–463. https://doi.org/10.1086/466437

Gong, X. (2021). How many vowels are there in Lhasa Tibetan? *Linguistics of the Tibeto-Burman Area*, *43*(2), 225–254. https://doi.org/10.1075/ltba.19004.gon

Good, J. (2004). Tone and accent in Saramaccan: Charting a deep split in the phonology of a language. *Lingua*, *114*(5), 575–619.

https://doi.org/10.1016/S0024-3841(03)00062-7

Gope, A. (2016). *Phonetics and phonology of Sylheti tonogenesis.* [Indian Institute of Technology Guwahati]. http://gyan.iitg.ernet.in/handle/123456789/741

Gope, A. (2021). The phonetics of tone and voice quality interactions in Sylheti. *Languages*, *6*(4), 154.

Gordon, M. (2006). *Syllable weight: Phonetics, phonology, typology*. Routledge. https://doi.org/10.4324/9780203944028

Gordon, M. (2011). Stress systems. In *The handbook of phonological theory* (pp. 141–163). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781444343069.ch5

Green, R. J. (2012). The phonology of voicing and aspiration in Amdo Tibetan. *Linguistics of the Tibeto-Burman Area.*, *35*(2), 1–31.

Gruber, J. (2009). The Composition of Phonological Tone in Burmese. *Proceedings from the Annual Meeting of the Chicago Linguistic Society*, *45*(1), 161–175.

Gussenhoven, C. (2004). *The Phonology of Tone and Intonation*. Cambridge University Press.

Hagberg, L. R. (1993). *An autosegmental theory of stress* [PhD Dissertation]. University of Arizona.

Hammond, M. (2000). There is no lexicon! *Coyote Papers*. https://repository.arizona.edu/handle/10150/311816

Hartley, L. R. (1996). The role of regional factors in the standardization of spoken Tibetan. *The Tibet Journal*, *21*(4), 30–57.

Hayes, B. (1985). Iambic and Trochaic Rhythm in Stress Rules. *Annual Meeting of the Berkeley Linguistics Society*, 429–446. https://doi.org/10.3765/bls.v11i0.1898

Hayes, B. (1995). *Metrical stress theory: Principles and case studies*. University of Chicago Press.

Hu, F. (2012). Tonogenesis in Lhasa Tibetan – Towards a gestural account. In *Tonogenesis in Lhasa Tibetan – Towards a gestural account* (pp. 231–254). De Gruyter Mouton. https://doi.org/10.1515/9781614510772.231

Hu, F., & Xiong, Z. (2010). Lhasa tones. *Proc. SpeechProsody*, paper 163. https://doi.org/10.21437/SpeechProsody.2010-29

Huang, Y. (2019). Revisiting non-idempotency in Tibetan vowel harmony. *UC San Diego: San Diego Linguistic Papers*, *7*, 2–16.

Hyman, L. (1985). *A theory of phonological weight*. De Gruyter.

Hyman, L. (2006). Word-prosodic typology. *Phonology*, *23*(02), 225–257. https://doi.org/10.1017/S0952675706000893

Hyman, L., & Mtenje, A. (1999). Prosodic Morphology and tone: The case of Chichewa. In H. van der Hulst, R. Kager, & W. Zonneveld (Eds.), *The Prosody-Morphology Interface* (pp. 90–133). Cambridge University Press.

Hyslop, G. (2021). Between Stress and Tone: Acoustic Evidence of Word Prominence in Kurtöp. *Language Documentation & Conservation*, *15*, 551–575.

Indrawati, N. L. K. M. (2008). The Application of the Autosegmental Phonological Theory to the Indonesian Reduplication. *Linguistika*, *15*.

Inkelas, S. (1999). Exceptional stress-attracting suffixes in Turkish: Representations versus the grammar. In H. van der Hulst, R. Kager, & W. Zonneveld (Eds.), *The Prosody-Morphology Interface* (pp. 134–187). Cambridge University Press. https://doi.org/10.1017/CBO9780511627729.006

Inkelas, S., & Zoll, C. (2005). *Reduplication: Doubling in Morphology*. Cambridge University Press.

Itô, J., & Mester, A. (1995). The core-periphery structure in the lexicon and constraints on re-ranking. In J. Beckman, L. W. Dickey, & S. Urbanczyk (Eds.), *Papers in Optimality Theory* (pp. 181-210.). University of Massachusetts.

Jang, T. (2024). *World Cultures: Dharamshala's Tibetan Community*. UBIQUE. American Geographical Society. https://ubique.americangeo.org/world-cultures/dharamshalas-tibetan-community/

Janhunen, J., & Norbu, K. (1999). Aspects of Amdo Tibetan Segmental Phonology. *Studia Orientalia Electronica*, *85*, 249–276.

Jäschke, H. A. (1881). *A Tibetan-English dictionary: With special reference to the prevailing dialects; to which is added an English-Tibetan vocabulary*. London : Secretary of State for India in Council.

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

https://doi.org/10.1017/CBO9780511812408

Keffala, B. J. (2007). *Tone in Mende: A Comparative Analysis of Theoretical Approaches* [Masters Dissertation]. Swarthmore College.

Kingston, J. (2011). Tonogenesis. In *The Blackwell Companion to Phonology* (pp. 1–30). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781444335262.wbctp0097

Kisseberth, C. W. (1970). On the Functional Unity of Phonological Rules. *Linguistic Inquiry*, *1*(3), 291–306.

Kjellin, O. (1977). Observations on consonant types and "tone" in Tibetan. *Journal of Phonetics*, *5*(4), 317–338. https://doi.org/10.1016/S0095-4470(19)31203-3

Lauer, T. (2015). Between desire and duty: On Tibetan identity and its effects on second-generation Tibetans. *Asian Ethnology*, *74*, 167–192.

https://doi.org/10.18874/ae.74.1.08

Leben, W. R. (1973). *Suprasegmental phonology.* [Doctoral Dissertation] Massachusetts Institute of Technology.

https://dspace.mit.edu/handle/1721.1/16364

Li, Q., & Chen, Y. (2016). An acoustic study of contextual tonal variation in Tianjin Mandarin. *Journal of Phonetics*, *54*, 123–150.

https://doi.org/10.1016/j.wocn.2015.10.002

Li, X., & Kager, R. (2018). An Acoustic Comparison between Two Pairs of Assimilatory and Dissimilatory Tone Sandhi Processes in Nanjing Mandarin in Categoricalness/Gradience. *2018 11th International Symposium on Chinese Spoken Language Processing (ISCSLP)*, 473–477.

https://doi.org/10.1109/ISCSLP.2018.8706572

Liberman, M., & Prince, A. (1977). On stress and linguistic rhythm. *Linguistic Inquiry*, *8*, 249–336.

Liberman, M. Y. (1975). *The intonational system of English.* [PhD Dissertation] Massachusetts Institute of Technology. https://dspace.mit.edu/bitstream/handle/

1721.1/27376/02025469-MIT.pdf?sequence=2

Lim, J. (2018). *Tonal and intonational phonology of Lhasa Tibetan* [PhD Dissertation]. University of Ottawa.

Lin, H. S. (2006). Directionality in Chengdu Tone Sandhi. *Concentric: Studies in Linguistics*, *32*(1), 31–67.

Malambe, G. B. (2017). Tone Shift and Tone Spread in siSwati: An Alignment Approach. *Nordic Journal of African Studies*, *26*(4), Article 4. https://doi.org/10.53228/njas.v26i4.83

Marantz, A. (1982). Re reduplication. *Linguistic Inquiry*, *13*(3), 435–482.

Matisoff, J. A. (2000). Tibeto-Burman tonology in an areal context. *The Fifth International Symposium on Languages and Linguistics*, 85–151.

Mattiola, S., & Masini, F. (2022). Discontinuous reduplication: A typological sketch. *STUF - Language Typology and Universals*, *75*(2), 271–316. https://doi.org/10.1515/stuf-2022-1055

McCarthy, J. J. (1995). Faithfulness in prosodic morphology and phonology: Rotuman revisited. *Ms. University of Massachusetts, Amherst*. https://www.academia.edu/download/5475732/10.1.1.172.408.pdf

McCarthy, J. J., & Prince, A. (1986). Prosodic Morphology. *Linguistics Department Faculty Publication Series. University of Massachusetts.*, *13*. https://scholarworks.umass.edu/linguist_faculty_pubs/13

McCarthy, J. J., & Prince, A. (1993). Generalized alignment. In G. Booij & J. Van Marle (Eds.), *Yearbook of Morphology 1993* (pp. 79–153). Springer Netherlands. https://doi.org/10.1007/978-94-017-3712-8_4

McCarthy, J. J., & Prince, A. (1995). Faithfulness and reduplicative identity. *Papers in Optimality Theory*, 249–384.

McCarthy, J. J., & Prince, A. (1996). Prosodic Morphology 1986. *Linguistics Department Faculty Publication Series. University of Massachusetts.*, *13*. https://scholarworks.umass.edu/linguist_faculty_pubs/13

McCarthy, J., & Prince, A. (1999). Faithfulness and identity in prosodic morphology. *The Prosody-Morphology Interface*, 218–309.

McConnell, F. (2016). *Rehearsing the State: The Political Practices of the Tibetan Government-in-Exile*. John Wiley & Sons.

Meredith, S. (1990). *Issues in the phonology of prominence* [Doctoral Dissertation]. Massachusetts Institute of Technology. https://dspace.mit.edu/handle/1721.1/14158

Miller, C. (2003). Reduplication in Arabic-based language contact. In *Twice as meaningful. Reduplication in Pidgins, Reduplication in Pidgins, Creoles and other contact languages.* (289th–299th ed.). Battlebridge Publications.

Milroy, L. (2002). Introduction: Mobility, contact and language change - Working with contemporary speech communities. *Journal of Sociolinguistics*, *6*(1), 3–15. https://doi.org/10.1111/1467-9481.00174

Monich, I. (2011). *Interaction of tone and intonation in Lhasa Tibetan: A working hypothesis*. Generative Linguistics in the Old World (GLOW34), Vienna, Austria. https://glowlinguistics.org/34/pdf/monich.pdf

Monich, Irina. (2011). *Interaction of tone and intonation in Lhasa Tibetan: A working hypothesis*. Generative Linguists of the Old World (GLOW 34), Phonology Workshop, Vienna, Austria.

Moravcsik, E. A. (1978). Reduplicative Constructions. In *Universals of Human Language. Volume 3: Word Structure* (pp. 297–334). Stanford University Press.

Morén, B., & Zsiga, E. (2001). Lexical tone and markedness in standard Thai. *Annual Meeting of the Berkeley Linguistics Society*, *27*(1), 181. https://doi.org/10.3765/bls.v27i1.3415

Morén, B., & Zsiga, E. (2006). The Lexical and Post-Lexical Phonology of Thai Tones*. *Natural Language & Linguistic Theory*, *24*(1), 113–178. https://doi.org/10.1007/s11049-004-5454-y

Mtenje, A. (2006). Tone in Cindali. *Lingua*, *116*(10), 1495–1506. https://doi.org/10.1016/j.lingua.2005.06.015

Nguyen, T., & Ingram, J. (2006). Reduplication and word stress in Vietnamese. *Proceedings of The11th Australian International Conference on Speech Science & Technology*. 11th Australian International Conference on Speech Science & Technology, University of Auckland, New Zealand.

Nishida, T. (1975). On the development of tones in Tibetan. *Acta Asiatica*, *29*, 43–55.

Nishida, T. (1979). The genesis of tones and evolution of languages. *Language*, *8*, 183–191.

Norbu, D. (2001). Refugees from Tibet: Structural causes of successful settlements. *The Tibet Journal*, *26*(2), 3–25.

Pater, J. (1994). Against the underlying specification of an 'exceptional' English stress pattern. *Toronto Working Papers in Linguistics*, *13*. https://twpl.library.utoronto.ca/index.php/twpl/article/view/6336

Phuong, L.-H., Nguyen, H., & Roussanaly, A. (2009). Finite-State Description of Vietnamese Reduplication. *7th Workshop on Asian Language Resources*, 63–69. https://doi.org/10.3115/1690299.1690308

Poser, W. J. (1989). The Metrical Foot in Diyari. *Phonology*, *6*(1), 117–148.

Prince, A., & Smolensky, P. (1993). *Optimality theory: Constraint interaction in generative grammar* (Technical Report no. RuCCS-TR-2). Rutgers University Center for Cognitive Science.

Qu, A. & Tan, K. (1983). *Ali Zangyu [Ali Tibetan]*. Zhongguo Shehui Kexue Yan Chubanshe (Chinese Academy of Social Sciences Press).

Qu, C., & Goad, H. (2012). The interaction of stress and tone in standard Chinese: Experimental findings and theoretical consequences. *Tone: Theory and Practice, Max Planck Institute for Evolutionary Anthropology*.

Rubino, C. (2011). Reduplication: Form, function and distribution. In *Studies on Reduplication* (pp. 11–30). De Gruyter Mouton.

https://doi.org/10.1515/9783110911466.11

Samuels, B. (2010). *The topology of infixation and reduplication*. *27*(2), 131–176. https://doi.org/10.1515/tlir.2010.006

Samuels, J. (2014). *Colloquial Tibetan* (1st ed.). Routledge.

https://doi.org/10.4324/9781315650036

Schütz, A. J. (1985). *The Fijian language*. Honolulu : University of Hawaii Press. http://archive.org/details/fijianlanguage0000schu

Seiler, H. (1967). Structure and Reconstruction in some Uto-Aztecan Languages. *International Journal of American Linguistics*, *33*(2), 135–147.

Selkirk, E. O. (1980). The role of prosodic categories in English word stress. *Linguistic Inquiry*, *11*(3), 563–605.

Selkirk, E. O. (1984). *Phonology and syntax: The relation between sound and structure*. MIT Press.

Shafer, R. (1955). Classification of the Sino-Tibetan Languages. *WORD*, *11*(1), 94–111. https://doi.org/10.1080/00437956.1955.11659552

Simon, C., & Hill, N. W. (2015). Tibetan. In *Edinburgh Handbook of Evaluative Morphology* (pp. 381–388). Edinburgh University Press.

Sprigg, R. K. (1955). The tonal system of Tibetan (Lhasa dialect) and the nominal phrase. *Bulletin of the School of Oriental and African Studies*, *17*(1), Article 1.

Staubs, R. (2014). Learning and the position of primary stress. *WCCFL*, *31*, 428–437.

Sun, J. T. (2006). Special linguistic features of gSerpa Tibetan. *Linguistics of the Tibeto-Burman Area*, *29*(1), 107–126.

Sun, J. T.-S. (1986). *Aspects of the phonology of Amdo Tibetan: Ndzorge Śæme Xg̳ra dialect*. Institute for the Study of Languages and Cultures of Asia and Africa.

Sun, J. T.-S. (2003). Phonological profile of Zhongu: A new Tibetan dialect of Northern Sichuan. *Language and Linguistics*, *4*(4), 769–836.

Suzuki, H. (2011). Phonetic Analysis of dGudzong Tibetan: The vernacular of Khams Tibetan spoken in the rGyalrong area. *Bulletin of the National Museum of Ethnology*, *35*(4), 617–653.

Suzuki, H. (2017). *Suprasegmentals in Tibetic languages of the eastern Tibetosphere: From a geolinguistic perspective.* (Studies in Asian Geolinguistics VII. “Tone and Accent”.). Geolinguistic Society of Japan.

Suzuki, H., & Wangmo, S. (2017). Vocabulary of Shingnyag Tibetan: A Dialect of Amdo Tibetan Spoken in Lhagang, Khams Minyag. *Asian and African Languages and Linguistics*, *11*, 101–127.

Tournadre, N., & Dorje, S. (2003). *Manual of standard Tibetan: Language and civilization: introduction to Standard Tibetan (spoken and written) followed by an appendix on Classical Literary Tibetan*. Snow Lion Publications.

Urbanczyk, S. (2017). Phonological and Morphological Aspects of Reduplication. In *Oxford Research Encyclopedia of Linguistics*. Oxford University Press.

https://doi.org/10.1093/acrefore/9780199384655.013.80

Utulu, D. C., Ajiboye, E. M., & Edojaimoni, I. E. (2023). Understanding the Urhobo Tonal Structure through Constraint-Based Framework. *Rupkatha Journal on Interdisciplinary Studies in Humanities*, *15*(2).

https://doi.org/10.21659/rupkatha.v15n2.02

Vollmann, R. (2010). Reduplication in Tibetan. *Grazer Linguistische Studien*, *71*, 115–134.

Watters, D. E. (2002). *A Grammar of Kham* (1st ed.). Cambridge University Press.

https://doi.org/10.1017/CBO9780511486883

Williams, E. S. (1976). Underlying Tone in Margi and Igbo. *Linguistic Inquiry*, *7*(3), 463–484.

Woodrow, H. (1911). The role of pitch in rhythm. *Psychological Review*, *18*(1), 54.

Woodrow, H. (1951). Time perception. In *Handbook of experimental psychology* (pp. 1224–1236). Wiley.

Xu, Y. (1993). *Contextual tonal variation in Mandarin Chinese* [Doctoral Dissertation]. University of Connecticut.

Yin, H. (2017). An Optimality Theory Perspective on Mandarin Tone 3 Sandhi. *Annals of Language and Literature*, *1*(2), 28–34.

https://doi.org/10.22259/2637-5869.0102004

Yip, M. (2002). *Tone*. Cambridge University Press.
https://doi.org/10.1017/CBO9781139164559

Zhang, H., Ji, T., Pagel, M., & Mace, R. (2020). Dated phylogeny suggests early Neolithic origin of Sino-Tibetan languages. *Scientific Reports*, *10*(1), Article 1.

https://doi.org/10.1038/s41598-020-77404-4

Zhang, L. S. (1987). *The Consonant System of Middle-Old Tibetan and the Tonogenesis of Tibetan* [Doctoral Dissertation]. University of California, Berkeley.

List of Maps

List of Publications from the Thesis

Published paper

Sarkar, S., & Kar, S. (2024). Word stress patterns in Dharamshala Tibetan: An Optimality Theoretic formalisation. *Concentric: Studies in Linguistics*.

Under review

Sarkar, S., Kar, S., & Gope, A. (Under review). Exploring the Multidimensional aspects of tone in (Dharamshala) Tibetan using Generalized Linear Regression Modeling and Machine Learning Algorithms. Under Review.