The Phonology of Stress in Moroccan Arabic Clitics: Constraint Indexation and Inconsistency Resolution*

Mohamed Smirkou
Ibn Tofail University, Kenitra
Morocco
mohamed.smirkou@uit.ac.ma

Abstract

The present study attempts to formally account for stress non-uniformity attested in clitics in Moroccan Arabic (MA). Similar to Semitic languages, stress assignment in MA observes certain phonological inconsistencies. Stress in MA falls on the final syllable if it is heavy; otherwise, on the penultimate (Boudlal, 2001). Nevertheless, the cliticised items limit the scope

*I would like to thank the participants and the audience at the International Conference on “Phonology and Morphology (ICPM8)” held at the College of Humanities, Hankyong National University, Korea (online edition), on June 11, 2022, where this paper was given as a talk, whose comments have contributed to the content of this paper. I would like to particularly acknowledge Jason Shaw for his helpful suggestions on my work. He deserves credit for his suggestion of applying Lexically-indexed constraints to account for stress non-uniformity in MA. Many thanks are extended to the anonymous peer reviewers for their valuable comments and suggestions which have greatly contributed to the overall quality of this work. Any remaining errors are my entire responsibility.
of this generalization in spite of ending up in heavy syllables. To handle this lexical idiosyncrasy, the analysis proposed in this study is distinguished from previous analyses in applying a relatively new Optimality Theory (OT) analysis in terms of lexically-indexed constraints (Pater, 2000) in which both faithfulness and markedness constraints must be appropriately indexed. We first show how a standard OT analysis cannot provide a unified analysis of stress in MA. Second, we posit lexically-conditioned versions of NONFIN (NONFIN-_{L}) and IAMB (IAMB-_{L}) and apply them only to the lexical items indexed for their application. This allowed a unified account for the optimality of both regular patterns and exceptional patterns.

**Keywords**: Lexically-indexed constraints, Moroccan Arabic, Optimality Theory, stress non-uniformity, stress on Clitics

## 1 Introduction

Over the last few decades, there has been a growing interest in studying stress in Moroccan Arabic. The present study offers a relatively new Optimality Theory-based analysis, which applies constraint indexation, of stress in MA. This study argues that irregularities and exceptions are better handled within Optimality Theory (OT) in terms of lexically indexed markedness and faithfulness constraints (Pater, 2000). The standard OT

1 In this paper, the term standard OT is used to simply refer to all OT developments and extensions that use general constraints other than the lexically-specific constraints. Lexically-specific constraints, also known as lexical markedness constraints or lexical markedness hierarchies, are constraints in OT that are specific to individual lexical items or word forms. Unlike general constraints that apply universally across languages, lexically-specific constraints target particular lexical items or classes of words.

and have been also employed to the lexical strata (Fukuzawa, 1999; Gelbart, 2005; Itô and Mester, 1999, 2001). Under lexically conditioned constraint approach, a constraint is used in a general version and in a lexically indexed version that applies to exceptions (Pater, 2000). Lexically-specific constraints are indexed versions of constraints that evaluate only the lexical item that bears that index. In this paper, we provide a further application of lexically specific constraints to the analysis of stress nonuniformity.

One of the least studied linguistic phenomena in MA phonology is stress. Following Benhallam’s (1990) classification, studies on MA stress are either impressionistic (Abdelmassih, 1973; Benhallam, 1990; Benkaddour, 1982; El Hadri, 1993; Fares, 1993) or instrumental (Benkirane, 1982; Boudlal, 2001; Bruggeman et al., 2021; El-Yamani, 2012; Hammourni, 1988; Kably, 2001; Nejmi, 1993, 1995). A common consensus among works on MA is that stress is phonetic and thus neither interacts with word-formation rules nor changes meaning. The main aim of this paper is to enrich the research on MA stress both from an empirical perspective by doing instrumental work and also from a theoretical perspective by applying lexically-specific constraints to account for stress residual issues in MA (stress inconsistency on MA clitics).
The structure of this paper can be seen along the following lines. Section two, literature review, defines lexically-specific constraints and shows how they differ from other models on inconsistency. It also defines the conceptualization of clitics and their types. Besides, this section provides a summary of the overall generalizations governing stress in MA along with introducing the issue under investigation in this paper. Section three describes the corpus selected for the analysis. In section four, we provide a succinct acoustic measurement of stress using the Praat software programme. Besides, we show how a standard optimality-theoretic analysis fails to provide a unified analysis of stress in MA. Then, most importantly, we propose a lexically-indexed constraint model (Pater, 2000) to better handle stress exceptionality in MA. This section also provides a succinct acoustic measurement of stress using the Praat software programme.

2 Literature review

2.1 Exceptions and lexically-specific constraints model

Lexically-specific constraints approach differs from any OT analyses that do not allow lexical indexation and those that allow lexically specified rankings. Items that undergo a process apply an indexation of markedness constraints, and those that block a process apply an indexation of faithfulness constraints. This contrast, however, is not captured in either of two alternative models of inconsistency in OT: the cophonology model wherein an item selects constraint rankings (Anttila, 2004; Inkelas and Zoll, 2007), or a model wherein only faithfulness constraints can be lexically indexed (Fukuzawa, 1999; Itô and Mester, 1999, 2001).

The application of the notion of indexed constraints was proposed in the foundational work on OT in terms of Edgemost constraints (Prince and Smolensky., 1993) that apply to specific morphemes to distinguish among prefixes, suffixes, and edge-oriented infixes. This conception of constraints is redefined in McCarthy and Prince’s (1993) Generalized Alignment. Constraint indexation was further extended from Alignment to other constraints by Fukuzawa (1999), Itô and Mester (1999, 2001), Kraska-Szlenk (1997), and Pater (2000). In this regard, a constraint can be multiply used in a hierarchy, and each use is indexed to apply to a specified set of lexical items. These indexed constraints are universal markedness and faithfulness constraints which apply to a specific set of lexical items. In a lexically specific constraint analysis, the exceptional or irregular items are accounted for by a ‘cloned’ constraint Con, i.e., an indexed version of that constraint ConL with a lexical diacritic, so that it applies only to those items.

By way of illustration, in English, nouns like cinema (e.g., Canada, memory, bakery, Africa) with light penultimate syllables generally receive antepenult stress (cinema, Cánada, mémory, bákery, África). However, exceptions like vanilla (e.g., banána, saliva, corólía, safári, boléré) receive stress on the penultimate syllable even though the penultimate syllable is light. Both stress patterns are attested in English (Pater, 1993). The exceptions, or what is called
lexically conditioned application, could underlingly block the application of the rule or constraint that would generally assign stress to the penultimate syllable. In this pattern of exceptionality, exceptional items undergo an alternation that does not apply to regular items; this is traditionally referred to as a minor rule. Under a lexically specific constraint approach, such exceptional lexical items are marked to be handled by an indexed specific constraint whose application is relativized to those lexical items. This state of affairs is illustrated in tableau (1).

Tableau (1) exhibits the role of lexically-indexed constraints in stabilizing the pronunciation of individual lexical items. The analysis uses a lexically-specific version of NONFIN, the constraint that prohibits stress-head in the final position of a prosodic word, which is in conflict with ALIGN-R. The lexically-specific NONFIN dominates ALIGN-R, and the general version is ranked beneath (i.e., NONFIN\textsubscript{i} \textasciitilde ALIGN-R \textasciitilde NONFIN). The lexical item \textit{cinema} and the lexically-specific NONFIN are marked with the diacritic ‘\textasciitilde’. \textit{Saliva} is not indexed with the diacritic, so NONFIN\textsubscript{i} does not apply. The output form \textipa{ˈkæn.ə.də} is optimal due to its satisfaction of the indexed constraint NONFIN\textsubscript{i}.

2.2 Non-uniformity in stress on clitics: Constraint indexation

2.2.1 What is a clitic?

The conceptualization of clitic is a matter of much debate in the study of language. Grammarians have long noted that this concern in this area is due to the fact that certain elements in many languages seem to play an independent role in the grammatical structure of sentences, but the unitary status of its attachment with the host is confirmed by its phonological behavior (Anderson, 2005; Berendsen, 1986; Booij, 1996; Klavans, 2018; Ordoñez and Repetti, 2006; Spencer and Luis, 2012; Zwicky and Pullum, 1983). A clitic is an element that has syntactic characteristics of a word, but hinges phonologically on another word or phrase. Under this
view, a clitic is syntactically independent but phonologically (especially accentual) dependent, i.e., it obligatorily attaches to the host (independent word). It plays a syntactic role at the phrase level, but it has the distribution of function words. Any grammatical category can be a clitic, but it is generally a pronoun or a determiner.

Clitics are classified into varied categories depending on their position in the host (Bisang, 2011; Cinque, 2005; Matthews, 1974; Payne, 1997; Zwicky and Pullum, 1983). A proclitic appears before its host as in French il m’a aidé (he helped me), in Italian lui mi ha aiutato (he helped me), and the informal second-person plural pronoun occurring in the (American) English y’all (“you all”). An enclitic appears after its host as in Portuguese: ela-te ajudou (she helped you). Portuguese also allows for mesoclitics, which appear between the stem of the host and other affixes as in dá-lo-ei (I will give it). The endoclitics appear inside the word: it splits apart the root and is epenthesis between the two elements. Endoclitics are found in Degema as in Òhóso mọ=kötú mọ̀ (Oho is calling you “sig”), clitic-host combination is separated by ‘=’.

According to Matthews (1974), clitics are “unaccented words which must lean for support […] on a neighbouring full word in their construction”. The type of clitics that lean forwards are called proclitics, and those that lean backwards are called enclitics (Matthews, 1974). Following Matthews’s (1974) definition provided above, the allative ‘l’ “to/for” or ‘li’ as in [lija] “to/for me”, [lik] “to/for you”, [lih] “to/for him”, [lihum] “to/for them” is a proclitic as it leans forwards, and the allative ‘-li’, ‘-lək’ and ‘-lu’ which appear commonly with verbs is an enclitic as it leans backwards (see also Ech-Charfi, n.d.). Note that in [lija], [lik], and [lih] ‘li’ is a clitic preposition and ‘ja’, ‘k’, and ‘h’ are clitics. Prepositions in MA behave as clitics (see Ech-Charfi, n.d., for further evidence using phonological tests such as schwa epenthesis and pronoun suffixation that prepositions are clitics).

2.2.2 Stress assignment in MA: General facts

The majority of studies on stress system in MA claims that MA is quantity sensitive (Abdelmassih, 1973; Benhallam, 1990; Benkaddour, 1982; Bohas, Hammoumi, and Chami, 1989; Boudlal, 2001; El Hadri, 1993; Hammoumi, 1988; Kably, 2001; Kandil, 2020; Nejmi, 1993, 1995). The bulk of studies agrees that stress in MA is attracted to one of the two final syllables. Stress falls on the ultimate syllable if it is heavy; otherwise, it is on the penultimate syllable. What follows is a summary of the overall generalizations in MA stress:

i Stress is restrictively located on one of the last two syllables of a word (Boudlal, 2001).

ii Stress falls on the ultimate syllable if it is heavy ([lawjín] ‘wilted, pl.’); otherwise, on the penultimate ([lāwja] ‘wilted, fem. Sg.’) (Benhallam, 1990; Benkirane, 1982; Boudlal, 2001).

iii If the penultimate syllable is an object clitic, stress falls on the preceding syllable: karkbihalhum “roll (2 fem.sg.) it for them” (Benhallam, 1990).
iv When the word has a closed syllable with schwa as a nucleus; it is considered a light syllable. Hence, it never attracts stress if there is a syllable with a full vowel as in [májál] ‘bent’ (masc.) or [wáďdak] ‘he promised you’ (Boudlal, 2001).

v Stress assignment is post-lexical, that is, it applies after all morphological and phonological rules have applied (Fares, 1993).

vi Stress is sensitive to syllable weight.

Following Boudlal’s (2001) work, stress assignment in MA can be accounted for by the following constraints ranking:

(2) ALIGN-R, Lx=Pr, TROC »*HL »WSP» NON-FIN » PARSE-σ» FT-BIN »ALIGN-Ft-R, IAMB

The constraints ranking above communicates some basic facts and generalizations regarding the domination relations among the constraints that interact to yield the correct stress patterns in MA. This hierarchy is motivated by the following generalizations.

i ALIGN-R, Lx=Pr, and TROC are undominated in MA:

a ALIGN-R must be undominated; stress assignment in (ṣan)(ˈḍa.ḷa) ‘sandal’ is more harmonic than (ˈṣan)(da.ḷa).

b Lx=Pr, which impels every lexical word to consist of a prosodic word, must be undominated; (xda) ‘he took’ is a better parsing than xda.

c TROC must be undominated; (ṣan)(ˈda.ḷa) is more harmonic than (ṣan)(ḍa.ˈḷa).

ii The other constraints, although they are all dominated by higher ranking constraints, are ranked relative to each other:

a *HL, which requires a foot to end in a strong–weak contour at the moraic level, must dominate WSP; (ˈbab.ha) ‘its/her door’ is a better parsing than (ˈbab)ha.

b WSP must dominate NON-FIN; li(ˈmun) ‘an orange’ is a better parsing than (ˈli.mun).

c NON-FIN must dominate IAMB; ba(ˈna.na) ‘a banana’ is a better parsing than ba(naˈna).

d NON-FIN must dominate FT-BIN; (ʕəṛ.ga)(ˈnin) is preferred over (ʕəṛˈga)nin.

e NON-FIN must dominate PARSE-σ; (lawˈjin)hum is a better parsing than (law.jin)(ˈhum).

f ALIGN-Ft-R must be dominated; (ʕəṛ.ga)(ˈnin) is a better parsing than (ʕəṛ)gaˈnin).

g PARSE-σ must dominate FT-BIN; (mad)(ˈra.ṣa) is a better parsing than (madˈra)ṣa.
2.2.3 Stress assignment on clitics in MA: Lexically specific constraints

Phonological systems often exhibit a considerable non-uniformity which limits the scope of certain generalizations to a subset of the lexicon. For example, in MA, stress falls on the final heavy syllable but not on those items whose final syllable is the object clitic (Boudlal, 2001). Determining stress placement in cliticised words displays inconsistency in their application (Benhallam, 1990). The overall generalization of stress rule in MA is that it falls on the final syllable of that word if it is heavy; otherwise, on the penultimate (Boudlal, 2001). However, the cliticised items do not adhere to this principle in spite of ending up in heavy syllables. This also violates the principle of Positional Faithfulness (Beckman, 1998, 2004) that mandates the preservation of specific phonological features or segments in particular positions within a word or phrase. A positional faithfulness rule concerning stress location in MA entails that stress is restrictively located on the ultimate syllable containing a full vowel, as principled by the positional faithfulness. Conversely, the parsing *li.kúm is disallowed even though the ultimate syllable contains a full vowel. Having a heavy ultimate stress, the word li.kum violates the positional faithfulness constraint by licensing stress to appear in a position where it is not typically expected.

To solve it out, Boudlal’s (2001) analysis of stress treats clitics [-kum] in likum (for/to you ‘plural’), [-hum] as in lihum (for them), and lih in dirihalih (do it ‘fem’ for him) as light syllables. However, to more formally handle stress irregularities in items in (3), the present analysis applies lexically-specific constraints in which both faithfulness and markedness constraints must be appropriately indexed (see Pater, 2000 on indexation as a resolution for non-uniformity in English secondary stress; Winslow, 2003, and Pater, 1993 on indexation as inconsistency resolution; as well as Ota, 2004 for discussion of Japanese postnasal voicing in similar terms).

3 Data description

The corpus selected for the analysis considers that stress is sensitive to syllable weight. Both simple and affixed forms and cliticized forms with final heavy syllable were chosen to capture the behavior of stress relative to syllable weight and the syntactic/morphological structure of the item. The corpus at hand includes generally cliticized forms and simple items to warrant a comparative analysis of stress pattern in the two forms and to test whether clitics with final CVC structure are stressed ‘similarly’ to the final CVC structure in simple forms. The items include disyllabic, trisyllabic, and polysyllabic words and are labeled in terms of syllable topology and word form (simple form or clitic). Note that each clitic is listed with a corresponding simple or affixed form having the same structure (CVC) of the syllable. The clitics
in question end in CVC structure syllable, so do the selected simple or affixed forms. Consider the data classification in (3), wherein pl., sg., masc., and fem. stand for plural, singular, masculine, and feminine; clitics are in bold.

<table>
<thead>
<tr>
<th>(3)</th>
<th>Simple/affixed form</th>
<th>Cliticized forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disyllabic:</td>
<td>law.jin “wilted (pl.)”</td>
<td>kla.hu.m “he ate them”</td>
</tr>
<tr>
<td></td>
<td>li.mun “oranges”</td>
<td>li.ku.m “for/to you (pl.)”</td>
</tr>
<tr>
<td></td>
<td>fa.qur “hatchet”</td>
<td>xud.li.k “take for you (sg.)”</td>
</tr>
<tr>
<td></td>
<td>ku.mir “baguette”</td>
<td>daghu.m “their house”</td>
</tr>
<tr>
<td></td>
<td>sar.wal “trousers”</td>
<td>ketab.ku.m “your (pl.) book”</td>
</tr>
<tr>
<td></td>
<td>qan.tan “bored”</td>
<td>gal.lih “He told him”</td>
</tr>
<tr>
<td></td>
<td>bu.lis “police”</td>
<td></td>
</tr>
<tr>
<td>Trisyllabic:</td>
<td>ma фа.kil “problems”</td>
<td>gal.li.ku.m “he told you (pl.)”</td>
</tr>
<tr>
<td></td>
<td>ma.qa.dı “ingredients”</td>
<td>law.ji.n.hum “they are twisting them”</td>
</tr>
<tr>
<td></td>
<td>man.dı.rı “clementine”</td>
<td>wal.mu.hum “they fit them”</td>
</tr>
<tr>
<td></td>
<td>tu.mu.dı “car”</td>
<td>boz.ta.m.kum “your (pl.) wallet”</td>
</tr>
<tr>
<td></td>
<td>nti.xa.bat “elections”</td>
<td>ga.lu.lih “they told him”</td>
</tr>
<tr>
<td></td>
<td>ti.li.fun “phone”</td>
<td>ḥaj.tu.lih “they called him”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ḥaj.tı.lih “they called you”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ḥır.tu.lih “I bought it (masc.) for you (sg.)”</td>
</tr>
<tr>
<td>Polysyllabic:</td>
<td>ti.li.fu.nat “phones”</td>
<td>di.ru.ha.lih “you (fem.) do it (fem.) for him”</td>
</tr>
<tr>
<td></td>
<td>tu.mu.bi.lat “cars”</td>
<td>xdi.na.ha.lik “we took it (fem.) for you (sg.)”</td>
</tr>
<tr>
<td></td>
<td>na.mu.si.jat “beds”</td>
<td>ga.lu.ha.li.hum “they said it (fem.) to them”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>gal.bi.ha.ku.m “they reversed it (fem.) for/to you”</td>
</tr>
</tbody>
</table>

Five master students of linguistics at Ibn Tofail University, Kenitra, were asked to articulate the items in (3). For ease of exposition, the items were given parsed into syllables. Note that CəC is treated as a light syllable, similar to CV. The recordings were fed into Praat for an acoustic measurement of stress in MA. To generate spontaneous data, the subjects were informed that the recordings were carried out for an instrumental analysis whose objective is to account for certain phonological aspects of MA without specifying the aspect (word-stress) under investigation.

4 Data analysis

The objective of the instrumental test is to measure stress by comparing the values for fundamental frequency (F0), intensity (IT), and duration (D) as well as by the sound waves drawn in spectrograms. Recall that the corpus was organized in such a way to include disyllabic, trisyllabic, and polysyllabic items of both simple and affixed forms to see whether or not stress pattern varies according to whether the word is affixed item or cliticized form. The stress patterns of MA obtained from test items are presented below:

Since Chomsky and Halle (1968), it has been established that syllable weight plays a deter-
<table>
<thead>
<tr>
<th>(4)</th>
<th>Simple/affixed form</th>
<th>Cliticized forms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disyllabic:</strong></td>
<td>law.jín “wilted (pl.)”</td>
<td>klá.hum “he ate them”</td>
</tr>
<tr>
<td></td>
<td>li.mún “oranges”</td>
<td>li.kum “for/to you (pl.)”</td>
</tr>
<tr>
<td></td>
<td>ʃa.qúr “hatchet”</td>
<td>xúd.lik “take for you (sg.)”</td>
</tr>
<tr>
<td></td>
<td>ku.mír “baguette”</td>
<td>dár.hum “their house”</td>
</tr>
<tr>
<td></td>
<td>sər.wál “trousers”</td>
<td>ktáb.kum “your (pl.) book”</td>
</tr>
<tr>
<td></td>
<td>qən.ʃán “bored”</td>
<td>gal.lik “He told him”</td>
</tr>
<tr>
<td></td>
<td>ku.lís “police”</td>
<td></td>
</tr>
<tr>
<td><strong>Trisyllabic:</strong></td>
<td>ma.ʃa.kíl “problems”</td>
<td>ga.li.kum “he told you (pl.)”</td>
</tr>
<tr>
<td></td>
<td>ma.qa.ḍír “ingredients”</td>
<td>law.jín.hum “they are twisting them”</td>
</tr>
<tr>
<td></td>
<td>man.ʃa.ʃín “clementine”</td>
<td>wəldáti.ní “they said it (fem.) for/to you”</td>
</tr>
<tr>
<td></td>
<td>ṭu.ʃa.ʃín “car”</td>
<td>boz.ʃa.ʃín “you (pl.) wallet”</td>
</tr>
<tr>
<td></td>
<td>nti.xa.štán “elections”</td>
<td>ga.ʃa.ʃín “they told him”</td>
</tr>
<tr>
<td></td>
<td>ʃa.ʃa.ʃín “phone”</td>
<td>ʃa.ʃa.ʃín “they called him”</td>
</tr>
<tr>
<td></td>
<td>ti.ʃa.ʃín “phone”</td>
<td>ʃa.ʃa.ʃín “they called you”</td>
</tr>
<tr>
<td></td>
<td>ti.ʃa.ʃín.fú “I bought it (masc.) for you (sg.)”</td>
<td></td>
</tr>
<tr>
<td><strong>Polysyllabic:</strong></td>
<td>ti.ʃa.ʃín.fú.nát “phones”</td>
<td>di.ʃa.ʃín “you (fem.) do it (fem.) for him”</td>
</tr>
<tr>
<td></td>
<td>ṭu.ʃa.ʃín.fú.nát “cars”</td>
<td>xdi.ʃa.ʃín “we took it (fem.) for you (sg.)”</td>
</tr>
<tr>
<td></td>
<td>na.ʃa.ʃín.fú.nát “beds”</td>
<td>ga.ʃa.ʃín.hum “they said it (fem.) to them”</td>
</tr>
<tr>
<td></td>
<td>ga.ʃa.ʃín.hum “they reversed it (fem.) for/to you”</td>
<td></td>
</tr>
</tbody>
</table>

mining role in stress placement. The items above show that MA makes recourse to syllable weight in placing stress. In MA, syllable weight falls into bimoraic heavy syllables (CVC) and monomoraic light syllables, which distinguishes between the structure (CV) where the mora dominates one segment and (CσC) where the mora dominates the schwa and another consonant. The data also shows that stress is restricted to the final syllable of the word (especially simple or affixed forms). If a word ends up in a heavy syllable, it receives final stress (e.g., ku.mír); otherwise, stress falls on the penultimate syllable, be it light (e.g., ʃa.nʃán) or heavy (e.g., wəldáti.ní), if the last syllable is light.

### 4.1 Instrumental test: Stress pattern visualization through Praat

The generalizations about stress placement in MA outlined and accounted for in the previous section are questioned for two sets of words: lexical exceptions and cliticized words. The generalization drawn for the above data is that stress falls on the final syllable if it is heavy; otherwise, on the penultimate. However, the items that end up in the object clitics [-kum] and [-hum] do not receive stress in spite of their being heavy and in the final position. The spectrograms in figures 1 and 2 are screenshots from Praat that acoustically visualize stress. While the figures in (1a) and (2a) visualize the stressed syllables, the figures in (1b) and (2b) present the unstressed syllables. The central objective of this presentation is to contrast the factors (intensity, pitch, and duration) that determine stress in the word.

The spectrograms in figures 1 and 2 show that the words likum and limun have different stress
Figure 1:

Screenshots from Praat: The word *likum*

a.

b.
Figure 2:

Screenshots from Praat: The Word \textit{limun}

a.

b.
placement in spite of having similar structure (CV.CVC). The environment where likum is stressed is un-stressed in limun. These two stress variants seem to agree with the generalization of stress assignment in MA that stress is sensitive to syllable weight and that clitics are stressless. In figure 1, it can be seen that the stressed syllable is li which has a duration of 0.232 s (see figure 1a) longer than the syllable kum whose duration is 0.17 s (see figure 1b). The intensity (loudness) is indicated by the yellow line and the green number on the lower right-hand side (above the tier) with the unit dB. The intensity in the stressed syllable is 62.54 dB (see figure 1a), while the unstressed syllable is 55.66 dB (see figure 1b). The pitch height average can be seen at the left-hand side: it is the red number with the unit Hz. The pitch of each selected syllable is indicated by blue numbers on the right-hand side. In figure 1a, the stressed syllable (li) is higher (198.3 Hz) than the unstressed syllable (127.1 Hz).

By the same token, the syllable mun is the stressed syllable in limun (compare the figures 1 and 2). In li, the pitch is falling down, while in mun, the pitch is rising, especially in the part of vowel. The stressed syllable is higher than the unstressed one. And the duration of the second syllable mun is longer than the first. The table in (5) shows this more clearly:

<table>
<thead>
<tr>
<th>(5)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Speaker 1</th>
<th>Pitch (Hz)</th>
<th>Intensity (dB)</th>
<th>Duration (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>likum</td>
<td>Li</td>
<td>196.3</td>
<td>62.54</td>
</tr>
<tr>
<td></td>
<td>kum</td>
<td>127.1</td>
<td>55.66</td>
</tr>
<tr>
<td>limun</td>
<td>Li</td>
<td>109.8</td>
<td>62.47</td>
</tr>
<tr>
<td></td>
<td>mun</td>
<td>117.9</td>
<td>65.63</td>
</tr>
<tr>
<td>Speaker 2</td>
<td>Pitch (Hz)</td>
<td>Intensity (dB)</td>
<td>Duration (s)</td>
</tr>
<tr>
<td>likum</td>
<td>Li</td>
<td>187.2</td>
<td>61.86</td>
</tr>
<tr>
<td></td>
<td>kum</td>
<td>119.1</td>
<td>54.43</td>
</tr>
<tr>
<td>limun</td>
<td>li</td>
<td>108.6</td>
<td>62.1</td>
</tr>
<tr>
<td></td>
<td>mun</td>
<td>116.7</td>
<td>64.21</td>
</tr>
<tr>
<td>Speaker 3</td>
<td>Pitch (Hz)</td>
<td>Intensity (dB)</td>
<td>Duration (s)</td>
</tr>
<tr>
<td>likum</td>
<td>li</td>
<td>198.2</td>
<td>63.21</td>
</tr>
<tr>
<td></td>
<td>kum</td>
<td>130.1</td>
<td>55.86</td>
</tr>
<tr>
<td>limun</td>
<td>li</td>
<td>110.2</td>
<td>62.87</td>
</tr>
<tr>
<td></td>
<td>mun</td>
<td>121.6</td>
<td>66.13</td>
</tr>
<tr>
<td>Speaker 4</td>
<td>Pitch (Hz)</td>
<td>Intensity (dB)</td>
<td>Duration (s)</td>
</tr>
<tr>
<td>likum</td>
<td>li</td>
<td>201.3</td>
<td>63.26</td>
</tr>
<tr>
<td></td>
<td>kum</td>
<td>132.1</td>
<td>56.13</td>
</tr>
<tr>
<td>limun</td>
<td>li</td>
<td>106.7</td>
<td>62.23</td>
</tr>
<tr>
<td></td>
<td>mun</td>
<td>118.5</td>
<td>65.51</td>
</tr>
<tr>
<td>Speaker 5</td>
<td>Pitch (Hz)</td>
<td>Intensity (dB)</td>
<td>Duration (s)</td>
</tr>
<tr>
<td>likum</td>
<td>li</td>
<td>202.4</td>
<td>64.1</td>
</tr>
<tr>
<td></td>
<td>kum</td>
<td>132.8</td>
<td>56.16</td>
</tr>
<tr>
<td>limun</td>
<td>li</td>
<td>105.3</td>
<td>61.71</td>
</tr>
<tr>
<td></td>
<td>mun</td>
<td>116.2</td>
<td>65.34</td>
</tr>
</tbody>
</table>

The table above presents the physical properties that correlate with stress. These include Pitch or Fundamental Frequency (F0), Intensity or Loudness (amplitude), and Vowel Length. The table indicates that while the ultimate syllable in the word limun attracts stress for having
both a higher intensity and pitch as well as a longer vowel duration, stress falls on the first syllable in likum, in a similar fashion.

In what follows, we turn to capture the stress assignment in MA within constraint-based approach. We first show how a standard optimality-theoretic analysis (not in terms of constraint indexation) by establishing a constraint that militates against stress on clitics cannot provide a unified analysis for stress on clitics, and then most importantly we argue for a treatment of this lexical idiosyncrasy in terms of lexically specific constraints.

4.2 The behaviour of stress on clitics: *CLITICstress constraint

Clitics are words which cannot project prosodic feet; therefore, they lack stress. Anderson (2005, p. 23) states this as in (6):

\[(6) \text{Phonological clitic: a linguistic element whose phonological form is deficient in that it lacks prosodic structure at the level of (prosodic) Word.}\]

Under this view, the form (gəlbu)(hál)kum is a better parse than (gəlbu)(hálkum) or (gəlbu)(hál)(kum). Clitics are unstressed elements that are prosodically attached to another phonological word. They lack prosodic structure and are unfooted on their own. As such, they show their inability to bear stress (at least in part) cross-linguistically (Berendsen, 1986; Cressey, 1978; Hualde, 2005; Klavans, 2018; Zwicky and Pullum, 1983). For example, while in Spanish, enclitics may bear stress under certain conditions (Hualde, 2005; Ordóñez and Repetti, 2006; Soriano, 1999), in MA, clitics are taken to be invisible for stress assignment. Given this apparatus, we propose the constraint in (7) that bans clitics to be stressed:

\[(7) *\text{CLITICstress} = \text{clitics are unstressed elements.} \]

*CLITICstress interacts with Weight-to-Stress Principle (WSP) (Prince and Smolensky, 1993) constraint which demands heavy syllables to be parsed as the head syllable of a foot. Thus, WSP expresses that a heavy syllable must bear stress over a light syllable. With *CLITICstress ranked above WSP, stress falls on the penultimate syllable instead of ultimate in spite of being heavy. Tableau (8) illustrates this result. Heavy syllables must be stressed:

\[(8) *\text{CLITICstress} \gg \text{WSP}\]

<table>
<thead>
<tr>
<th>Form</th>
<th>*CLITICstress</th>
<th>WSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>/walmuhum/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wal(muhum)</td>
<td>!</td>
<td>*</td>
</tr>
<tr>
<td>(walmūhum)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since the heavy syllable in the optimal form (walmūhum) is unstressed, this candidate violates WSP. As shown by the other candidate (walmuhūm), the satisfaction of WSP requires
the violation of the higher-ranking constraint that bans placing stress on clitic.

With just the constraint (*CLITIC\textsubscript{stress}) introduced above, the clitics \textit{lih} and \textit{lik} would be treated as \textit{kum} and \textit{hum}, and be visible for stress assignment. However, these clitics receive stress, as in \textit{xudlík} and \textit{gallíh} (see also Boudlal, 2001). The grammar in (8) would predict the suboptimal candidate. Consider the tableau below:

\begin{tabular}{|c|c|c|}
\hline
\textit{gallíh}/ & *CLITIC\textsubscript{stress} & WSP \\
\hline
\textit{gallíh} & *! & * \\
\hline
\end{tabular}

The pattern *CLITIC\textsubscript{stress} \(\rightarrow\) WSP does not yield the correct form. To rule out \textit{gallíh}, WSP should be ranked above *CLITIC\textsubscript{stress}. This will result in having specific ranking of constraints, and each item would select a certain ranking (the ‘cophonology’ approach; e.g.\(^2\), Anttila, 2004; Inkelas and Zoll, 2007); for example, while \textit{walmúhum} selects *CLITIC\textsubscript{stress} \(\rightarrow\) WSP, \textit{gallíh} favours WSP \(\rightarrow\) *CLITIC\textsubscript{stress}. Under this approach, the analysis may fail to express the distinction between the exceptional, impossible and regular patterns. To establish a unified analysis, we propose a lexically indexed constraint that captures generalizations which escape the partial ordering theory of cophonologies.

\subsection{4.3 Constraint indexation: A resolution to stress inconsistency on clitics}

Having established an experimental basis for stress assignment in MA, now we turn in the following section to see how the variation in stress is better accounted for within the lexically specific constraint. Not all patterns of stress are phonologically conditioned. There is a set of words (cliticsized forms) that is identical in the relevant phonological characteristics, yet fails to have stress on the final heavy syllable. Some examples are repeated in (10):

\begin{enumerate}
\item a. li.kum
\item b. ktáb.kum
\item c. ga.li.kum
\item d. wal.mú.hum
\item e. ga.lu.ha.li.hum
\item f. gəl.bu.hál.kum
\end{enumerate}

Stress in MA displays evidence of lexically conditioned non-uniformity; in some phonological environments, whether or not a principle applies depends on the lexical item at hand. In other words, while words with the final heavy syllable receive stress, final stress does not apply to clitics with the final heavy syllable. Consider the following example.

Tableau (11) summarizes two results booked so far. First, words such as \textit{limun} shape the regular stress pattern in MA by stressing the heavy syllable. Second, the exceptional items such as \textit{likum} appear to be that of stresslessness in this environment. The fact that stress in

\footnote{Under this approach, a grammar has a single instantiation of each constraint, but individual items can impose a different ranking of some of them.}
MA is sensitive to syllable weight requires a ranking of WSP » NONFIN to secure stress on the heavy syllable regardless of its position in stress domain (i.e., the last two syllables). However, clitics are exception of this generalization. Therefore, we assume that these exceptional items (as in 10) are subject to a lexically indexed NONFIN constraint. This version of NONFIN (NONFIN-L) ranks above WSP, and applies only to those lexical items indexed for its application (here with an ‘L’ for ‘lexical’). The collapsed tableaux in (11) show the results of applying the grammar NONFIN-L » WSP » NONFIN to a form that lacks the index (/limun/), and one that bears it (/likumL/).

The effects of lexically specific constraints can be seen in the grammar NONFIN-L » WSP » PARSE-σ. The result of this lexically specific ranking is illustrated in (12):

Stressing the last syllable, if it is heavy, is the regular pattern. The absence of stress in such environment as in gallikum forms exceptionality. To capture this pattern, we can posit a lexically specific version of NONFIN (NONFIN-L) that dominates PARSE-σ. For words such as gallikum that are targeted by NONFIN-L, penultimate stress is preferred, even though this results in a PARSE-σ violation. For regular words that are not subject to NONFIN-L, the violation of PARSE-σ and WSP makes penultimate stress ungrammatical since, as shown in (12), WSP outranks the general NONFIN constraint.

This further example of lexically idiosyncratic stress assignment can be captured by cloning IAMB (i.e., IAMB-\_L) and ranking it above WSP. Consider the collapsed tableaux (13) which provide further evidence of lexically specific ranking.

As walmukum is targeted by IAMB-L, its ranking above WSP renders the penultimate-stress
(walmúkum) optimal, even with the violation of WSP. When IAMB-L does not apply, as in *mandařin*, the ranking WSP» NONFIN favours ultimate stress over penultimate stress, leading to the grammaticality of *mandařin*.

To account for the attested instances of stress exceptionality in MA, the following diagram (14) incorporates the rankings of the lexically specific NONFIN-L and IAMB-L into the hierarchy proposed for regular stress in (2):

(14)

```
ALIGN-R, Lx=Pr, TROC
  *HL
 /NONFIN-L  IAMB-L
   WSP
 /NONFIN  IAMB
   FT-BIN
   PARSE-g
   ALIGN-Ft-R
```

The OT analysis, adopting lexically specific constraints, of stress offered in this paper has allowed to account for variation in the stress pattern of MA and more formally explain stress
non-uniformity in MA. The ranking above communicates the domination relations of the constraints that interact to yield the correct stress patterns in MA. The constraints in the initial stratum (ALIGN-R, Lx=Pr, and TROC) are undominated in MA. ALIGN-R must be undominated; (man.ḍa)(ˈrin) ‘clementine’ is more optimal than (ˈman.ḍa)(rin) or (man.ˈḍa)(rin). Lx=Pr, a constraint requiring each lexical word to be made up of a prosodic word, must be undominated; the parsing (bab) ‘a door’ is more harmonic than bab. TROC must be undominated; (man.ḍa)(ˈrin) is more harmonic than (man)(ḍaˈrin).

The other constraints, although they are all dominated by the top-ranked constraints, are ranked relative to each other. *HL, a constraint requiring a foot to end in a strong–weak contour, must dominate WSP; (ˈdar.ha) ‘its/her house’ is a better parsing than (ˈdar)(ha). WSP must outrank NON-FIN; (man.ḍa)(ˈrin) is a better parsing than (man.ˈḍa)rin. IAMB is outranked by NON-FIN so that the parse (mad)(ˈɾa.ṣa) ‘school’ is more harmonic than (mad)(ɾaˈṣa). However, the lexically specific version of NONFIN (NONFIN-L) must outrank PARSE-σ so that ga(li.kum) is more harmonic than (ga.li)(kûm). IAMB-L, a cloned constraint of IAMB, outranks WSP to secure the penultimate-stress on the cliticized words whose ultimate syllable is heavy so that wal(mû.kum) is more harmonic than wal(mu.kûm). FT-BIN must be dominated by NON-FIN (man.ḍa)(ˈrin) is preferred over (man.ˈḍa)rin. NON-FIN should outrank PARSE-σ; stress assignment in (lawˈjin)hum is more optimal than (law.jin)(ˈhum). PARSE-σ must be dominated by FT-BIN; ba(ˈna.na) is a better parsing than (ba)(ˈna.na). ALIGN-Ft-R must be dominated; (ɾaɾ.gə)(ˈnin) is a better parsing than (ɾaɾ)(gaˈnin).

5 Conclusion

This paper sets out the problem that previous non-constraint-based approaches and OT-based analyses encounter in explaining the exceptions of MA stress (i.e., clitics). The analysis proposed in this paper is distinguished from previous analyses in applying a relatively new OT-based analysis in terms of lexically-indexed constraints (Pater, 2000).

Previous works on MA stress agree in that stress is phonetic and thus does not interact with word-formation nor changes the meaning. In MA, stress is restrictively located on one of the last two syllables of a word: it falls on the ultimate syllable if it is heavy; otherwise on the penultimate. If the last syllable is a clitic, stress falls on the preceding syllable. Stress is sensitive to syllable weight.

In this paper, we have argued that stress exceptionality in MA can be better accounted for by applying lexically-specific constraints. First, we have carried out an instrumental test of stress using Praat to measure the physical properties that correlate with stress. The findings show that Pitch or Fundamental Frequency (F0), Intensity or Loudness (amplitude), and Vowel Length are determining factors in stress placement. The stressed syllable was attested to have a higher intensity and pitch as well as a longer vowel duration than the unstressed syllable. The conclusion drawn from the spectrograms reveals that MA is a quantity sensitive system, stress is restricted to the last two syllables, and clitics (kum and hum) are stressless in spite
of their being heavy syllable.

Second, from an OT perspective, we have proposed the constraint *CLITIC\text{stress} that bans stress to fall on clitics. With *CLITIC\text{stress} ranked over WSP, likum favours penultimate stress as an exception to stressing heavy syllable. However, this conclusion would treat the clitics lih and lik (which are attested to trigger stress as in xulik and gallih) as kum and hum, and be visible for stress assignment. Third, to establish a unified analysis, we have proposed a lexically indexed constraint wherein versions of NONFIN (NONFIN\text{-}L) and IAMB (i.e., IAMB\text{-}L) rank above WSP, and apply only to those lexical items indexed for their application. Such a ranking better rules out *likúm and provides a unified account for the optimality of both regular patterns (e.g., limún) and exceptional patterns (e.g., likum).

References


