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Phonological Processes in Algerian Arabic as Spoken in Mostaganem: An Optimalty Perspective

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Abstract
This study attempts to identify some of the phonological processes that are manifested in Mostaganem Spoken Arabic (MTG), a dialect of Algerian Arabic, and account for such processes within an optimality theory (OT) framework. The findings of the study identified four types of phonological processes in MTG, namely epenthesis, syncope, assimilation and major class change. Epenthesis includes /≅/ epenthesis to avoid tri-consonantal onsets and /j/ epenthesis between /i/ and /a/ so as to prevent vowel hiatus. Syncope involves the deletion of /≅/ when it occurs in an unstressed open syllable. Assimilation is sub-divided to voice assimilation in which an obstruent changes its voice feature so as to agree with a following obstruent. Place assimilation which occurs when the nasal /n/ is realized as a labial in order to be homorganic with a following labial. Total assimilation which involves a change in the voice and manner features of /l/ of the definite article / ?≅l/ 'the' so that it becomes totally identical to a following coronal consonant. Major class change involves a change from the vowels /i/ and /u/ to the glides /j/ and /w/ in order to avoid vowel hiatus. Application of OT in order to account for those phonological processes indicated that all four types of phonological processes are the outcome of interaction between certain types of markedness constraints and faithfulness constraints.
Keywords: Phonological processes, constraints, OT, epenthesis, syncope, assimilation, major class change, Mostaganem Spoken Arabic.

1. Introduction

Phonological processes, such as epenthesis, deletion and assimilation, may be described and explained within different theoretical frameworks. Optimality theory (OT) is among such theoretical frameworks.

Optimality theory (OT) was proposed by Prince and Smolensky (1993) and McCarthy and Prince (1995) among others. Within an OT framework, languages' grammars are viewed as consisting of a set of universal constraints. Such constraints are divided into two major categories, namely markedness constraints and faithfulness constraints. Markedness constraints "are conditions on the well-formedness of the output" (Prince and Smolensky 2004: 4). Faithfulness constraints, on the other hand, are "conditions asking for the exact preservation of the input in the output" (Prince and Smolensky ibid: 4). OT describes and accounts for phonological processes, such as epenthesis, syncope and assimilation, in terms of interaction between markedness and faithfulness constraints.

The grammar of OT consists of four components, namely the constraint set, the lexicon or input, the generator (GEN) and the evaluator (EVAL). OT grammar maps input forms into output forms through such components (Archangeli 1997: 15). The constraint set (CON) consists of markedness and faithfulness constraints. The lexicon or input is the underlying representation which includes forms before they undergo any phonological change or process. The generator (GEN) is the component of OT which derives the possible output forms of an input form (McCarthy 2007: 4). The evaluator (EVAL) is the component of OT grammar which evaluates the set of candidates generated by GEN and selects the eventual output form which is called the optimal candidate (ibid: 4). The optimal candidate is the one that is the most harmonious with constraint hierarchy. In other terms, the winning candidate is the candidate that satisfies the higher-ranked constraints which could be markedness or faithfulness constraints, depending on constraint ranking in the language under study.

OT was applied in accounting for different types of phonological processes in different languages, including Arabic. For example, Louriz (2004) applied OT to account for vowel deletion in French loanwords that are used in Moroccan Arabic (MA). The deletion of the vowel /a/ in French loanwords like /αγρεσε/ 'to attack' is considered as the result of the dominance of the markedness constraint ONS which requires syllables to have onsets over the faithfulness constraint MAX-IO. As a matter of fact, the vowel /a/ is deleted since the syllable /a/ is onsetless. Furthermore, deletion rather than epenthesis takes place because DEP-IO dominates MAX-IO in MA. Hence, /αγρεσε/ is realized as [γρισα] in MA.

Btoosh (2006) also accounted for the process of glottal stop /?/ epenthesis in Jordanian Arabic words like /α□μαδ/ 'Ahmed' from an OT perspective by viewing it as a result of the dominance of markedness constraint ONS over the faithfulness constraint DEP-IO which prohibits the insertion of segments (Btoosh 2006: 197). Hence, /?/ is inserted at the beginning of the onsetless syllable /α□μαδ/, yielding the realization [?α□.μαδ]. However, there is nothing in the analysis that indicates why is /?/ inserted and not part of the input /α□μαδ/?

Hall (2006) analyzed regressive voice assimilation in Mekkan Arabic, a dialect spoken in Saudi Arabia, from an OT perspective. In this dialect, a voiced obstruent is realized as voiceless when it is followed by a voiceless obstruent as in /?αγσαμ/ 'he swore an oath' which is realized as [?ακσαμ] (Hall 2006: 2). Such type of assimilation is the outcome of the satisfaction of the markedness constraints AGREE (voice) which requires adjacent obstruents to agree in their voice feature and NO Voiced Obstruents (NO VCD OB_S) which prohibits voiced obstruents over the faithfulness constraint IDENT-IO (voice) which requires input obstruents to preserve their voice feature in the output (Hall 2006: 5).

Mustafawi (2006) applied OT to explain the process of fronting or affrication of the dorsals /k/, /g/ to /tΣ/, /dZ/ in Qatari Arabic (QA). QA affrication is manifested in such words as /λακιν/ 'but' and /λιγαν/ 'a large dish' which are respectively realized as [λατΣιν] and [λιδΖαν] (Mustafawi 2006: 69). Mustafawi (2006) accounted for the application of affrication of /k/, /g/ to /tΣ/ and /dΣ/ in terms of the dominance of the markedness constraint [k]/ [g] <--> ¬ [i(:)] which considers the dorsals /k/, /g/ as being marked before the high front vowel /i/ over the faithfulness constraint MAX-IO (dorsal) which requires that "every dorsal specification in the input is present in the output" (Mustafawi 2006: 67).

Masacro (2007) studied total assimilation of the definite article /?al/ 'the' in Modern Standard Arabic (MSA) from an OT perspective. Masacro (2007: 727) demonstrates that in MSA /l/ of /?al/ totally assimilates to the consonants /t, T, d, Δ, r, l, n, z, s, s, d, t, Δ/. Masacro (2007:727) assumes that the morpheme /?al/ possesses the allomorphs /?αλ, ?ατ, ?αT, ?αδ, ?αΔ, ?αρ, ?αν, ?αζ, ?ασ, ?ασ, ?αδ, ?ατ, ανδ ?αΔ/. Such allomorphs are included in the input. Thus, the input /?al-Σams/ 'the sun' contains all the allomorphs of /?al/ (/?α{λ, τ, T, δ, Δ, ρ, ν, ζ, σ, σ, δ, τ, Δ}-Σams/). Then, each candidate that GEN generates includes one of these allomorphes. However, the optimal output is the one that satisfies the higher ranked markedness constraint AGREE/ C which requires "total identity of any adjacent consonants" (Masacro 2007: 724). In the case of forms like /?αλ–Σαμσ/, GEN generates candidates like [?αλΣαμσ], [?ατΣαμσ], [?αTΣαμσ], [?ασΣαμσ], [?αΣΣαμσ] and so on. Yet, [?αΣΣαμσ] is optimal as it satisfies AGREE /C, whereas the other candidates violate it.

As it appears from the previous review, OT was applied to account for different types of phonological processes in different Arabic dialects. However, if one considers Mostaganem Spoken Arabic, a dialect of Algerian Arabic that was abbreviated to MTG in Hamerlain (2006), one discovers that no study applied OT in order to account for phonological processes in that dialect. The present study applies the model of OT in order to account for four types of phonological processes in MTG, namely epenthesis, deletion, assimilation and major class change.

2. Method

The data of the study were accessed via twelve hours of audiotaped recordings of the speech of fifty MTG speakers in different occasions. Such occasions included family meetings, conversation with neighbours as well as conversations at the hairdresser, in the supermarket and at the beach. Furthermore, phonological differences that relate to gender, age and education were not taken into account since this study is a descriptive study. After the recording sessions were completed, four types of phonological processes were identified, namely epenthesis, deletion, assimilation and major class change. Such processes were then accounted for on the basis of the principles of interaction between markedness constraints and faithfulness constraints in a constraint hierarchy.

3. Results and discussion

Four types of phonological processes were identified from the findings of the study, namely epenthesis, deletion, assimilation and major class change. Each type of phonological processes may be explained in terms of interaction between certain types of markedness constraints and certain types of faithfulness constraints.

3.1. Epenthesis in MTG

The data of the study identifies two types of epenthesis in MTG, namely vowel epenthesis and consonant epenthesis. Each type of epenthesis is motivated by the requirements that are made by one or more well-formedness constraints and can be accounted for in terms of the interaction between such markedness constraints and faithfulness constraints.

Vowel epenthesis involves the insertion of /≅/ between the first and second consonants of a tri-consonantal cluster after the first, second and third person singular/plural masculine/feminine present tense prefixes 'n-', 't-', 'j-' are added to the stem of a verb that starts with two consonants. The following examples illustrate vowel epenthesis in MTG verbs with tri-consonantal onsets:

(1)

Input	Output	Gloss	Ill-formed Forms
ν–γλα∂	ν≅γλα∂	'I take off'	*νγλα∂
ν–τφαραδΖ	ν≅τφαραδΖ	'I watch'	*ντφαραδΖ
ν–δ∂ι	ν≅δ∂ι	'I pray for'	*νδ∂ι
τ–ξραδΖ	τ≅ξραδΖ	'she goes out'	*τξραδΖ

Vowel insertion does not take place in MTG when the present tense prefixes are added to the stem of a verb that starts with a single consonant. The examples in (2) exemplify cases where vowel epenthesis does not apply in MTG:

(2)

Input	Output	Gloss	Ill-formed forms
ν–∂αωνακ	ν∂αωνακ	'I help you'	*ν≅∂αωνακ
τ–βα:ν	τβα:ν	'she looks like'	*τ≅βα:ν
ν–φαω≅τλακ	νφαω≅τλακ	'I pass you'	*ν≅φαω≅τλακ
τ–ραδΖ∂ακ	τραδΖ∂ακ	'she turns you into'	*τ≅ραδΖ∂ακ

It appears from the examples in (1) that forms like /ν–γλα∂/ 'take off' are realized with an epenthetic /≅/ separating the prefix and stem's onset to avoid three consonants in onset position. Yet, verbs like /τ–βα:ν/ 'she looks like' in the examples in (2) are realized with no epenthetic /≅/ since the stem of the verb starts with a single consonant and prefixation would result in a bi-consonantal onset, yielding [τβα:ν]. Thus, MTG allows complex onsets, but the maximum number of consonants that are allowed in onset position is two. Hence, each time the addition of the present tense prefixes to the stem of a verb results in more than two consonants in onset position, /≅/ is inserted to break such impermissible cluster. In /ν–γλα∂/ the tri-consonantal onset /νγλ/ is broken up by the epenthetic vowel /≅/ between /n/ and /g/. However, in /τ–βα:ν/, no insertion takes place between /t/ and /b/. The impermissibility of complex onsets like /νγλ/ is formulated in the markedness constraint *COMPLEX ONS which disallows complex onsets. However, *COMPLEX ONS bans all sorts of complex onsets, including bi-consonantal ones like /tb/ in [τβα:ν]. A solution to such a dilemma is inspired by Al-Mohanna (2007: 58) who suggests that *COMPLEX may be parameterized to adapt to the requirements of a given language. In MTG, *COMPLEX ONS disallows tri-consonantal onsets and may be formulated as follows:

(3) *COMPLEX ONS CCC: No more than two consonants in onset position. (tri-consonantal onsets are prohibited).

In [ν≅γλα∂], /≅/ epenthesis results in the violation of the anti-epenthesis correspondence constraint DEP-IO. Hence, *COMPLEX ONS CCC dominates DEP-IO in MTG. Furthermore, since epenthesis and not the deletion of one of the consonants that make up the impermissible onset occurs, then the anti-deletion correspondence constraint MAX-IO dominates DEP-IO in MTG. Constraint hierarchy for /≅/ epenthesis in MTG is as follows:

(4) *COMPLEX ONS CCC>>MAX-IO>>DEP-IO.

Tableau 1 demonstrates why [ν≅γλα∂] is the optimal output of /ν–γλα∂/:

Tableau 1. Selection of the Optimal Output for /ν–γλα∂/

ν–γλα∂	*Complex ONS CCC	MAX-IO	DEP-IO
a. νγλα∂	*!		
☞ b.ν≅γλα∂			*
c. νλα∂		*!	
d. νγα∂		*!	

Tableau 1 indicates that candidate (b) is the winning candidate since it incurs the least costly violation of constraints, violating only the lower ranked DEP-IO. (a) is excluded because it violates the higher ranked

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*COMPLEX ONS CCC by including the offensive tri-consonantal onset /νγλ/. (c) and (d) are rejected since they incur a violation of MAX-IO by lacking the input segments /g/ and /l/ respectively.
In the case of bi-consonantal onsets like [τβα:ν], no insertion takes place since *COMPLEX ONS CCC is not violated by such form. Inserting /≅/ would erroneously produce ∗[τ≅βα:ν] which violates DEP-IO unnecessarily, and thus disrespects the principle of economy. Tableau 2 indicates why [τβα:ν] is the optimal output for /τ–βα:ν/:

Tableau 2. Selection of the Optimal Output for /τβα:ν/

τ–βα:ν	*Complex ONS CCC	MAX-IO	DEP-IO
☞ a.τβα:ν			
b. τ≅βα:ν			*
c. τα:ν		*!	

Tableau 2 demonstrates that (a) is the optimal candidate. Given that *Complex ONS CCC allows no more than two consonants in onset position, bi-consonantal onsets such as /τβ/ are allowed which makes it unnecessary to insert or delete. Hence, (b) and (c) are excluded because they unnecessarily violate DEP-IO and MAX-IO.
Glide insertion involves the epenthesis of the glide /j/ between /i/ and /a/ when the first person pronoun /ανα/ 'I/me' is added after a word that ends with the high front vowel /i/. The following examples illustrate such process:
(5)

Input	**Output**	**Word translation**	**Gloss**	**Ill-formed forms**
∂λαβαλι ανα	∂λαβαλι φανα	Know I	I know'	∗∂λαβαλι ανα
φ≅Σριλι ανα	φ≅Σριλι φανα	Buy I	'he buys me'	∗φ≅Σριλι ανα
□αωδΖι ανα	□αωδΖι φανα		'oh my God'	∗□αωδΖι ανα
∂ι ανα	∂ι φανα	Just I	'just me'	∗∂ι ανα

As the examples in (5) indicate, the glide /j/ is inserted because /i/ and /a/ occur in a sequence as in /∂λαβαλι ανα/ 'I know'. Such insertion is achieved in order to satisfy the markedness constraint ONS which requires syllables to have onsets. Given that /a/ in /ana/ is onseteless, it violates ONS, and thus /j/ is inserted as a repair strategy to fix the violation. A glide is inserted and not another consonant, such as the glottal stop /?/, since the sequence [+high] [-high] is marked as indicated in Uffmann (2007: 465) who reports that a glide is inserted when the first vowel of a hiatus is [+high]. A markedness constraint which requires a glide to be inserted when the first vowel of a hiatus is [+high] could be formulated as follows:
(6) *[+high] [-high]: a glide should be inserted after a high vowel.
Given that /j/ is a semi-vowel, it has the vowel feature [+high] just like the vowel /i/. Thus, it is more suitable to add /j/ after /i/ than /?/ which does not possess the feature [+high]. Furthermore, /j/ is preferred to /?/ as the markedness scale for intervocalic consonants considers glides as less marked in intervocalic position than /?/ which is a laryngeal. Such a scale is formulated below, as stated in Uffmann (2007: 465):
(7) *V-V/Lar(laryngeal)›› *V-V/Obs (obstruent)›› V-V/Nas (nasal)›› *V-V/Liq (liquid)›› *V-V/Gli (glide) ›› *V-V/V.
In addition to repairing for ONS violation, glide insertion is also a strategy that is used to avoid vowel hiatus which is prohibited by the markedness constraint NO HIATUS. Given that both ONS and NO HIATUS lead to glide insertion, they must be left unranked with regard to each other in MTG. In other terms, their requirements do not conflict. For the same reason, *[+high] [-high] is left unranked with regard to ONS and NO HIATUS.
Another repair strategy for vowel hiatus could be to delete one of the vowels that make up the hiatus. /a/ in /∂λαβαλι ανα/ could be deleted which would yield a form like [∂λαβαλι να]. Such form would violate neither ONS nor NO HIATUS. Yet, deletion is excluded by the anti-deletion constraint MAX-IO which is higher ranked in MTG than the anti-epenthesis constraint DEP-IO. Hence, the best option in this case is glide insertion.
Constraint hierarchy for glide insertion in MTG is as follows:
(8) ONS, NO HIATUS, *[+high] [-high]››MAX-IO ››DEP-IO.
Tableau 3 indicates why [∂λαβαλι φανα] is the optimal candidate of /∂λαβαλι ανα/:

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Tableau 3. Selection of the Optimal Output for /∂λαβαλι ανα/

∂λαβαλι ανα	ONS	NO HIATUS	*[+high] [-high]	MAX-IO	DEP-IO
a. ∂λαβαλι ανα	*!	*!			
☞ b.∂λαβαλι φανα					*
c. ∂λαβαλι ?ανα			*!		*
d. ∂λαβαλι να				*	

Another markedness constraint could be added to the constraint hierarchy of glide insertion in MTG. This constraint is based on the markedness scale of intervocalic consonants (Uffmann 2007: 465) and is formulated as follows:

(9) *V-V/Laryngeal ›› *V-V/Glide (glides are less marked intervocalically than laryngeals)

Constraint hierarchy for glide insertion in MTG is reformulated as follows:

(10) ONS, NO HIATUS, *[+high] [-high], *V-V/Larryngeal›› V-V/Glide ›› MAX-IO ›› DEP-IO.

Tableau 4 includes the new constraint hierarchy for glide insertion in MTG and demonstrates why [∂λαβαλι φανα] is the optimal output of /∂λαβαλι ανα/:

Tableau 4. Selection of the Optimal Output for /∂λαβαλι ανα/using the new constraint hierarchy

∂λαβαλι ανα	ONS	NO HIATUS	*[+high] [-high]	*v-v/La›› v-v/Gli	MAX-IO	DEP-IO
a. ∂λαβαλι ανα	*!	*!				
☞ b.∂λαβαλι φανα						*
c. ∂λαβαλι ?ανα			*! *!			*
d. ∂λαβαλι να					*	

It appears from tableau 4 that candidate (b) is the optimal candidate as it incurs the least costly violation of constraints as it violates only the low ranked constraint DEP-IO. (a) is rejected as it violates the higher ranked constraints ONS and NO HIATUS. (a) includes the vowel hiatus /i a/ which results in the onsetless syllable /a/. (c) is eliminated as it violates the higher ranked *[+high] [-high] and *V-V/Lar›› V-V/Gli because it has /ʔ/ as the epenthetic segment. /ʔ/ is a laryngeal, and is thus marked intervocalically. Furthermore, only a [+high] should follow [+high] /i/. /ʔ/ is not a [+high], and thus it cannot follow /i/. (d) is excluded as it violates MAX-IO by lacking input /a/ in the output.

In cases where /ανα/ is preceded by a word that ends in a consonant, no glide is inserted as the word's final consonant syllabifies as onset of the syllable /a/ in /ανα/. The following examples illustrate such case:

(11)

Input	Output	Word translation	Gloss	Ill-formed forms
κλι:τ ανα	κλι:τ ανα	Ate I	'I ate'	*κλι:τ φανα
νσαγ≅μ ανα	νσαγ≅μ ανα	Adjust I	'I adjust'	*νσαγ≅μ φανα
ν□αω≅σ ανα	ν□αω≅σ ανα	Help you I	'I look for'	*ν□αω≅σ φανα
δαξ≅λ ανα	δαξ≅λ ανα	Am coming in I	'I am coming in'	*δαξ≅λ φανα

In /κλι:τ ανα/ 'I ate', no glide is inserted since /t/ of /κλι:τ/ syllabifies as onset of /α/ in /ανα/. Tableau 5 indicates why [κλι:τ ανα] is the optimal realization of /κλι:τ ανα/:

Tableau 5. The Selection of the Optimal Output for /κλι:τ ανα/

κλι:τ ανα	ONS	NO HIATUS	*[+high] [-high]	*v-v/La›› v-v/Gli	MAX-IO	DEP-IO
☞ a.κλι: τανα						
b.κλι:τ φανα						*
c. κλι:τ ?ανα						*
δ. κλι:τ να					*	

Tableau 5 indicates that candidate (a) is the optimal candidate since it does not violate any constraint. There is no need for insertion in this case as there is no vowel hiatus. Furthermore, ONS is satisfied by syllabifying /t/ as onset of /a/ in /ανα/ which excludes both candidates (b) and (c). Deletion of /a/ in /ανα/ is also unnecessary since /t/ provides the onset for /a/ which excludes candidate (d).

3.2. Syncope in MTG

Vowel syncope occurs in MTG when a vowel initial suffix like the feminine or the plural markers for adjectives or participles /a/ and /ι:ν/ are added to a bi-syllabic word whose second syllable has the vowel /≅/ as its nucleus and is closed with a coda consonant. After suffixation of the vowel-initial suffix, the coda of the second syllable in the stem re-syllabifies as onset for such vowel-initial suffix and /≅/ which becomes nucleus in an unstressed open syllable is deleted. The following examples illustrate /≅/ syncope in both adjectives and participles:

(12)

Input	Output	Gloss	Ill-formed forms
ωα| Ζ≅δ–ι:ν	ωα| Ζδι:ν	'ready'	*ωα| Ζ≅δι:ν
φα| η≅μ.–α	φα| ημα	'wise'	*φα| η≅μα
ρα| φ≅δ–α	ρα| φδα	'carrying'	* ρα| φ≅δα
∂α| θ≅λ–α	∂α| θλα	'kind'	*∂α| θ≅λα

It appears from the examples in (12) that after a suffix like /a/ is added to a word such as /ρα| φ≅δ/ 'carrying', the coda /d/ re-syllabifies as onset of /a/, and /≅/ is deleted since it is the nucleus in the open unstressed syllable /f≅/. As reported by Kabrah (2011: 36) "Deletion of unstressed short vowels from open syllables is a common process in Arabic". The schwa /≅/ is deleted in this case since a markedness constraint called *Weak Nucleus (*WN) prohibits weak nuclei like /≅/ to occur in open syllables. As indicated in Btoosh (2006: 201) "weak nuclei cannot stand in open syllables in most Arabic varieties". The schwa /≅/ is a weak nucleus because it is not stressed, and thus cannot occur in the open syllable /f≅/. Furthermore, stress pattern is relevant to the process of /≅/ syncope. The schwa /≅/ is deleted because it occurs in the open syllable /f≅/, but also because such syllable is unstressed. As a matter of fact, the vowel /a/ also occurs in the open syllable /ra/ in /ρα| φ≅δ/. Yet, /a/ is not deleted since the syllable /ρα| / is stressed. Therefore, /a/ resists deletion more than /≅/ because /a/ is stressed and /≅/ is not (Taylor 1994: 13).

One may wonder, however, why deletion and not insertion takes place in this case. A consonant could be inserted to fill the coda position, creating a closed syllable, and thus preventing the deletion of /≅/. Indeed, insertion would be less costly than deletion since it would violate DEP-IO which is lower ranked than the anti-deletion constraint MAX-IO in MTG. /?/ cannot be inserted in this case since it is only inserted in onset position. As indicated in Uffmann (2007: 458) "glottal stops are found epenthetically in onsets of initial or stressed syllables".

A more suitable epenthetic consonant in such position would be an obstruent since coda position is a margin position, and obstruents are the least marked consonants in margin position as indicated in Hall (2011: 958). An obstruent like /b/ could be inserted, yielding [ρα| φ≅β.δα]. Yet, such possibility is excluded by the markedness constraint Morpheme Contiguity (M-CONT) which prohibits "the insertion of elements into a morpheme" (Eddington 2001: 40). Hence, insertion of a coda consonant to render /f≅/ closed is prevented by the markedness constraint M-CONT since the epenthetic consonant would intervene between /≅/ and /d/ which are part of a single morpheme /ρα| φ≅δ/. Given that deletion takes place in MTG and not insertion, the constraint M-CONT dominates MAX-IO and DEP-IO in MTG. Constraint hierarchy for /≅/ deletion in MTG is as follows:

(13) ONS, *WN, M-CONT>> MAX-IO ››DEP-IO.

Tableau 21 indicates why [ρα| φδα] is the optimal output of /ραφ≅δα/:

Tableau 6. Selection of the Optimal Output for /ρα| φ≅δ–α/

ρα| φ≅δ–α	ONS	*WN	M-CONT	MAX	DEP
a. ρα| .φ≅.δα		*!			
☞ b.ρα| φ.δα				*!	
c. ρα.| φ≅β.δα			*!		*
d. ρα| .φ≅δ.α	*!				

It appears from tableau 6 that candidate (b) is the optimal candidate as it incurs the least costly violation of constraints, only violating MAX-IO. (a) is eliminated as it violates the higher ranked *WN by including the weak nucleus /≅/ in the open syllable /f≅/. (c) is rejected since the epenthetic /b/ intervenes between /f/ and /d/ which are part of the same morpheme, and thus violates M-CONT. Finally, (d) is rejected as it contains one onsetless syllable /a/ which is banned by ONS.

In case no suffix is inserted, /≅/ is not deleted since the coda consonant preserves its coda position and /≅/ is part of a closed syllable which does not violate *WN. The following examples include the same forms in examples (12) without suffixation and illustrate the absence of /≅/ syncope:

(14)

Input	Output	Gloss	Ill-formed forms
ωα| Ζ≅δ	ωα| Ζ≅δ	'ready (singular)'	*ωα| Ζδ
φα| η≅μ	φα| η≅μ	'wise (masculine)'	*φα| ημ
ρα| φ≅δ	ρα| φ≅δ	'carrying (masculine)'	*ρα| φδ
∂α| θ≅λ	∂α| θ≅λ	'kind (masculine)'	*∂α| θλ

3.3. Assimilation in MTG

3.3.1. Regressive voice assimilation

Coda-to-onset voice assimilation

The findings of the study demonstrate the existence of regressive voice assimilation, a process which involves a change in the voice feature of one obstruent so that it agrees with a following obstruent, in different cases in MTG. One case of regressive voice assimilation occurs between the coda and onset obstruents of two adjacent syllables. In such a case, the coda obstruent changes its voice feature to agree with the onset obstruent of the following syllable. The following examples exemplify such type of voice assimilation in MTG:

(15)

Input	Output	Gloss	Forms without assimilation
τ≅**δ**□ακ	τ≅**τ**□ακ	'she laughs'	**δ**α□κατ 'she laughed'
□σα**β**τηα	□σα**π**τηα	'I thought she…'	□σα**β** 'he thought'
τ≅**β**κι	τ≅**π**κι	'she cries'	**β**ακι 'cried (participle)'
ωα**γ**φα	ωα**κ**φα	'standing up (feminine)'	ωαγ≅φ 'standing up (masculine)'

As it is demonstrated in the examples in (15), an obstruent like /g/ in /wagfa/ 'standing up' assimilates the voicing feature of the following obstruent whenever /g/ is in coda position and the obstruent to which it assimilates to is in onset position of the following syllable. Voice assimilation between /g/ and /f/ is motivated by the markedness constraint AGREE [Voice] obs (obstruents) which requires adjacent obstruents to agree in voice feature (Lombardi 1995: 2). Assimilation of /g/ to /f/ incurs a violation of the identity constraint IDENT – IO [Voice] which requires the voice feature of input obstruents to be preserved in the output (Kabrah 2011: 25). However, such violation is necessary in order to satisfy AGREE [voice] obs. Satisfaction of AGREE [Voice] obs over that of IDENT [voice] in such cases as [wakfa] indicates that AGREE [Voice] obs dominates IDENT [voice] in MTG.

One may wonder why it is /g/ that assimilates to /f/ in /wagfa/ and not the reverse. Direction of assimilation is regressive in this case because of the positional identity constraint IDENT ONSET [voice] (ID ONS [voice]) (Lombardi 1995: 2) which requires onset obstruents to preserve their input voice feature in the output. Such constraint must dominate IDENT-IO [voice] to render the necessity of preserving the voice feature of the input onset prior to the general requirement of preserving the voice feature of all input obstruents in the output. Constraint hierarchy for coda to onset voice assimilation in MTG is provided below:

(16) AGREE [Voice] obs›› ID ONS [Voice] ›› IDENT-IO [Voice].

Tableau 7 demonstrates why [wakfa] is the optimal output of /wagfa/:

Tableau 7. Selection of the Optimal Output for /ωαγφα/

ωαγφα	AGREE [Voice]obs	ID ONS [Voice]	IDENT-IO [Voice]
a. ωαγφα	*!		
☞ b.ωακφα			*
c. ωαγϖα		*!	

Tableau 7 demonstrates that candidate (b) is the optimal candidate as it is the most harmonious with constraint hierarchy, only violating the lower ranked IDENT-IO [Voice]. Candidate (a) is excluded since it includes the sequence /gf/ in which the two obstruents disagree in their voice feature, thus violating AGREE [Voice] obs. (c) is eliminated as the onset /f/ does not preserve its input voice feature in the output which leads to a violation of ID ONS [Voice].

Prefix-to- stem voice assimilation

According to the results of the study, regressive voice assimilation also occurs when the present tense prefix /t/ is attached to a verb of the first, second, sixth, seventh or tenth binyanim (see McCarthy (1981) for definition of Arabic binyanim) that starts with a voiced obstruent. In such case /t/ assimilates the voice feature of the following voiced obstruent, and is thus realized as a voiced obstruent. The following examples illustrate such case of regressive voice assimilation:

(17)

	Input	Output	Gloss
	τδι:ρ	δδι:ρ	'you do'
	τδαωΣι	δδαωΣι	'you have a shower'
	τγυ:λ	δγυ:λ	'you say'
	τδαωρι	δδαωρι	'you wander'

The examples in (17) indicate that /t/ assimilates the voice feature of /d/ in forms like /τδι:ρ/ 'she does' when 't-' is prefixed to a stem that starts with a voiced obstruent like /d/. AGREE [Voice] obs is the constraint which requires /t/ and /d/ to agree in their voice feature, and thus leads to voice assimilation. The direction of assimilation in this case is not determined by ID ONS [voice] since both /t/ and /d/ syllabify as onset in /τδι:ρ/. Another positional identity constraint is then required to explain why voice assimilation is regressive in this case. This constraint is IDENT STEM ONSET (Laryngeal) (ID STEM ONS) and requires onset stem obstruents to preserve their input voice feature in the output (Dvorak 2010: 12). Given that /d/ is the onset stem obstruent, it has to preserve its voice feature to satisfy ID STEM ONS and /t/ is realized as /d/ in order to satisfy AGREE [Voice] obs. Constraint hierarchy for prefix-to-stem regressive assimilation in MTG is formulated below:

(18) AGREE [Voice] obs>> ID STEM ONS>> IDENT-IO [voice].

Tableau 8 shows why [δδι:ρ] is the optimal output of /τ–δι:ρ/:

Tableau 8. Selection of the Optimal Output for /τδι:ρ/

τδι:ρ	AGREE [voice] obs	ID STEM ONS	IDENT-IO [voice]
a. τδι:ρ	*!		
☞ b. δδι:ρ			*
c. ττι:ρ		*!	

Tableau 8 indicates that candidate (b) is the optimal candidate as it is the most harmonious with constraint hierarchy, violating only the lower ranked IDENT-IO [voice]. (a) is excluded as it violates AGREE [Voice] obs by including the sequence /td/ whose obstruents disagree in voicing. (c) is eliminated since the stem obstruent /d/ does not preserve its input voice feature in (c), thus violating ID STEM ONS.

Obstruent-clusters regressive voice assimilation

The data of the study shows the existence of another case of regressive voice assimilation. When a cluster of obstruents which disagree in voicing occurs either in onset or coda position, regressive voice assimilation takes place. In such a case, the voiced obstruent becomes [-voice] to agree with the adjacent voiceless obstruent as in the following examples:

(19)

Input	Output	Gloss	Forms without assimilation
Γαφ≅**β**τ	Γαφ≅**π**τ	'I was absent'	Γαφ≅**β** 'he was absent'
σα**β**τ	σα**π**τ	'I found'	σα:**β** 'he found'
?ακα**δ**τ	?ακα**τ**τ	'I made sure'	?ακα**δ** 'he made sure'
Γσαλτι	**ξ**σαλτι	'you washed'	**Γ**ασλατ 'she washed'

The examples in (19) show that the voiced obstruent of an obstruent cluster becomes voiceless in order to agree with the following voiceless obstruent in the cluster. The word /Γσαλτι/ 'you washed' which is realized as [ξσαλτι] illustrates such process since /Γ/ is realized as /x/ in order to agree with the voiceless /s/. AGREE [voice] obs is what triggers assimilation in this case. Direction of assimilation cannot be determined by ID ONS [Voice] since both /Γ/ and /s/ are part of the onset. ID STEM ONS does not determine the direction of assimilation in this case neither since both /Γ/ and /s/ are part of the stem /Γsal/ 'wash'. Direction of assimilation is determined in this case by the markedness constraint *Laryngeal (*Lar) (Lombardi 1995: 2) which considers voiced obstruents as marked. Given that /Γ/ is a voiced obstruent, it is marked and it is realized as /x/ which is [-voice] to satisfy *Lar and to agree with /s/ in voicing. Given that /Γ/ is realized as /x/ in /Γsalt/ *Lar dominates IDENT-IO [voice] in MTG. Constraint hierarchy for obstruent-cluster regressive voice assimilation in MTG is provided below:
(20) AGREE [voice] obs>>*Lar>> IDENT-IO [voice].
Tableau 9 explains why [ξσαλτ] is the optimal output of /Γsalt/:

Tableau 9. Selection of the Optimal Output for /Γσαλτ/

Γσαλτ	AGREE [voice] obs	*Lar	IDENT-IO [voice]
a. Γσαλτ	*!	*!	
☞ b.ξσαλτ			*
c. Γζαλτ		**!	

Tableau 9 indicates that candidate (b) is the winning candidate as it is the most harmonious with constraint hierarchy, only violating the lower ranked IDENT-IO [voice]. (a) is eliminated since it violates the higher ranked AGREE [voice] obs by containing the cluster /Γσ/ in which the obstruents disagree in voicing. (a) also violates *Lar by including the voiced /Γ /. (c) is rejected as it incurs two violations of *Lar by including two voiced obstruents, namely /Γ/ and /z/.

Stem to suffix regressive voice assimilation

The results of the study indicate the existence of another case of regressive voice assimilation in MTG. Such case of regressive voice assimilation involves the assimilation of the final obstruent of a stem to the negative suffix /Σ/ which is [-voice]. Such assimilation occurs when the stem-final obstruent is [+voice]. The following examples illustrate stem to suffix regressive voice assimilation in MTG:
(21)

Input	Output	Gloss
μα–φ≅γ∂ο**δ–**Σ	μαφ≅γ∂ο**τ**Σ	'he does not stay'
μαν≅τφαρα**δΖ–**Σ	μαν≅τφαρα**τΣ**Σ	'I do not watch'
μα–τΓι:**δ–**Σ	ματΓι:**τ**Σ	'it does hurt'
μα–θα**δ–**Σ	μαθα**τ**Σ	'it was not enough'

(Note that [ma…Σ] is a transfix or a discontinuous morpheme in MTG)
The examples in (21) demonstrate that in a form like /μα θαδΣ/'it is not enough', stem final /d/ is realized as [-voice] /t/ to agree with the [-voice] suffix /Σ/. AGREE [voice] obs is what triggers voice assimilation in this case. As to the direction of assimilation, it cannot be determined by ID ONS [voice] since /Σ/ is not an onset, but part of a coda together with /d/. ID STEM cannot determine the direction of assimilation neither since it is the suffix /Σ/ which preserves its input voice feature, while stem final /d/ alternates its voicing. The positional identity constraint which determines the direction of assimilation in this case is IDENT suffix [voice] (Al-Harbi

2005: 9) which requires suffix obstruents to preserve their input voice feature in the output. *Lar also contributes in determining the direction of assimilation in this case since /d/ becomes [-voice] which satisfies *Lar. Constraint hierarchy for stem to suffix regressive voice assimilation in MTG is indicated below:

(22) AGREE [voice] obs›› ID suffix [voice] ›› *Lar›› ID STEM [voice] ›› IDENT-IO [voice].

Tableau 10 indicates why [ma qatΣ] is the optimal output of /maqadΣ/:

Tableau 10. Selection of the Optimal Output for /μα θαδΣ/

μα–θαδ–Σ	AGREE [voice]	ID suffix	*Lar	ID STEM ONS	IDENT-IO [voice]
a. μαθαδΣ	*!		*!		
☞ b.μαθατΣ				*	*
c. μαθαδZ		*!	**!		

It appears from tableau 10 that candidate (b) is the optimal candidate as it is the most harmonious with constraint hierarchy, violating only the lower ranked ID STEM and IDENT-IO [voice]. (a) is rejected because it violates the higher ranked AGREE [voice] by including the sequence /dΣ/ in which the obstruents disagree in voicing. Furthermore, (a) violates *Lar since it includes the [+voice] /d/. (c) is eliminated since the suffix /Σ/ does not preserve its input voice feature in (c). Moreover, (c) violates *Lar twice by including two [+voice] obstruents, namely /d/ and /Z/.

3.3.2. Place assimilation in MTG (nasal homorganic assimilation)

The data of the study also indicated the existence of place assimilation in MTG. As it was observed from the data, the nasal /n/ changes its place feature from [CORONAL] to [LABIAL] when it is followed by a labial consonant. The following examples illustrate such type of place assimilation:

(22)

Input	Output	Gloss
κα:**ν** μρι:δ	κα:**μ** μρι:δ	'hewasill'
?α**ν**βιφα:?	?α**μ**βιφα:?	'the prophets'
ωι:**ν**μα	ωι:**μ**μα	'wherever'
μ≅**ν**βα∂δ	μ≅**μ**βα∂δ	'later'

The examples in (22) demonstrate that /n/ in forms like /μ≅νβα∂δ/ 'later' is realized as /m/ in order to be homorganic with the following labial consonant which is /b/. At first glance, the trigger of place assimilation in forms like / μ≅**ν**βα∂δ/ seems to be the markedness constraint AGREE [place]. Yet, if AGREE [place] is what causes place assimilation in this case, then why is it /n/ which assimilates to /b/ and not the reverse? In other terms, it is possible that /b/ assimilates to /n/ yielding [μ≅νδα∂δ]. Hence, some limitation needs to be imposed on AGREE [place] so that place assimilation results in a sequence of labials rather than that of coronals.

One solution could be to substitute AGREE [place] by AGREE [LABIAL]. Such solution would guarantee that /n/ assimilates to /b/ and not the reverse. Yet, AGREE [LABIAL] is still general and needs further limitation. If AGREE [LABIAL] were the trigger of place assimilation in MTG, then it would be active in all cases where a coronal and a labial are adjacent, including cases like [ωακφα] 'standing up' in the examples in (16). In such word [dorsal] /κ/ would have to alter to [LABIAL] /p/ to agree with the following labial /f/ and satisfy AGREE [LABIAL] which is not the case since /k/ does not alter to /p/ in [wakfa]. Hence, AGREE [LABIAL] is not the constraint that motivates nasal homorganic assimilation in MTG forms like /μ≅νβα∂δ/. However, AGREE [LABIAL] is involved in this type of place assimilation as it is what guarantees that the sequence /nb/ alternates to a labial sequence rather than a coronal one.

The constraint which limits place assimilation only to /n/ when it is followed by a labial and excludes cases where /n/ is not included as in /wakfa/ is *n [LABIAL]. *n [LABIAL] was introduced in Kang (1996: 486) and considers the coronal /n/ as being marked before labials, and requires /n/ and the following labial to be homorganic with each other. Given that /n/ alternates to /m/ in /m≅nba∂d/, *n [LABIAL] dominates the faithfulness constraint IDENT-IO [place] which requires input place feature to be preserved in the output in MTG. *n [LABIAL], AGREE [LABIAL] and AGREE [place] are all involved in place assimilation in MTG. Yet, *n [LABIAL] needs to be higher ranked than AGREE [LABIAL] and AGREE [place] to limit nasal assimilation just to the sequence of /n/ followed by a labial. Constraint hierarchy for nasal homorganic assimilation in MTG is provided below:

(23) *n [LABIAL] ›› AGREE [LABIAL] ›› AGREE [place] ›› IDENT-IO [place].

Tableau 11 demonstrates why [μ≅μβα∂δ] is the optimal output of /μ≅νβα∂δ/:

Tableau 11. Selection of the Optimal Output for /μ≅νβα∂δ/

μ≅νβα∂δ	*n [LABIAL]	AGREE [LABIAL]	AGREE [place]	IDENT-IO [place]
a. μ≅νβα∂δ	*!	*!	*!	
☞ b.μ≅μβα∂δ				*
c. μ≅νδα∂δ		*!		*

Tableau 11 indicates that candidate (b) is the optimal candidate as it incurs the least costly violation of constraints, only violating the lower ranked IDENT-IO [place]. (a) is excluded because it violates the higher ranked *n [LABIAL], AGREE [LABIAL] and AGREE [place] by including the sequence /nb/ whose consonants do not agree in the place feature [LABIAL]. (c) is rejected since it violates the higher ranked AGREE [LABIAL] by including the sequence /nd/ whose consonants are not labials but coronals.

3.3.3. Total assimilation in MTG

The findings of the study reveal the existence of total assimilation in MTG. Such type of assimilation affects the /l/ of the definite article /?≅l/ 'the' which assimilates the manner feature of a following coronal as well as its voicing, and thus becomes completely identical to it. The following instances exemplify total assimilation in MTG:

(24)

	Input	Output	Gloss
	?≅**λ**– τοθβα	?≅**τ**– τοθβα	'the hole'
	?≅**λ**– ζωα:θ	?≅**ζ**– ζωα:θ	'the decoration'
	?≅**λ**– δαξλα	?≅**δ**– δαξλα	'the entrance'
	?≅**λ**– σα□α	?≅**σ**– σα□α	'the health'

The examples in (24) indicate that /l/ totally assimilates to a following coronal as in /?≅**λ**– σα□α/ 'health'. Yet, total assimilation does not occur when /l/ is followed by a non-coronal. Hence, /l/ needs to share the same place feature with the sound to which it totally assimilates. The examples in (25) illustrate such case where total assimilation does not apply in MTG:

(25)

Input	Output	Gloss
?≅λ–□αλθα	?≅λ–□αλθα	'the episode'
?≅λ–∂αλαμ	?≅λ–∂αλαμ	'the world'
?≅λ–γαλβ	?≅λ–γαλβ	'the heart'
?≅λ–?ιμα:μ	?≅λ–?ιμα:μ	'the imam'

Total assimilation of /l/ in words like /?≅**λ**– σα□α/ 'the health' which is realized as [?≅**σ**– σα□α] is triggered by the markedness constraint AGREE/ C which requires total identity of adjacent segments. Total assimilation results in the violation of the faithfulness constraint IDENT [F], with [F] being a composite of voice and manner features. Given that /l/ alternates to /s/ in /?≅**λ**– σα□α/, the input voice feature of /l/ [+voice] becomes [-voice] in the output and the input manner feature of /l/ which is a lateral alternates to a stop in the output. The resulting output [?≅**σ**– σα□α] does not preserve νeither the voice nor the manner features of the input, and thus violates IDENT [F]. Thus, total assimilation of /l/ is the result of interaction between AGREE/C and IDENT [F] with AGREE/C being higher ranked than IDENT [F] in MTG. Tableau 12 indicates why [?≅**σ**– σα□α] is the optimal realization of /?≅**λ**– σα□α/:

Tableau 12. Selection of the Optimal Output for /?≅l-σα□α/

?≅l-σα□α	AGREE/C	IDENT-IO [F]
☞ a.?≅s-σα□α		*
b.?≅l-σα□α	*!	

If we use the same constraint hierarchy that is sketched in tableau 12 above to designate the optimal output of forms like /?≅l- □αλθα/ 'the episode', the optimal candidate would be [?≅□- □αλθα] which is not the actual output of /?≅l- □αλθα/. Tableau 13 demonstrates how the constraint hierarchy AGREE/C>>IDENT-IO [F] results in erroneously selecting [?≅□- □αλθα] as the optimal output of /?≅l- □αλθα/:

Tableau 13. Selection of the Optimal Output for /?≅l-□αλθα/

?≅l-□αλθα	AGREE/C	IDENT-IO [F]
☞ a.?≅□-□αλθα		*
b.?≅l-□αλθα	*!	

AGREE/C needs to be limited in order to block total assimilation in cases like / ?≅l-□αλθα/ which is realized as [?≅l-□αλθα]. A specific version of AGREE/C could be developed to allow /l/ to totally assimilate to coronals only. λ [CORONAL] AGREE/C could be such version of AGREE/C. λ [CORONAL] AGREE/C could be read as follows:

(26) λ [CORONAL] AGREE/C: /l/ becomes totally identical to a following coronal.

The selection of [?≅s-σα□α] as the optimal output of /?≅l-σα□α/ is re-explained using λ [CORONAL] AGREE/C in tableau 14:

Tableau 14. Selection of the Optimal Output for /?≅l- σα□α /

?≅l-σα□α	λ [CORONAL] AGREE/C	IDENT-IO [F]
☞ a.?≅s- σα□α		*
b.?≅l- σα□α	*!	

Absence of total assimilation in cases like /?≅l-□αλθα/ can also be explained using λ [CORONAL] AGREE/C. Given that /□/ is not a coronal, /l/ does not have to totally assimilate to it and the output [?≅l-□αλθα] does not violate λ [CORONAL] AGREE/C since /□/ is not a coronal. Tableau 15 shows why [?≅l-□αλθα] is the optimal output of /?≅l-□αλθα/:

Tableau 15. Selection of the Optimal Output for /?≅l-□αλθα/

?≅l- □αλθα	l [CORONAL] AGREE/C	IDENT-IO [F]
a.?≅□- □αλθα		*
☞ b.?≅l- □αλθα		

Another explanation for total assimilation of /λ/ in MTG could be inspired from Masacro's (2007) account of total assimilation of the definite article /?αλ/ 'the' in standard Arabic (SA). It could be assumed that in MTG /?≅l/ is a morpheme that has a set of allomorphs. Such allomorphs would include /?≅l/, /?≅r/, /?≅n/, /?≅t/, /?≅d/, /?≅t/, /?≅d/, /?≅s/, /?≅z/, /?≅s/, /?≅Σ, ?≅Z/. Such allomorphs would be listed in the input of every form that undergoes total assimilation. Hence, /?≅l- σα□α/ would have the input /?≅{l, r, n, t, d, t, d, s, z, s, Σ, Z}- σα□α/. Each output candidate for /?≅l- σα□α/ would include one of these allomorphs. All output candidates would satisfy IDENT [F], yet, the optimal candidate would be the one that satisfies AGREE/C. Tableau 16 indicates how Masacro's method explains why [?≅σ– σα□α] is the optimal output /?≅l- σα□α/:

Tableau 16. Selection of the Optimal Output for /?≅l- σα□α/ applying Masacro's method

?≅l {λ, ρ, ν, τ, δ, τ, δ, σ, ζ, σ, Σ, Z} σα□α	AGREE/C	IDENT [F]
α. ?≅λ– σα□α	*!	
β. ?≅ρ– σα□α	*!	
χ. ?≅ν– σα□α	*!	
δ. ?≅τ– σα□α	*!	
ε. ?≅δ– σα□α	*!	
φ. ?≅τ– σα□α	*!	
g. ?≅d- σα□α	*!	
h. ?≅σ– σα□α	*!	
i. ?≅ζ– σα□α	*!	
☞ j. ?≅σ– σα□α		
k. ?≅Σ– σα□α	*!	
l. ?≅Z– σα□α	*!	

Masacro's method can also be applied to explain the absence of total assimilation in cases like /?≅l- □αλθα/. The optimal candidate [?≅l- □αλθα] is the one that satisfies the faithfulness constraint PRIORITY which requires the optimal form to include the unmarked allomorph of /?≅l/ (Masacro 2007: 725). According to Masacro (ibid: 725) "the allomorphs of a morpheme are ordered from the unmarked to the marked. The optimal output is the unmarked allomorph". Mascaro (ibid) considers that /?al/ is the unmarked allomorph for SA /?al/.

Hence, in MTG /?≅l/ would be the unmarked allomorph of /?≅l/, while other allomorphs like /?≅Σ/ would be marked and would, thus, violate PRIORITY. Tableau 17 indicates how Masacro's method would explain why [?≅l- □αλθα] is the optimal output for /?≅l- □αλθα/:

Tableau 17. Selection of the Optimal Output for /?≅l-φυταφ/ applying Masacro's method

?≅l {λ, ρ, ν, τ, δ, τ̲, δ̲, σ, ζ, σ̲, Σ, Z} □αλθα	PRIORITY	AGREE/C	IDENT [F]
☞ a.?≅λ– □αλθα		*!	
b. ?≅ρ– □αλθα	*!	*!	
c. ?≅ν– □αλθα	*!	*!	
d. ?≅τ– □αλθα	*!	*!	
e. ?≅δ– □αλθα	*!	*!	
f. ?≅τ̲– □αλθα	*!	*!	
g. ?≅d̲- □αλθα	*!	*!	
h. ?≅σ– □αλθα	*!	*!	
i.?≅ζ– □αλθα	*!	*!	
j. ?≅σ̲– □αλθα	*!	*!	
k. ?≅Σ– □αλθα	*!	*!	
l. ?≅Z– □αλθα	*!	*!	

Given that all candidates violate AGREE/C, PRIORITY is the constraint which determines which candidate is optimal. (a) emerges as optimal as it is the only candidate which satisfies PRIORITY by including the unmarked allomorph /?≅l/.

Masacro's method succeeds in explaining why total assimilation occurs in cases like [?≅s̲- σ̲α□α], but is blocked in other cases like [?≅λ– □αλθα]. However, it seems that the earlier method which was adopted in tableaus 14 and 15 is more economical and less complex than Masacro's method. Furthermore, in the method that was adopted in tableaus 14 and 15, IDENT [F] helps determine the optimal candidate in /?≅λ– □αλθα/ even though it is lower ranked in MTG. Yet, in Masacro's method IDENT [F] is inactive both when total assimilation occurs and when it is blocked.

3.4. Major class change in MTG

The results of the study indicate the existence of another type of phonological process in MTG which is major class change. Such process occurs when the plural suffix '-u' and second person singular feminine suffix '-i' are added to a verb which ends in a non-high vowel. In such case, /u/ and /i/ are changed to the glides /w/ and /j/ respectively in MTG. The following examples exemplify major class change in MTG:

(27) Plural suffix /u/

Input	Output	Gloss
□φα–υ	□φαω	'they resurrected'
φ≅τωαδα–υ	φ≅τωαδαω	'they purify their bodies for prayer'
φ≅βδα–υ	φ≅βδαω	'they start'
τ≅τλαθα–υ	τ≅τλαθαω	'they meet'

(28) The suffix /i/

Input	Output	Gloss
τ≅πθα–ι	τ≅πθαφ	'you stay'
τ≅τ∂αΣα–ι	τ≅πθαφ	'you have dinner'
?αρδΖα–ι	?αρδΖαφ	'wait'
τ≅τμαΣα–ι	τ≅τμαΣαφ	'you walk'

The examples in (27) and (27) indicate that when the high vowel suffixes /u/ and /i/ are added to a vowel final verb, /u/ and /i/ alternate to /w/ and /j/ in verbs like /□φα–υ/ 'they resurrected' and /τ≅πθα–ι/ 'you stay' which are respectively realized as [□φαω] and [τ≅πθαφ]. /u/ and /i/ change to /w/ and /j/ because the syllables /i/ and /u/ in /□φα−υ/ and /τ≅πθα−ι/ are onsetless, and thus violate ONS. Furthermore, adding /u/ and /i/ to /□φα/ and /τ≅πθα/ results in vowel hiatus which violates NO HIATUS.

Other repair strategies may be applied in order to avoid vowel hiatus and satisfy ONS. The vowel /a/ can be deleted, for instance, yielding the outputs [□φυ] and [τ≅πθι]. Yet, such possibility is excluded as deletion would result in the violation of MAX-IO which is high ranked in MTG and dominates DEP-IO.

Given that DEP-IO is lower ranked in MTG, insertion of a consonant to break vowel hiatus and syllabify as onset of onsetless /u/ and /i/ could be another solution. A glide could be inserted between /a/ and /u/ or /i/ in /□φα−υ/ and /τ≅πθα−ι/, yielding [□φα.ωυ] and [τ≅π.θα.φι]. However, glides are inserted only when the first vowel of the hiatus is high (Uffmann 2007: 465). In the case of [□φα.ωυ] and [τ≅π.θα.φι] the first vowel of the hiatus is /a/ which is [-high].

Another consonant like the glottal stop /?/ could be inserted between /a/ and /u/ or /i/, yielding /□φα?υ/ and /τ≅π.θα.?ι/. Given that in MTG major class change rather than / ?/ epenthesis takes place in order to resolve vowel hiatus in each of /□φα−υ/ and /τ≅πθα−ι/, another faithfulness constraint must be lower ranked than DEP-IO in MTG. Violation of such faithfulness constraint must be less costly than that of DEP-IO in MTG. Such constraint is IDENT [SYLLABIC] and is violated by the optimal [□φαω] and [τ≅πθαφ] since input /υ/ and /ι/ which are [+SYLLABIC] change to
[-SYLLABIC] in the output. Constraint hierarchy for major class change in MTG is as follows:
(29) ONS, NO HIATUS >>MAX-IO>>DEP-IO>>IDENT [SYLLABIC].
Tableaus 18 and 19 indicate why [□φαω] and [τ≅πθαφ] are the optimal outputs of /□φα−υ/ and /τ≅πθα−ι/ respectively:

Tableau 18. Selection of the Optimal Output for /□φα−υ/

□φα−υ	ONS	NO HIATUS	MAX-IO	DEP-IO	IDENT [SYLLABIC]
a. □φα.υ	*!	*!			
b. □φυ			*!		
c. □φα.ωυ				*!	
d. □φα.?υ				*!	
☞ e.□φαω					*

Tableau 19. The Selection of the Optimal Output for /τ≅πθα−ι/

τ≅πθα−ι	ONS	HIATUS	MAX-IO	DEP-IO	IDENT [SYLLABIC]
a. τ≅π.θα.ι	*!	*!			
b. τ≅π.θι			*!		
c. τ≅π.θα.φι				*!	
d. τ≅π.θα.?ι				*!	
☞ e.τ≅π.θα.φ					*

In case /u/ and /i/ are added to verbs that end in a consonant, there is no major class change since no vowel hiatus exists. Furthermore, the consonant of the stem-verb re-syllabifies as the onset of the new onsetless syllable that is created through the suffixation of /u/ and /i/. The following examples illustrate such case where no major class change occurs:

(30) The suffix /u/

Input	**Output**	**Gloss**
φ≅ργσ–υ	φ≅ργσυ	'they dance'
δα:ρ–υ	δα:ρυ	'they did'
φΓασλ–υ	φΓασλυ	'they wash'
φβα:ν–υ	φβα:νυ	'they appear'

(31) The suffix /i/

Input	**Output**	**Gloss**
τ≅τφαρδΖ–ι	τ≅τφαρδΖι	'you watch'
καμλ–ι	καμλι	'finish'
δαωΣ–ι	δαωΣι	'shower'
φαωτ–ι	φαωτι	'spend'

Conclusion

It appears from the findings of the study that MTG possesses four types of phonological processes, namely epenthesis, syncope, assimilation and major class change. Furthermore, each type of phonological processes was regarded as being the outcome of the domination of certain types of markedness constraints over certain types of faithfulness constraints. However, such processes are not the only types of processes that exist in MTG. Other types of processes do certainly exist in MTG. Hence, further studies could identify those other types and apply OT in accounting for them. Moreover, further studies could also attempt to indentify phonological processes in other dialects of Algerian Arabic and apply OT in accounting for them. In fact, studies of the phonological processes of other dialects of Algerian Arabic would help us discover whether OT account of phonological processes in those dialects is the same as the one in MTG or it is different.

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