A Non-templatic Approach to the Formation of the Past Participle in Moroccan Arabic[1]

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This paper attempts to provide a non-templatic analysis of the past participle formation in Moroccan Arabic, using the constraint-based framework of Optimality Theory. The main claim of this paper is that the past participle morpheme is represented by the discontinuous circumfix [m-u], such that the [m] is prefixed and the [u] is suffixed to a base root or a base word. Such an assumption is crucial to paving the way for a non-templatic analysis of PPs, whereby the latter's templatic shape is argued to be emergent rather than being base-generated. In this context, it is suggested that the infixal position of the [u], in the PPs where it surfaces, follows from the interaction between different alignment constraints with conflicting alignment demands. In addition, it is argued that the non-realization of the [u] in certain PP classes can be the result of phonological well-formedness or output-output correspondence demands.

Keywords: *past participle; templatic morphology; word formation; morphophonology; infixation; Moroccan Arabic; Optimality Theory*

1. Introduction

The present paper surveys the formation of the past participle (PP) in Moroccan Arabic (MA). In particular, we show that the templatic properties of the PP form in MA can be accounted for without referring to fixed and base-generated templates. Rather, we demonstrate that the PP form can acquire its distinctive templatic shape through the interaction of independently-needed phonological and morphological constraints.

There are five distinct PP classes in MA. The difference between one class and the other stems from the nature of the base forms from which they are derived. Some PPs are derived from purely consonantal bases; others, however, are derived from bases that contain vocalic elements or are morphologically complex. However, our goal is to propose an analysis that could uniformly account for all the observed PP classes despite the noticeable discrepancies that exist between them.

The gist of our analysis rests on the assumptions that the PP morpheme is the discontinuous affix [m-u] and that the prosodic structure of the PP form is emergent. To support these assumptions, we show how alignment demands, rather than templatic demands, can be responsible for the infixal position of the vocalic part of the PP affix. We also show that the non-realization of the latter in some PPs can be straightforwardly attributed to phonological well-formedness demands, namely identity avoidance, or output-output correspondence demands. Furthermore, we account for glide formation and geminate breaking in those PPs derived from middle-weak roots and final-geminated roots, respectively. We illustrate that glide formation is adopted to avoid structures with minor syllables while geminate breaking is enforced to ensure the right edges of the prosodic word and the root coincide.

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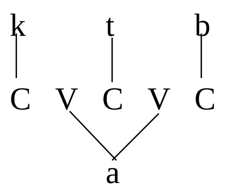
The structure of this paper is laid out as follows. Section 2 offers a succinct overview of the development of templatic morphology. Section 3 describes and compares the different PP classes attested in MA. Section 4 presents a terse overview of Standard Optimality Theory. Section 5 reviews the previous accounts of PP formation. Section 6 highlights the basic assumptions underlying our analysis. Section 7 offers a unitary non-templatic account of PP formation, couched within the framework of OT. The latter section consists of five subsections, each focusing on one of the PP classes. Section 8 sums up the results of this paper.

2. Templatic morphology: An overview

Semitic languages have always been defiant to the linear ideal of word formation that came to characterize Indo-European languages as well as other language families. Particularly, in Semitic, words are largely formed via intercalating vocalic elements between consonantal root elements. In many cases, the inserted vowels specify the grammatical category of the grammatically underspecified consonantal roots. For instance, in Hebrew, the vocalic sequence [a-a] signifies the perfective active form (e.g. *gadal* 'he grew') while the vocalic sequence [u-a] yields the perfective passive form (e.g. *gudal* 'he was raised'). Arabic exhibits similar verbal morphology. For example, the perfective active form in Arabic is also denoted by the vocalic sequence [a-a] (e.g. *katab* 'he wrote') whereas the perfective passive form is represented by the vocalic sequence [u-i] (e.g. *kutib* 'it was written'). What has been of significance to morphological theory is the discontinuous linearization of the vowels in relation to the root elements. Also, in Semitic, specific sequences of consonants and vowels tend to correspond to specific grammatical categories. For instance, the sequence CVCVC corresponds to the perfective simple form of verbs whereas the sequence CVCCVC represents the perfective causative form of verbs (McCarthy, 1971, 1981)

This characterization of Semitic morphology has led to the development of the theory of nonconcatenative morphology, which represents an approach to account for all the possibilities of ordering vowels and consonants to build words in Semitic languages. This was first materialized in the form of a theory of root-and-pattern in the works of McCarthy (1979, 1981). The theory of root-and-pattern makes use of CV-prosodic templates whose role is to determine the position of the consonants and the vowels that make up the consonantal roots and the vocalic melodies, respectively. The role of the CV template is exemplified for the Arabic verb *katab 'he wrote'* as follows:

(1) The root-and-pattern theory of Semitic morphology (McCarthy, 1979, 1981)



In this way, the CV-prosodic template prespecifies the order of the consonants and vowels involved in the derivation of the verb form *katab*. This means that the nonconcatenative nature of Arabic morphology follows from templates like these. The theory also assumes that these templates are morphemes that are supplied by the lexicon.

Later on, the nature of the CV template was called into question. It has been shown that the predictive extent of CV templates is unrestricted. Also, they happen to fall short of explanatory power. In other words, the theory cannot determine which templates are possible and which ones are not. For these reasons, the theory of prosodic morphology has taken over (McCarthy and Prince, 1986, 1990a). The center assumption of prosodic morphology is that templates should be expressed in terms of prosodic units. These units are the ones that make up the prosodic hierarchy shown in (2):

(2) Prosodic hierarchy in prosodic morphology (McCarthy and Prince, 1986; Inkelas, 1989; Nespor and Vogel 1986; Selkirk, 1984)

Prosodic word (PrWd)
|
Foot (Ft)
|
Syllable (σ)
|
Mora (μ)

One advantage of the theory of prosodic morphology lies in its ability to restrict the number of possible templates. Another advantage is the fact that templates are expressed in terms of units that are motivated by phonological theory. Still, like the root-and-pattern theory, the theory of prosodic morphology also assumes templates to be base-generated.

With the advent of Optimality Theory (OT; Prince and Smolensky, 1993), templates had to be encoded in the form of ranked and violable constraints. This was mainly because OT has inherited the assumption that templates are underlying morphological entities, which was at the center of the theory of prosodic morphology. However, it was not long before it was discovered that templatic constraints had to be dispensed with due to their typological limitations (McCarthy & prince, 1999). The problem was that templatic constraints were found to predict grammars that do not exist. For instance, it was shown that the use of templatic constraints may predict a case where the prosodic shape of the reduplicant is imposed on the base, which is typologically unattested. Consequently, this has led to the emergence of an OT version of the theory of nonconcatenative morphology dubbed the Generalized Template Theory (GTT; McCarthy and Prince, 1994; 1999). This theory adheres to the idea that templates should follow from the interaction of constraints on phonological and morphological well-formedness and whose existence is independently justified.

Along the lines of GTT, we will assume that templates have no morphological status whatsoever (Ussishkin, 1999, 2000; Kramer, 2007; Tucker, 2010; Noamane, 2018c-d). Instead, we will entertain the idea that templates are emergent structures that follow from independently motivated morphological and phonological demands. Under this view, templatic shapes are not regarded as primitive morphological constituents that are specific to Semitic morphology, but only as structures that are constructed and shaped to satisfy the phonological and morphological well-formedness of the languages in question.

3. The past participle in Moroccan Arabic: data description

The past participle is a form used to express completed actions. It can also be used as an adjective to modify nouns. Past participles in MA can be classified into five distinct classes. These classes happen to differ from each other in terms of the nature of the base forms from which they are derived, which then reflects on the shape of their constituent forms, yielding different PP shapes. First, there are those PP forms that are straightforwardly derived from tri-consonantal bases through what appears to be the prefixation of the [m] and the infixation of the [u]. These PPs uniformly take the shape *məC.CuC*, where C stands for any consonant. Consider the examples below:

Class I: PPs derived from triliteral roots

Verb	*PP*	
ktəb	*məktub*	'write'
ḍrəb	*məḍrub*	*'hit'*
ʃrəb	*məʃrub*	'drink'
ʕrəḍ	*məʕruḍ*	'invite'
ħsəd	*məħsud*	'envy'
ʕṭəb	*məʕṭub*	'injure'

Second, there also exist PPs that are derived from base forms that end in a vowel. Such PPs tend to occur with final open syllables and without the vowel [u] that normally emerges with the PPs derived from tri-consonantal bases, taking the final shape *məC.CV*, where V is a full vowel. Examples from this class include the following items:

Class II: PPs derived from final weak roots

Verb	*PP*	
kri	*məkri*	'rent'
ʃri	*məʃri*	'buy'
kwi	*məkwi*	'weld'
ɣli	*məɣli*	'boil'
kmi	*məkmi*	'smoke'

Third, forming a class of their own are those PPs derived from base forms with medial vowels. What is unique about these PPs is the fact that the vowels of their bases turn into glides. More specifically, the rounded high vowel [u] and the unrounded high vowel [i], whose quality happens to be idiosyncratic, both turn to the glide [j]. What is also interesting is the occurrence of the infixed [u] with these forms as well. The PPs of this class share the following shape: *məC.juC.*

Class III: PPs derived from middle weak roots

Verb	*PP*	
biʕ	*məbjuʕ*	'buy'
dir	*mədjur*	'do'
ʃuf	*məʃjuf*	'see'
luħ	*məljuħ*	'throw'

Fourth, falling under one class are the PPs derived from final geminated base forms. Characterizing this class of PPs is the fact that their final consonant and medial consonant are identical. Other than that, this class does not seem to differ much from the first class, featuring PPs derived from tri-consonantal bases, except that it does. The interesting fact about this class is the tendency to break up their geminates, which tend to be immune to breaking elsewhere. This issue is further addressed in section 6.5, where we deal with the effect of the PP formation on geminate integrity. Members of this class have in common the following shape: *məC.C_iuC_i*.

Class IV: PPs derived from final geminated verbs

Verb	*PP*	
sədd	*məsdud*	'close'
ħəll	*məħlul*	'open'
ʕəḍḍ	*məʕḍuḍ*	'bite'
ʃəqq	*məʃquq*	'crack'
ʃədd	*məʃdud*	'catch'
ħədd	*məħdud*	'limit'

Finally, there is a class of PPs whose members are derived from morphologically complex bases, mainly causatives, reduplicated verb stems and borrowed verbs. The [u] does not show up in these PPs as well. Besides, the phonological and morphological make-up of their base forms is totally preserved. As a result, the PP formation in the case of this class boils down to the prefixation of the [m-] as shown by the following examples:

Class V: PPs derived from morphologically complex forms

Causative bases	*PP*	
kəttəb	*mkəttəb*	'write'
dəwwəz	*mdəwwez*	'pass'
wəlləf	*mwəlləf*	'accustomed'
ʕərri	*mʕərri*	'naked'
rəqqəq	*mrəqqəq*	'slim'

Reduplicated bases	*PP*	
ʒəṛʒəṛ	*mʒəṛʒəṛ*	'drag'
ʃəṛʃəṛ	*mʃəṛʃəṛ*	'splash'
fərtət	*mfərtət*	'sprinkle'
kərkəb	*mkərkəb*	*'roll'*

Borrowed bases	*PP*	
ṭəṛʒəm	*mṭəṛʒəm*	'translate'
sərbi	*msərbi*	'serve'
gərfəṭ	*mgərfəṭ*	'tie'
ʃəjjək	*mʃəjjək*	'style'

Later, we will devote a section to every PP class described above. The purpose of each section will be to account for the intricacies characterizing each class. The subsequent section, however, will be devoted to describing the fundamental tenets of classic OT.

4. The OT framework

OT (Prince and Smolensky, 1993; McCarthy and Prince, 1993) embodies a constrained-based approach to modelling and formalizing human language. Constraints in OT are universal and violable; they interact with each other to produce the most optimal candidate. A candidate is optimal if and only if it incurs the least costly violations of the relevant constraint set, taking into account the latter's specific ranking. Two other principles underlie the OT apparatus: inclusiveness and parallelism. Inclusiveness states that the generation of candidates is governed by general consideration of structural well-formedness. Parallelism represents a version of OT where constraints are evaluated in a parallel fashion.

The OT machinery is composed of three major components: the constraint set (CON), the generator (GEN) and the evaluator (EVAL). The constraint set consists of three major families of universal constraints. These include: markedness constraints, faithfulness constraints and alignment constraints. Markedness constraints disfavor marked structure and favor their unmarked counterparts. Faithfulness constraints, however, enforces the maintenance of similarity between the output and its input. GEN is able to produce an unlimited number of candidates, which compete with each other to be chosen as the optimal form. EVAL is the component responsible for ranking the constraints and evaluating the candidates for their optimality. For the sake of visualization, OT utilizes a formal device termed a tableau:

(3) The OT table

/Input/	Constraint A	Constraint B
a. ☞ Candidate (a)		*
b. Candidate (b)	*!	

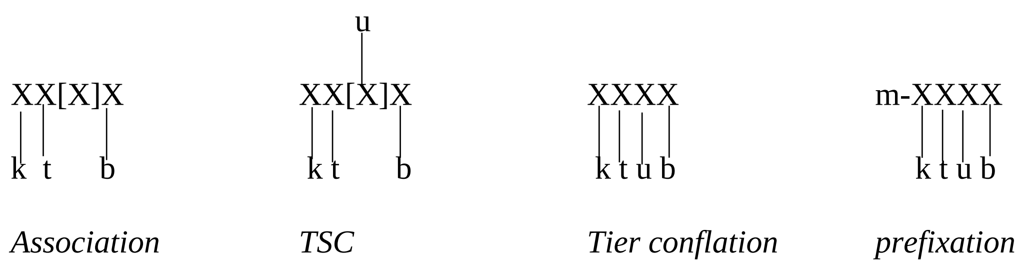
In this table, the input is placed at the top of the leftmost column. Under this posited input, all the possible candidate analyses are listed vertically in a random fashion. Constraints, on the other hand, are horizontally ranked from left to right according to their importance and prominence, indicating their hierarchical organization from the highest to the lowest. A solid line between two constraints indicates that the ranking between them is crucial, while a dotted-line shows that no ranking is established. A given constraint violation incurred by a given candidate is signaled by an asterisk (*) in the relevant cell. An empty cell indicates that the constraint in question has been satisfied by the corresponding candidate. A fatal violation of a given constraint is marked by an exclamation mark next to the violation mark (*!). The candidate which fares better on the constraint hierarchy, hence admitted as being optimal, is signaled by a pointing finger (☞).

5. Previous analyses

Earlier literature dealing with PPs in MA has been dominated by templatic analyses, whereby the formation of the PP form is argued to follow from mapping melodic constituents that carry lexical meaning to an underlying morphological template whose shape has been lexically marked to correspond to the PP form. The basic body of literature includes the works of Boudlal (1993; 1996; 2001). Each of these accounts has been inspired by new developments in the theory of nonconcatenative morphology.

Boudlal (1993) suggests an analysis that requires an underlying template consisting of four underspecified skeletal positions (i.e., XXXX). In addition, this analysis posits that the formation of the PP form involves the prefixation of [m] to the designated template. The analysis also calls for the epenthesis of the vowel [u] in order to comply with the Template Satisfaction Condition (TSC; McCarthy and Prince, 1986), which demands all the template positions to be filled in. The epenthetic position of the /u/ is then accounted for by marking the prefinal position of the template (i.e., XX[X]X). This can be illustrated as follows:

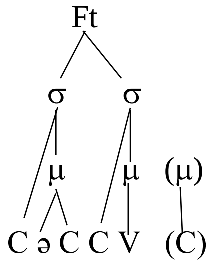
(4)



In the case of PPs derived from final weak base forms, the analysis also makes use of an assimilation rule that assimilates the epenthetic [u] to the vowel of the base to become [i] and a deletion rule that deletes the assimilated [i].

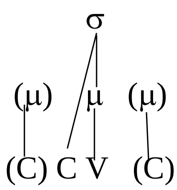
Using the framework of prosodic morphology, Boudlal (1996) provides an updated analysis of the PP formation. In this analysis, the templatic shape of the PP form is defined in prosodic terms. In particular, it is suggested that the PP is an iambic foot consisting of two light syllables (i.e. LL iamb).

(5) The PP as an iamb



This is not very different from Boudlal (1993) since both assume the templates are morphological and their satisfaction is responsible from the epenthesis of the vowel [u]. Such an analysis assumes the extrasyllabicity of word final codas and initial syllabic consonants:

(6) Extrasyllabicity



The latter assumption has been later criticized and dispensed with in Boudlal (2001), where a more elaborate templatic analysis was developed within the OT framework. Boudlal (2001) posits that the PP template is actually an iamb foot that consists of a light syllable followed by a heavy one (i.e. LH). Therefore, the author believes that the constraint representing this type of iamb foot has to dominate the constraint representing the LL iamb. Also, the analysis suggests that both of these constraints will have to dominate DEP-u in order to trigger the epenthesis of the vowel /u/, which can then satisfy the templatic requirement of the constraint LH. The default epenthetic vowel in MA is schwa, meaning that DEP-ə ranked below DEP-u in order for it to apply elsewhere. The interaction between these constraints is illustrated by the following tableau (Boudlal, 2001:226):

(7) LH >> LL >> DEP-u >> DEP-ə

/m-ktb/	LH	LL	DEP-u	DEP-ə
☞a. mək.tub		*	*	*
b. mək.tu.bu	*!		**	*
c. mək.təb	*!			**

This table demonstrates that any candidate that does comply with the stipulation of the high-ranking template-specific constraint LH will be excluded from the competition. The candidate in (7a) emerges as the winner since it clearly respects the stipulation of LH.

Steering away from the above-reviewed templatic approaches, the current work will attempt to offer a non-templatic analysis to the formation of PPs. This means that, in our analysis, no template-specific constraints will be used. Therefore, our analysis stands out in two ways. First, it is able to support the claim that the PP morpheme is underlyingly represented by the discontinuous affix [m-u], regardless of whether this affix is realized in its entirety or not. The second merit consists in advancing a unitary non-templatic approach to the various PP classes attested in MA, irrespective of the differences between the morphological and phonological nature of their base forms.

6. Basic assumptions

The main purpose of this section is to present internal evidence for the morphological status of the [u] and the emergent nature of the PP template. One central idea for our analysis is that the PP affix is represented by the discontinuous morpheme [m-u]. In other words, it is argued that the [u], which characterizes only a subset of the PP classes, is in fact part of the underlying structure of the PP morpheme. Such a claim is substantiated by two insightful points. First, it is worth mentioning that the vowel [u] characterizing some of the PPs establishes morphological contrast between a large set of nouns and their PP counterparts, working as a meaningful morphemic entity. To illustrate this point, some examples are listed below:

(8)

PP	*Noun*	
məktub	*məktəb*	'write'
məlʕub	*məlʕəb*	'play'
məḍrub	*məḍrəb*	'hit'
mədfun	*mədfen*	'bury'
mərbuṭ	*mərbəṭ*	'tie'
məxzun	*məxzən*	'store'
məʃrub	*məʃreb*	'drink'
mədluk	*mədlək*	'flat'
məlbus	*məlbəs*	'wear'

Second, we believe that rooting for the morphological status of the vowel [u] is essential for the development of a non-templatic analysis, whereby the templatic shape of the PP forms is taken to be derived through the interaction of independently needed constraints, rather than being base-generated. Claiming otherwise would mean that templates would have to be base-generated, which results into many complications related to crosslinguistic overprediction.

Alternatively, one could attribute the morphological contrast between the nouns and PPs in (8) to their templates (see Boudlal, 1993; 1996; 2001). Under this view, the nature of the epenthetic vowel would have to follow from the templatic properties of each form (i.e. LH vs. LL). However, the morphemic status of the [u] is further supported by the fact that no nouns of the shape [məC.C_iəC_i] are found in MA - where the last two consonants can be the result of geminate breaking (see Noamane (2018a) for more on geminate breaking and its morphological and phonological implications). If both the vowel [u] and the schwa were equally epenthetic vowels that are used to satisfy some templatic requirements, then nouns like the ones in (9a) should also be possible. Said differently, for templatic reasons, one would also expect schwa to break the geminates in the potential, yet nonexistent, nominals in (9a), in the same way the full vowel [u] breaks the geminates in the PPs in (9b). Nonetheless, the vowel [u] is exclusively entitled to splitting geminates, suggesting a difference between schwa and the full vowel [u], with the difference being that the [u] is morphological and underlying and schwa is merely epenthetic.

(9)

a.	*sədd*	**məs.dəd*
	ħəll	**məħ.ləl*
	ʃədd	**məʃ.dəd*
	ʕəḍḍ	**məʕ.ḍəḍ*
	ʃəqq	**məʃ.qəq*
b.	*sədd*	*məs.dud*
	ħəll	*məħ.lul*
	ʃədd	*məʃ.dud*
	ʕəḍḍ	*məʕ.ḍuḍ*
	ʃəqq	*məʃ.quq*

Therefore, the fact that no such lexical items are attested could be understood as an indication to the inadequacy of templatic effects in predicting the nature of epenthetic vowels in MA. Accordingly, it is more convincing to treat the [u] as part of the underlying representation of the PP morpheme. This justifies the overall purpose of this work since we believe that if we assume that the [u] is prosodic (or epenthetic), then we will have to use template specific constraints that would need to trigger its epenthesis, forcing us to use constraints that have been criticized for their overpredictive power and typological limitations.

7. A constraint-based non-templatic Analysis

In this section, we construct a non-templatic analysis of the PP form in MA, using independently-needed constraints. We begin in section 7.1 with presenting the core of the analysis, showing that the infixation of the vocalic part of the PP morpheme is the result of conflicting alignment demands. In section 7.2, we account for the non-realization of the vowel [u] in the PPs derived from final-weak roots. Then, in section 7.3, we explain the process of glide formation which characterizes the PPs derived from middle-weak roots. In section 7.4, we describe the effect of the PP formation on the integrity of geminate consonants in final-geminated roots. Section 7.5 justifies the non-realization of the vowel [u] in those PPs derived from morphologically complex bases.

7.1 *The core of the analysis*

The first class to consider in our analysis consists of PPs that are derived from tri-consonantal roots. This class of PPs will be used to illustrate the essence of our analysis. Examples are reproduced below for convenience:

(10)

Verb	*PP*	
ktəb	*məktub*	'write'
ḍrəb	*məḍrub*	'hit'
ʃrəb	*məʃrub*	'drink'
ʕrəḍ	*məʕruḍ*	'invite'
ħsəd	*məħsud*	'envy'
ʕṭəb	*məʕṭub*	'injure'

The first aspect of the PP formation that we will deal with concerns the distribution of the PP morpheme and the infixal position of the vowel [u] in the PPs where it surfaces. In doing so, we will make the claim that the [m] and the [u] target different edges of the roots to which they are attached, such that the [m] is prefixed and the [u] is suffixed.

To put this in context, it should be pointed out that, within OT, the theory of alignment makes the claim that morphemes have no intrinsic affixal status. Instead, the theory argues that that their locations, relative to the constituents they attach to, are defined by a category of constraints dubbed anchor or alignment constraints. Anchor constraints are one of Prince and Smolensky's (1993/2004) earliest contributions in OT. Building on the idea of anchoring, McCarthy and Prince (1993b) proposed a general family of constraints to capture the various constituent-edge effects in both morphology and phonology. Linguistic theory provides the grammar with a wide range of prosodic (PCat) and grammatical (GCat) categories. Thus, "a GA requirement demands that a designated edge of each prosodic or morphological constituent of type Cat1 coincide with a designated edge of some other prosodic or morphological constituent Cat2." (See McCarthy and Prince, 1993b:2) The general schema of this constraint family comes as follows:

(11)

Generalized Alignment: (McCarthy and Prince, 1993b)
Align (Cat1, Edge1, Cat2, Edge2) =def
$\forall$ Cat1 $\exists$ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide
Where
Cat1, Cat2 $\in$ PCat $\cup$ GCat
Edge1, Edge2 $\in$ {Right, Left}

Though alignment constraints are equally violated, their violation should be kept minimal. The designated affix should be as close as possible to the designated edge. Therefore, alignment constraints need to be gradiently assessed for violations, whereby the degree or multiplicity of violation is measured in terms of distance from the designated edge. The formal constraint which represents this general constraint family is ALIGN, which can be then specified for the targeted edges and the relevant categories.

One of the major functions of ALIGN constraints is the formation of new words by affixing morphemes to the left or the right of a stem. GA conceives of affixation as an edge-oriented phenomenon. Under this model, the prefixhood or suffixhood of morphemes is dictated by alignment constraints. In this context, prefixation and suffixation occur when ALIGN constraints refer to the left edge and the right edge, respectively.

Under this conception, the constraint that is responsible for the morphological distribution of the PP morpheme in our OT analysis is the following alignment constraint:

(12) **ALIGN (m, L, u, R)**
The right edge of [m-] is aligned to the left edge of the stem, the left edge of [-u] is aligned to the right edge to the stem.

This constraint characterizes the PP morpheme as a circumfix, in that the [m] of the affix is aligned to the left edge of the root while the [u] is aligned to the right edge of the root. However, while the [m] is consistently left aligned, the [u] of the morpheme always appears inside the derived forms, contrary to the stipulation of the posited alignment constraint. In order to account for the misalignment of the [u], we postulate another alignment constraint, which we define as follows:

(13) **ALIGN- (Rt, R, PrWd, R)**
The right edge of the root should coincide with the right edge of the prosodic word.

The type of demand made by this alignment constraint is that the right edge of the root should match the right edge of the derived PP form. By being in a dominant position, this constraint pushes the [u] of the PP morpheme inside the prosodic word. The interaction between these two alignment constraints is illustrated by the following tableau:

(14) ALIGN- (Rt, R, Pwrd, R) >> ALIGN (m, L, u, R)

√ktb /m, u/	ALIGN- (Rt, R, Pwrd, R)	ALIGN (m, L, u, R)
☞a. mək.tub		*
b. mək.t.bu	*!	

Considering the constraint hierarchy shown by this tableau, candidate (14b) is ruled out for failing to join the right edges of the root and the prosodic word. The optimal candidate in (14a) satisfies this requirement successfully by infixing the suffixed part of the PP morpheme, allowing the right edge of the root and that of the prosodic word to match. Seemingly, the possible candidate *[mək.təb] would seem to tie with the optimum, in that it too conjoins the right edges of the root and the prosodic word. However, this candidate can be discarded for the obvious reason that it fails to realize the PP morpheme in its entirety, hence violating the faithfulness constraint MAX-Affix. Though it is not shown in our tableau, it should be noted that the independent ranking of PARSE-Seg over DEP-ə is responsible for the schwa epenthesis in the first syllable.

7.2 *Vocalic elision*

The class of PPs to consider next in our analysis is derived from final weak triliteral roots (i.e. roots whose third segment is a vowel). Unlike all other classes, the PPs that belong to this class end with an open syllable. Also specific to this class is the fact that the [u] that appears with PPs from other classes is absent. We will see that these two characteristics are closely intertwined. Consider the following illustrative items:

(15)

Verb	*PP*	
kri	*mək.ri*	'rent'
ʃri	*məʃ.ri*	'buy'
kwi	*mək.wi*	'weld'
ɣli	*məɣ.li*	'boil'
kmi	*mək.mi*	'smoke'

In order to derive the appropriate forms constituting this class, two additional constraints are called for. These are as follows:

(16)

a. **MAX-Affix**: every affixal material in the input must have a correspondent in the output.
b. **$*High^2_{Pwd}$**: the repetition of the vocalic feature [+high] is banned in the domain of the prosodic word.

The role of the faithfulness constraint in (16a) is to ensure that the affix material in the input is fully preserved in the output. To account for the deleted [u] of the PP morpheme, this constraint would have to be dominated by some other constraint, which we believe to be the conjoined markedness constraint $*High^2_{Pwd}$. Such a constraint penalizes the co-occurrence of two high vowels within the domain of the prosodic word. It is formalized using the mechanism of Constraint Conjunction (Smolensky, 1995, 1997), which enhances the effect of individual independently motivated well-formedness constraints by making their conjoined violation more serious than the violation of their single instantiations. This means that conjoined constraints are expected to always dominate their individual constituents (i.e. [C1&C2] >> C1, C2). The deletion of the vowel [u] is captured by the following constraint interaction:

(17) $*High^2_{Pwd}$ >> MAX-Affix

√ʃri /m-u/	$*High^2_{Pwd}$	MAX-Affix
☞a. məʃ.ri		*
b. məʃ.rui	*!	

Under the pressure of the high-ranking constraint *High$^2_{Pwd}$, the vowel [u] of the affix is deleted in the optimum, causing a less serious violation of the low-ranking MAX-Affix. Evidently, the vocalic material of the root is observed due to what we believe is the privileged status of root elements over affix elements. This means that *High$^2_{Pwd}$ should be dominated by the faithfulness constraint MAX-Root, thus precluding the deletion of the root vowel. The following tableau summarizes the whole process of output selection:

(18) ALIGN- (Rt, R, Pwrd, R), *High$^2_{Pwd}$ >> MAX-Affix, ALIGN-Affix[2]

√ʃri /m-u/	ALIGN- (Rt, R, Pwrd, R)	*High$^2_{Pwd}$	MAX-Affix	ALIGN-Affix
☞a. məʃ.ri			*	*
b. məʃ.riu	*!W	*!W	L	L
c. məʃ.rui		*!W	L	*
d. məʃ.ruj		*!W	L	*

In addition to violating *High$^2_{Pwd}$, the sub-optimal candidate (18b) violates the alignment constraint on edges. Candidate (18c) satisfies the latter by infixing the [u], but still incurs a fatal violation of *High$^2_{Pwd}$. Therefore, despite losing some of its morphological substance, candidate (18a) gets out of the competition victorious. The other candidate that should be considered is **məʃ.ruj*. This candidate alters the consonantal specification of the root vowel, turning it into a glide. Glides are semi-vowels that are intrinsically [+high] too. Therefore, this candidate would still be ruled out by our conjoined constraint against the local repetition of high vocoids.

The choice to use the conjoined markedness constraint against the co-occurrence of high vocoids to account for the deletion of the [u] is not random. The alternative way to derive the same effect is to argue that the [u] is deleted under the pressure of the markedness constraint *Hiatus, such that the [u] deletes to avoid a sequence of two adjacent vowels. However, a careful look at more data where two vowels are adjacent shows that *Hiatus is rather resolved through the process of glide formation. The supplementary data we refer to here is drawn from the formation of the agent noun. In particular, we refer to those agent nouns derived from final weak bases (see Noamane (2018d) for a detailed account of the formation of agentive nouns in MA).

[2] The notation W/L (Prince, 2002) is used to highlight and emphasize the ranking arguments that make up our analysis. The notation means that in a pairwise comparison between the optimal candidate and its competitors, every constraint that favors a loser (L) must be outranked by a constraint that favors the winner (W).

(19)

Base	*PP*		*AN*	
kri	*mək.ri*	**mək.ruj*	*kərraj*	'rent'
ʃri	*məʃ.ri*	**məʃ.ruj*	*ʃərraj*	'buy'
kmi	*mək.mi*	**mək.muj*	*kəmmaj*	'smoke'
ħḍi	*məħ.ḍi*	**məħ.ḍuj*	*ħəḍḍaj*	'watch over'
ṭfi	*məṭ.fi*	**məṭ.fuj*	*ṭəffaj*	'extinguish'

The point here is that the deletion of the [u] is not actually about hiatus avoidance since the latter is resolved elsewhere in the grammar of MA via glide formation. Rather, what is at stake is the juxtaposition of two high vocoids, which still cannot be resolved if one of the high vowels turn to a glide as demonstrated by the suboptimal PPs included in (19) above.

7.3 *Glide formation*

We now turn to the class of PPs whose bases happen to be medial-weak tri-segmental roots (i.e. roots whose second segment is a vowel). This class is characterized by turning the medial vowel of their base roots into a glide. The latter occupies the onset position of the second syllable.

(20)

Verb	*PP*	
biʕ	*məb.juʕ*	'buy'
dir	*məd.jur*	'do'
ʃuf	*məʃ.juf*	'see'
luħ	*məl.juħ*	'throw'

This class of PPs shares with the previous one the fact that the high vowel of the root co-occurs with the high vowel of the affix in the same domain. However, the two classes differ in the way each one handles its double high vowel co-occurrence. Hence, the constraint set involved in deriving the PPs of the previous class (e.g. *məʃri* 'sold') yields the wrong forms in this particular case. This is illustrated by the following tableau:

(21) ALIGN- (Rt, R, Pwrd, R), *High$^2_{Pwd}$ >> MAX-Affix, ALIGN-Affix

√biʕ /m-u/	ALIGN- (Rt, Pwrd, R)	*High$^2_{Pwd}$	MAX-Affix	ALIGN-Affix
a. məb.juʕ		*!W	L	*
b. məb.iuʕ		*!W	L	*
c. m.bi.ʕu	*!W	*!W	L	L
☹d. m.biʕ			*	*

In fact, in spite of comprising two high vowels, the class of PPs we are dealing with here does not resort to the deletion of the vowel [u]. Note that, unlike in the case of the previous class, deletion in this situation could give rise to forms with syllabic consonants (e.g.*_m.biʕ_). Therefore, deriving the right forms requires a constraint that could rule out this structure. The markedness constraint against syllabic consonants in MA is: *μ/C. Thus, the latter has to dominate *High$^2_{Pwd}$ so that it can block deletion. This means that the grammar of MA prefers a structure with two high vocoids over one with a syllabic consonant. This can be summed up through the following ranking: *μ/C >> *High$^2_{Pwd}$ >> MAX-Affix.

(22) ALIGN- (Rt, R, Pwrd, R), *μ/C >> *High$^2_{Pwd}$ >> MAX-Affix, ALIGN-Affix

√biʕ /m-u/	ALIGN- (Rt, Pwrd, R)	*μ/C	*High$^2_{Pwd}$	MAX-Affix	ALIGN-Affix
☞a. məb.iuʕ			*		*
c. m.bi.ʕu	*!W	*!W	*		L
d. m.biʕ		*!W	L	*	*

Candidate (22a) is almost ready to become the optimal form. What needs to be accounted for now is the hiatus structure that we do not find in the output forms. Instead, the latter occur with a glide that corresponds with the high vowel of the root. To account for this alternation two more supplementary constraints are needed. These are *Hiatus and IDENT-Cons:

(23)

a. ***Hiatus**: assign one violation to every pair of adjacent vowels.
b. **IDENT-Cons**: correspondent segments in the input and output have identical values for consonantal.

The markedness constraint *Hiatus militates against sequences of vowels in adjacent syllables. This constraint is posited because a hiatus structure is formed when the vowel of the root and that of the affix are juxtaposed. Hiatus structures are cross-linguistically marked (Casali, 1996; 1997; 2011). Different languages employ different strategies to resolve hiatus structures. One of the most common hiatus resolving strategies is deletion, whereby one of the relevant vowels is deleted. Other strategies include consonant insertion, coalescence and glide formation. According to our data, the one strategy employed by the grammar of MA is glide formation. In particular, the high vowel of the root is turned to a glide to avoid a hiatus structure. Here comes the role of the faithfulness constraint IDENT-IO [Cons], which militates against the change of the consonantal specification of segments. Being outranked by *Hiatus, the demand made by this constraint is overridden in favor of satisfying *Hiatus.

(24) *Hiatus >> IDENT-Cons

√biʕ /m-u/	*Hiatus	IDENT-Cons
☞a. məb.juʕ		*
b. məb.iuʕ	*!	

As noted before, roots that constitute the base forms for this class of PPs contain a medial high vowel which can be either [+round] (i.e. [u]) or [-round] (i.e. [i]). Being the vowel at the edge of the second syllable, the root vowel turns into a glide, filling the place of an onset position. Typically, a [+round] high vowel corresponds to a [+round] glide (i.e. [w]). However, even in the case of roots whose medial vowels are [+round] (e.g. ʃuf 'see'), the formed glide is always [-round] (i.e. [j]). Following Boudlal (2001:230), we believe this to be yet another case of identity avoidance alternation, whereby a sequence of two adjacent [+round] vowels is not allowed. The constraints that we conjecture to be responsible for the observed alternation are *RdRd and IDENT-IO [round]. These interact as follows:

(25) *RdRd >> IDENT-IO [round]

ʃuf /m-u/	*RdRd	IDENT-IO [round]
☞a. məʃ.juf		*
b. məʃ.wuf	*!	

On a related note, the fact that glide formation affects the root vowel rather than the affix vowel seems to contradict the theory of Positional Faithfulness (Beckman, 1997), whereby root elements are argued to be consistently less prone to phonological change in comparison with affix elements. Therefore, this begs the following question: why is it that the root vowel, but not the affix vowel, is what changes its consonantal status? To answer this question, we will have to consider the candidate **m.biw.ʕ*, which represents the scenario of changing the affix vowel and which ties with the optimal candidate with regards to the ranking of *Hiatus over IDENT-Cons. We argue that the suboptimality of this candidate emanates from the fact that it incurs a double violation of the constraint against syllabic consonants (i.e. *μ/C). Accordingly, it must be that the effect of 'Root faithfulness >> Affix faithfulness' is neutralized by the dominance of *μ/C (i.e. *μ/C >> Root faithfulness >> Affix Faithfulness).

7.4 *Geminate integrity*

This section will be devoted to investigating the morphological effect of the PP derivation on geminate integrity. We look at those PPs derived from bases with final geminates (check Noamane (2018a-c, 2019, 2020) for detailed treatments of the behavior, representation and distribution of geminate consonants in MA). Consider (26) below for examples:

(26)

Verb	*PP*	
sədd	*məsdud*	'close'
ħəll	*məħlul*	'open'
ʕəḍḍ	*məʕḍuḍ*	'bite'
ʃəqq	*məʃquq*	'crack'
ʃədd	*məʃdud*	'catch'
ħədd	*məħdud*	'limit'

Note that the same geminates that resist schwa epenthesis in the verb forms in (26) tend to be split by the vowel [u] in the corresponding PP forms. Our analysis of this case of geminate breaking is based on the idea that geminates can be split by morphological rules but not by phonological ones (Benhallam, 1980; 1991). We demonstrate that such assumption is supported by constraint interaction á la OT. The constraint needed to accurately describe this data set is GEM-Integrity, which is a formalization of the tendency of geminates to observe their integrity. First, when the [u] of the PP morpheme moves inside the derived form, it splits the relevant geminates in the process. This follows from ranking ALIGN- (Rt, R, PrWd, R) over ALIGN-Affix as shown by the tableau in (27):

(27) ALIGN- (Rt, R, PrWd, R) >> ALIGN-Affix

√sdd /m, u/	ALIGN- (Rt, R, PrWd, R)	ALIGN-Affix
☞a. məs.dud		*
b. məs.d.du	*!	

However, this also means that the alignment constraint regulating the edges of the root and the prosodic word (i.e. ALIGN- (Rt, R, PrWd, R)) has to outrank the constraint GEM-Integrity as well.

(28) ALIGN- (Rt, R, PrWd, R) >> GEM-Integrity

√sdd /m, u/	ALIGN- (Rt, R, Pwrd, R)	GEM-Integrity
☞a. məs.dud		*
b. məs.d.du	*!	

What disqualifies candidate (28b) is its persistence to observe the integrity of the geminate by keeping the [u] of the PP morpheme at the right edge, hence violating the high-ranking alignment constraint. The winner, however, gives up the integrity of the geminate in question by allowing the right edges of the root and the prosodic word to match. A summary tableau is provided below:

(29) ALIGN- (Rt, R, PrWd, R) >> ALIGN-Affix, GEM-Integrity

√sdd /m, u/	ALIGN- (Rt, R, Pwrd, R)	ALIGN (m, L, u, R)	GEM-Integrity
☞a. məs.dud		*	*
b. məs.d.du	*!W	L	L
c. m.sudd		**!	

Recall that, in the theory of generalized alignment, affixation is basically edge-oriented. Therefore, affixes should be as close to their designated edges as possible. This means that moving the [u] of the PP morpheme further inside the prosodic word would be costlier, causing multiple violations of ALIGN-Affix. This situation is represented by candidate (29c) which is excluded exactly for this reason.

Relatedly, as shown in (26) above, the phonological process of schwa epenthesis fails to break geminates. We argue that this case is due to the ranking of GEM-Integrity above ALIGN- (Major-σ, R). When undominated, the latter constraint produces triliteral verbs (or adjectives) whose major syllables are right aligned (Al Ghadi, 1994; Bensoukas and Boudlal, 2012a-b). This means that the patterning of geminate integrity in MA can be captured by the general ranking of geminate integrity between morphology and phonology in the following way: ALIGN- (Rt, R, Pwrd, R) >> GEM-Integrity >> ALIGN- (Major-σ, R).

7.5 *Output-output correspondence*

The other class of PPs to deal with is the one whose members are derived from morphologically complex quadrisegmental bases. What uniquely characterizes the PPs belonging to this class is the fact they are derived from an output form instead of a minimal root (see Noamane (2018b) for more on root-based vs. word-based derivation in MA). Besides, this class is marked by the non-realization of the vocalic part of the PP morpheme (i.e. [u]). It will be shown that these two facts are connected. For illustration consider the data sample below:

(30)

Output base	*PP*	
kəttəb	*mkəttəb*	‘write’
dəwwəz	*mdəwwez*	‘pass’
wəlləf	*mwəlləf*	‘accustomed’
ʕərri	*mʕərri*	‘naked’
rəqqəq	*mrəqqəq*	‘slim’

Being derived from an output form, the PPs cited above are subject to an output-output correspondence relation with their base forms. Output-output correspondence relations refer to a situation whereby morphologically related words are required to be phonologically identical (Benua, 1997). OO-correspondence relations may force a derived word to resist some rules to maintain its resemblance to its output base. On this note, the PPs under consideration are argued to deviate from the canonical form of the PP which involves the complete affixation of the morpheme [m-u] by non-realizing the vocalic part of the morpheme to maintain a perfect match between the base forms and their corresponding derived forms. To accomplish this result, we posit the general faithfulness constraint FAITH-OO, which requires the output to be maximally faithful to the base form. The non-realization of the vocalic part of the PP morpheme takes place as a result of the following interaction between FAITH-OO and MAX-Affix.

(31) FAITH-OO >> MAX-Affix

Input: √ktb Base: kət.təb	FAITH-OO	MAX-Affix
☞a. m.kət.təb		*
b. m.kət.tub	*!	

This table demonstrates a competition between candidate (31b), which fully realizes the PP morpheme, and candidate (31a), which preserves the structure of the output base. Candidate (31b) is ruled out due its violation of FAITH-OO. Candidate (31a) emerges as the winner despite violating the dominated MAX-Affix. The subsequent tableau summarizes all the interactions involved in deriving the right forms:

(32) FAITH-OO, ALIGN- (Rt, R, PrWd, R) >> ALIGN-Affix, MAX-Affix

Input: √ktb Base: kət.təb	FAITH-OO	ALIGN- (Rt- R, Pwrd, R)	ALIGN-Affix	MAX-Affix
☞a. m.kət.təb			*	*
b. m.kət.tub	*!W		*	L
c. m.kət.t.bu	*!W	*!W	L	L

This table evaluates an additional candidate, shown in (32c), which satisfies FAITH-OO by keeping the output base of the PP intact. However, this candidate incurs a fatal violation of the equally high-ranked ALIGN- (Rt- R, Pwd, R), which demands that the right edges of the root and the prosodic word should coincide. Therefore, the [u] fails to surface as it can neither stay at the right edge nor get infixed inside the PP form.

8. Conclusion

This paper has presented a non-templatic analysis of PPs in MA within the framework of Optimality Theory. The premise has been to treat the PP formation as the simple affixation of the circumfix [m-u] to some base form, rather than a result of complying to a base-generated template. Templates, however, were shown to emerge from independently needed morphological and phonological constraints. First, the infixation of the vocalic part of the PP morpheme has been analyzed as misaligned suffixation. This was explained as the work of a highly ranked alignment constraint, demanding the right edges of the root and the prosodic word to be aligned, which then forces the [u] to move leftward, resulting in its infixation (i.e. ALIGN- (Rt, R, Pwrd, R) >> ALIGN (m, L, u, R))

In what followed, we proceeded to account for the phenomena of vowel elision, glide formation, geminate integrity and output-output correspondence, which characterize the derivation of the different PP classes. First, the elision of the [u] in the PPs derived from final weak bases was shown to follow from a constraint against the cooccurrence of two adjacent high vocoids (i.e. $*High^2_{Pwd}$), which then has to dominate the faithfulness constraint MAX-Affix. Second, the glide formation characterizing the PPs derived from middle-weak bases has been explained as a case of hiatus avoidance, whereby the identity of the medial base vowel changes to a glide to supply the second syllable with an onset. Third, geminate integrity was shown to be compromised to make place for the infixation of the vowel [u]. Finally, we have addressed the effect of output-output correspondence on the derivation of the PPs based on morphologically complex bases. We have shown that the constraint FAITH-OO prefers the morphological and phonological make-up of the base form to remain intact.

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