Root-and-Pattern Morphology and Initial Consonant Mutation: Are They Really Two Different Phenomena?

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1 Introduction

Nonconcatenative morphology, such as Irish Initial Consonant Mutation (1a)[1] and Moroccan Arabic Root-and-Pattern Morphology (1b; adapted from Boudlal, 2018: pg. 183, ex. 27a), has been a challenge for linguistic theory due to the complex interactions between syntax, morphology, and phonology that make it unclear where one module of the grammar ends and the next begins. This is particularly true for item-and-arrangement theories of morphology, like Distributed Morphology (DM; Halle and Marantz, 1993, 1994; Embick, 2010), which assume concatenative morphosyntactic structure building, leaving apparent nonconcatenativity to be derived at the level of phonological realization.

(1) a. *an bád /bʸɑːd̪ʸ/* ⟶ *ar an mbád [mʸɑːd̪ʸ] (Irish)*
'the boat (nominative) ⟶ on the boat (dative)'

b. *ktəb* ⟶ *kəttəb* *(Moroccan Arabic)*
'he wrote ⟶ he made (someone) write'

The data in (1) are challenging to analyze because morphological distinctions, such as the dative case (1a) and the causative (1b), are expressed through phonological processes, nasalization in (1a) and second consonant gemination in (1b), as opposed to the concatenation of segmental material (e.g., *play* becoming *played* in English). Accordingly, nonconcatenative morphology challenges linguistic theory in (at least) four ways (2).

(2) i. **A Problem of Representation:**
It is challenging to identify underlying representations for nonconcatenative morphemes.

ii. **A Problem of Form:**
To the degree that an underlying representation can be identified, it is challenging to derive the surface form for individual stems/roots.

iii. **A Problem of Timing:**
It is not trivial to determine when nonconcatenative morphological processes apply (e.g., in the lexicon, in the phonology, as a postsyntactic morphological operation).

iv. **A Problem of Modularity:**
If distinct linguistic modules are desired, each operating only on information unique to that module, nonconcatenative morphology is challenging because there is no clear distinction between morphology and phonology.

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[1] All Irish data comes from fieldwork with speakers of the Connemara and West Kerry dialects of Irish.

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In this paper, the problems in (2) are addressed through the examination of two examples of nonconcatenative morphology: 1) the Eclipsis of verbs in Irish and 2) the gemination of the second consonant of a tri-consonantal root for the formation of the causative in Moroccan Arabic. I argue that the Irish and Moroccan Arabic data can be analyzed within a strictly modular framework, in which the DM postsyntactic morphological component is responsible for converting morphosyntactic features into phonological exponents (Late Insertion) and for morpheme linearization. In contrast, the phonological component solely operates over phonological representations and lacks all access to morphosyntax (Embick, 2010; Bermúdez-Otero, 2012; Bye and Svenonius, 2012; Kastner, 2019). Furthermore, I propose the following solutions to the problems in (2). First, nonconcatenativity arises when the phonological exponent of a morpheme is prosodically deficient. Second, nonconcatenative surface forms are created in the phonology through language-specific phonological and phonotactic optimization. Third, morphology is always concatenative. It is responsible for linearization. And it precedes phonological computation. Finally, nonconcatenative morphology can be analyzed within a strictly modular grammar in which morphology manipulates only morphosyntactic material, and phonology manipulates only phonological material.

Through the examination and analysis of Irish verbal Eclipsis, I propose a novel representation of the structure of the autosegment responsible for the phonological alternations associated with Eclipsis. I also provide the specific morphosyntactic function of Eclipsis by creating a dedicated Vocabulary Item (VI) that maps finiteness features onto the autosegment responsible for Eclipsis alternations. As for Moroccan Arabic, I argue that the exponent of the causative morpheme is a prefixed mora. Second-consonant gemination, then, falls out from language-general phonotactic requirements on Moroccan Arabic syllable structure. This analysis demonstrates that Moroccan Arabic Root-and-Pattern Morphology does not require the morpheme-alignment constraints traditionally relied upon in Arabic Root-and-Pattern analyses (*contra* McCarthy and Prince, 1993b; Loutfi, 2020; Zukoff, 2022). The analysis, then, supports Embick (2010)'s argument that morphology should be local as opposed to global and that the phonological module should have no part in the selection or linearization of morphemes. Furthermore, the analysis put forth in this paper confirms the Four-Hypothesis Program of Bermúdez-Otero (2012), with the only change being that I strengthen the Indirect Reference Hypothesis (Bermúdez-Otero, 2012 citing Inkelas, 1989) to prohibit even prosodic-alignment constraints from referring to morphosyntactic information. The resulting architecture significantly constrains Optimality Theory (OT; Prince and Smolensky, 1993), removing the ability of phonology to do anything other than optimize an input of entirely phonological information with no access to the morphosyntax of the input.

The remainder of this paper proceeds as follows. In §2, I present the data and existing analyses of Irish verbal Eclipsis and (Moroccan) Arabic causative Root-and-Pattern Morphology. In §3, I give a novel analysis of each of these phenomena. In §4, I discuss the proposed analysis in relation to morphophonological theory and in comparison to previous approaches. In §5, I consider the implications of the analysis for our understanding of Irish Initial Consonant Mutation and Moroccan Arabic Root-and-Pattern Morphology, as well as providing some directions for future research. Finally, I conclude in §6.

2 Data, Background, and Previous Approaches

Two classic examples of nonconcatenative morphology are Irish Initial Consonant Mutation and Arabic Root-and-Pattern Morphology. While Irish has at least three mutations and Arabic has numerous Root-and-Pattern alternations, the current investigation considers two specific examples–Irish Eclipsis with verbs and the causative Root-and-Pattern alternation in Moroccan Arabic. These examples are infamous in the literature on nonconcatenative morphology and for that reason there are numerous analyses for each phenomenon (e.g., for Irish and other Celtic languages see: Hamp, 1951; Lieber, 1983; Ní Chiosáin, 1991; Pyatt, 1997; Green, 2006; Iosad, 2012; Hannahs, 2013; Iosad, 2014; Breit, 2019; Pruett, 2023 and for Arabic and other Semitic languages see: McCarthy, 1981; McCarthy and Prince, 1993b; Tucker, 2011; Boudlal, 2018; Kastner, 2019; Zukoff, 2022). Given this vast literature, I will focus on one prominent analysis for each language. For Irish, I will consider verbal Eclipsis in the context of the Trigger-Word Analysis (TWA: Lieber, 1983; Ní Chiosáin, 1991; Pyatt, 1997; Iosad, 2014; Breit, 2019) and show that this approach makes incorrect predictions about the distribution of Eclipsis after complementizers in Irish. For Moroccan Arabic, I will examine the causative Root-and-Pattern alternation with respect to the Morphophonological Prosodic-Alignment Analysis (MPA) of Arabic verbal Root-and-Pattern alternations (McCarthy and Prince, 1993b; Tucker, 2011; Zukoff, 2022).

While this analysis accounts for the data, it is inherently anti-modular, as morphophonological constraints require phonology to have access to morphosyntactic information. At least for Moroccan Arabic, the MPA is unnecessary to account for the data, allowing a modular analysis of Arabic data that relies solely on independently motivated phonotactic constraints on Moroccan Arabic syllable structure.

2.1 *Irish Verbal Eclipsis* Irish has a mutation called Eclipsis that affects verbs after most complementizers. So, for example, the verb *glan* /glˠɑnˠ/ 'clean' shows up in its eclipsed form *nglan* [ŋlˠɑnˠ] in all tenses except for the simple past after the subordinating complementizer *go* (3). In contrast, when no complementizer is present, as is the case in matrix clauses, Eclipsis does not occur (4).

(3) a. *dúirt* *Seán* *go* ***n**glan-ann* *sé* *a* *theach.*
say.PAST Sean that ^{N}.clean-PRES 3.M.NOM.SG 3.M.POSS.SG house
'Sean said that he cleans his house.'

b. *dúirt* *Seán* *go* ***n**glan-adh* *sé* *a* *theach.*
say.PAST Sean that ^{N}.clean-PAST.HAB 3.M.NOM.SG 3.M.POSS.SG house
'Sean said that he used to clean his house.'

c. *dúirt* *Seán* *go* ***n**glan-faidh* *sé* *a* *theach.*
say.PAST Sean that ^{N}.clean-FUT 3.M.NOM.SG 3.M.POSS.SG house
'Sean said that he will clean his house.'

d. *dúirt* *Seán* *go* ***n**glan-f-adh* *sé* *a* *theach.*
say.PAST Sean that ^{N}.clean-FUT-PAST 3.M.NOM.SG 3.M.POSS.SG house
'Sean said that he would clean his house.'

e. *dúirt* *Seán* *gu-r* *ghlan* *sé* *a* *theach.*
say.PAST Sean that-PAST clean.PAST 3.M.NOM.SG 3.M.POSS.SG house
'Sean said that he cleaned his house.'

(4) a. *glan-fad* *mo* *theach.*
clean-FUT.1.SG 1.POSS.SG house
'I will clean my house.'

b. *creid-eann* *tú* *í*
believe-PRES 2.NOM.SG 3.F.ACC.SG
'You believe her.'

Because Eclipsis only follows complementizers, it has traditionally been used as one of the best examples of the TWA. Eclipsis is absent when there is no complementizer and generally follows a complementizer when one is present. The only time Eclipsis does not surface after a complementizer is in the simple past tense when the complementizer is marked for tense with a final *-r* (5b). As a result, proponents of the TWA argue that complementizers in Irish possess an Eclipsis-triggering diacritic or autosegment (^{N}) at their right edge (5a).

(5) a. C^{N} b. C-*r* / $T^{0}_{[+PAST]}$

To illustrate how this analysis would work, consider the example in (6). Here we see that the question particle *an* carries an Eclipsis trigger, and when *an* is followed by the verb *creideann*, the trigger moves from the right edge of the complementizer and attaches to the left edge of the verb.

(6) *an-*^{N} *creideann* ⟶ *an* ***g**creideann*
ənˠ-^{N} cɾʲɛd̪ʲənˠ ⟶ ənˠ ɟɾʲɛd̪ʲənˠ

Based solely on this data, the TWA provides a reasonable explanation for the distribution of Eclipsis with Irish verbs. Under this analysis, verbal Eclipsis is nothing more than a morphologically-conditioned phonological alternation. In this sense, Eclipsis has no intrinsic morphological function. It is simply a phonological reflex of a particular construction.

While this analysis successfully accounts for the data presented above, it misses some key generalizations and falls apart once a wider variety of data is considered. For example, in Irish copular clauses, where there is no finite verb (Chung and McCloskey, 1987; Ó Sé, 1990; Carnie, 1995; Doherty, 1996; McCloskey, 2005), the predicate that directly follows a complementizer never permits Eclipsis (7).

(7) a.

an	*feirmeoir*	*é?*	*(*__bh__feirmeoir)*
ə	fʲɛɾʲmʲoːɾʲ	eː	(*__vʲ__ɛɾʲmʲoːɾʲ)
Q	farmer	3.M.ACC.SG	(*ᴺ.farmer)

'Is he a farmer?'

b.

dúirt	*Máire*	*go*	*feirmeoir*	*é*	*(*__bh__feirmeoir)*
d̪ˠuːɾʲt̪ʲ	mˠɑːɾʲə	gə	fʲɛɾʲmʲoːɾʲ	eː	(*__vʲ__ɛɾʲmʲoːɾʲ)
said.PAST	Máire	that	farmer	3.M.ACC.SG	(*ᴺ.farmer)

'Máire said that he is a farmer.'

Comparing the data in (3) and (7), it becomes clear that the morphosyntactic category of the word that follows the complementizer dictates whether or not Eclipsis surfaces after the complementizer. Specifically, if the following word is a finite verb, Eclipsis is obligatory, but if the following word is not, Eclipsis is prohibited. It cannot be the case that complementizers in Irish uniformly have an Eclipsis trigger at their right edge; otherwise, we would expect that Eclipsis should occur for all words following a complementizer, not just those that are finite verbs. Thus, the TWA incorrectly over-predicts the surfacing of Eclipsis. However, if the TWA is abandoned and Eclipsis is treated as an exponent for its own morpheme, the patterns can be straightforwardly accounted for. Ultimately, I argue that Eclipsis is the realization of a morpheme that marks finiteness on verbs in embedded contexts in Irish. If the exponent of this finiteness morpheme is a prefixal phonological autosegment, the surfacing of Eclipsis on verbs is accounted for by the fact that verbs must be marked for finiteness. Since this prefix is obligatory, verbs will surface in their eclipsed form. On the other hand, when the following word is not a verb, there is no finiteness prefix since only verbs are marked for finiteness in Irish.

2.2 *Moroccan Arabic Causative Root-and-Pattern Morphology* Moroccan Arabic, like all Semitic languages, has a rich system of alternations in syllable structure that express different morphosyntactic features. Primarily, consonantal roots of two to four consonants are interleaved with vocalic patterns to form different words with the same semantic core. This type of word formation, called Root-and-Pattern Morphology, is exemplified in (8; from Boudlal, 2018: pg. 183, ex. 27).

(8) a.

$\sqrt{KTB}$	⟶	*ktəb*	⟶	*kəttəb*
$\sqrt{WRITE}$		write		write.CAUS

b.

$\sqrt{TLF}$	⟶	*tləf*	⟶	*təlləf*
$\sqrt{LOSE}$		lose		lose.CAUS

Examples like (8) show that the morphological causative verb in Moroccan Arabic is formed via the gemination of the second root consonant. So, the roots *ktb* 'write' and *tlf* 'lose' are made causative by geminating the *t* and *l* respectively.

In the recent literature on Arabic Root-and-Pattern Morphology, it is widely accepted that second root consonant gemination involves a causative morpheme whose exponence is moraic in nature, though analyses differ as to whether this mora is introduced morphologically, templatically, or via alignment-based mechanisms (McCarthy, 1993; Noamane, 2018a; Loutfi, 2020; Zukoff, 2022). A simplex derivation of forming the causative for the verb 'write' can be represented as in (9).[2]

(9) $\sqrt{WRITE}$ + CAUS ⟶ *ktb* + μ ⟶ *kəttəb*

The derivation in (9) raises a number of questions. For example, it is not immediately clear why the addition of a new mora results in second consonant gemination and not first (e.g., *kkətəb*) or third (e.g., *kətəbb*) consonant gemination. That is, the driving force for this type of prosodic infixation is rather non-trivial. It

[2] Schwa is an epenthetic vowel used to satisfy phonotactic constraints on Moroccan Arabic syllable structure. This will be addressed in more detail during the analysis section.

is not obvious whether this is a morphological requirement of the causative morpheme (as would be the case if it were an infix) or a prosodic requirement due to the phonotactics of Moroccan Arabic (i.e., the mora is placed word internally to avoid some markedness constraint). The OT literature on this topic tends to favor a morphological approach (McCarthy, 1993; Tucker, 2011; Loutfi, 2020; Zukoff, 2022). Generally, this type of approach relies on a ranking relationship between Root-Alignment and Affix-Alignment constraints (McCarthy and Prince, 1993a). In the simplest cases, by ranking Root-Alignment above Affix-Alignment constraints, it is possible to derive an optimal output that privileges having root consonants at the edges of the word and the causative mora word-internally. An example of this analysis is given in the tableau in (10).

(10)

{ktb, μ}	ALIGN(ROOT, L, ω, L)	ALIGN(ROOT, R, ω, R)	ALIGN(AFFIX, L, ω, L)	ALIGN(AFFIX, R, ω, R)
☞ a. kətttəb			*	*
b. ktəbb		*!	*	
c. kkətb	*!			*

While this sort of analysis accounts for the data, it presents several problems that can be avoided by taking a different approach. For example, the analysis above departs from a strictly modular architecture by allowing phonological constraints to refer to morphological notions such as roots and affixes. Second, the above analysis yields incorrect predictions regarding other verbal morphemes. For instance, the passive morpheme *ttə-* is always prefixal (e.g., *ttəktəb*). Therefore, to limit the effects of infixation driven by the Alignment constraints, it would be necessary to adopt a form of Morpheme-Indexed constraints (Itô and Mester, 1999) or morpheme-specific Cophonologies (Inkelas and Zoll, 2007). While possible, such an addition to the system would miss key generalizations about the syllable structure of Moroccan Arabic. Thirdly, the analysis presented above gives phonology the sole power of morpheme linearization and placement. This is not a desirable outcome given the consensus in the DM literature that morphemes are linearized before the selection of phonological exponents and the application of phonology (Embick, 2010; Kalin, 2022). Finally, as I will show in the next section, it is entirely possible to derive the second consonant gemination for Moroccan Arabic causatives with independently necessary phonotactic constraints on Moroccan Arabic syllable structure. Since the Root-and-Pattern alternation can be accounted for by independently necessary language-general phonology, adding anti-modular constraints to the phonological grammar becomes superfluous and theoretically costly.

3 Analysis

Having now established that traditional analyses of Irish Eclipsis and (Moroccan) Arabic Root-and-Pattern Morphology make incorrect predictions about the distribution of nonconcatenative morphemes or are anti-modular, I now turn to a novel analysis of both phenomena that solves these issues. Before diving into the details of the proposal, it would be prudent to consider how Eclipsis and causative Root-and-Pattern Morphology fare regarding the four problems of nonconcatenative morphology laid out in (2).

As for the Problem of Representation, the previous section highlights that previous literature on (Moroccan) Arabic causative Root-and-Pattern Morphology has provided a solution to this problem. Specifically, it is widely accepted that the causative morpheme that is responsible for second root consonant gemination has an underlying phonological representation of a single unlinked mora. However, for Irish Eclipsis, the underlying phonological representation is less clear. For this reason, one goal of the present section is to propose a specific phonological representation for Eclipsis.

Regarding the Problem of Form, current theories of both Initial Consonant Mutation and Root-and-Pattern Morphology have ways of deriving the correct surface form in the phonology. However, the analyses rely on several assumptions that one may not want to accept. For example, and this ties into the Problem of Modularity, the Root-and-Pattern analyses for Root-and-Pattern Morphology tend to rely on morphophonological constraints that render the phonological grammar too powerful and conflate processes that should be ascribed to morphology or syntax with phonological processes. Furthermore, for Irish, the unclear representation of Eclipsis makes any proposal for deriving the surface phonology stipulative. Thus, the Problem of Form remains to be resolved for both phenomena.

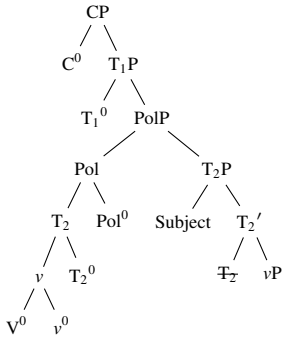
The Problem of Timing is similarly challenging for both Irish Eclipsis and Moroccan Arabic Root-and-Pattern Morphology. For example, with Irish Eclipsis, it is not clear whether the phonological application of

the mutation is a post-lexical phonological process akin to other sandhi processes, or whether it is part of the verb's lexical phonology and is therefore not a sandhi process at all. As for Root-and-Pattern Morphology, it is always the case in Moroccan Arabic that other inflectional prefixes and suffixes, such as the passive marker or agreement morphology, accompany causative verbs. It is not clear whether the phonology deriving the nonconcatenative causative applies before or after the addition of other affixes.

Finally, turning to the Problem of Modularity, it is clear that the current theory of Moroccan Arabic Root-and-Pattern is anti-modular. On the other hand, the TWA for Irish Eclipsis is purely located in the phonological module of the grammar, yet this denies any morphemic use of the mutation. Consequently, it is still necessary to develop an analysis that accounts for the morphological nature of both Initial Consonant Mutation and Root-and-Pattern Morphology, while maintaining a clear separation between the phonological and morphological modules. The remainder of this section is dedicated to proposing an analysis for each phenomenon that strives to solve the aforementioned problems and show that, in fact, Initial Consonant Mutation and Root-and-Pattern Morphology can be analyzed in the same manner.

3.1 *Eclipsis* Returning to Irish, consider the structure argued for by McCloskey (2017), given in (11).

(11)



McCloskey (2017)'s analysis of the Irish clause relies heavily on the distribution of tense and voice features. He labels both projections that host tense-sensitive morphemes as TP (T_1P for the higher tense node and T_2P for the lower one). The higher tense is related to tense marking on complementizers (*-r*), whereas the lower tense is responsible for tense and agreement suffixes on the main verb. I propose, however, that these two tense phrases should have separate labels. Since Eclipsis requires that the following word be a finite verb, I analyze it as the realization of a FiniteP projection, which is the locus of finiteness features in cartographic approaches to the left periphery (Rizzi, 1997), resulting in the following VIs (12).

(12) a. $[\text{Finite}^0, \text{-PAST}] \longleftrightarrow {}^{\text{N}}$ / C^0 ___ V^0 b. $[\text{Finite}^0, \text{+PAST}] \longleftrightarrow$ *-r* / C^0 ___

Evidence that Eclipsis and *-r* occupy the same syntactic head comes from the fact that, as shown in (3), *-r* alternates with Eclipsis depending on the tense of the clause. If the clause is past tense, *-r* appears. When the clause is in any other tense, Eclipsis surfaces. Having rejected the TWA and concluding that Eclipsis is the realization of its own morpheme, the complementary distribution of *-r* and Eclipsis provides solid evidence that these two morphemes occupy and compete for insertion at the same syntactic head. That is to say, Eclipsis and *-r* are realizations of the same syntactic head, though they expone different features.

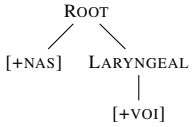
Now that the precise morphological function of Eclipsis with Irish verbs has been determined, it is time to turn to a phonological analysis of the effects of Eclipsis. For obstruents, Eclipsis causes voiceless consonants to become voiced and voiced consonants to become nasal. So, for example, the verb *creid* /cɾʲɛd̪ʲ/ 'believe' is voiced to *gcreid* [ɟɾʲɛd̪ʲ] and the verb *glan* /glˠɑnˠ/ 'clean' is nasalized to *nglan* [ŋlˠɑnˠ]. In contrast, sonorant consonants never change (13a) and vowels are prefixed by *n-* (13b).

(13) a. *dúirt* *Seán* *go* *rith-eann* *sé* *go dtí* *a* *theach.*
say.PAST Sean that run-PRES 3.M.NOM.SG to 3.M.POSS.SG house
'Sean said that he runs to his house.'

b. *dúirt* *Seán* *go* ***n****-ól-ann* *sé* *beoir.*
say.PAST Sean that ^{N}-drink-PRES 3.M.NOM.SG beer
'Sean said that he drinks beer.'

Previous accounts of the phonology of Irish Eclipsis usually claim that Eclipsis is driven by a phonological autosegment consisting of a [+NAS] and a [+VOI] feature (Lieber, 1983; Ní Chiosáin, 1991; Pruett, 2023). However, such a proposal remains unclear as to how and when the [+VOI] feature is chosen to link to a following segment, how and when the [+NAS] feature is chosen, and when an additional segment is epenthesized to host the nasal feature. Moreover, this proposal does not explain why epenthesis is possible before vowels with Eclipsis but not with the other major mutation–Lenition. As such, I offer a novel proposal for the underlying representation of Eclipsis. Specifically, I argue that the Eclipsis triggering autosegment possesses internal structure in the form of feature geometry (Clements, 1985). In many ways, this likens the Eclipsis autosegment to underspecified nasal consonants. There are two major benefits to this analysis. First, by adding a root node to the autosegment, one can explain the difference in epenthesis observed between Eclipsis and Lenition. If Lenition is an autosegment with no root node, then the epenthesis of a segment to host the Lenition autosegment would introduce a new timing slot into the phonological representation. On the other hand, if Eclipsis has a root node, the epenthesis of a segment will not introduce a new timing slot. This can then be interpreted as evidence that Irish prefers not to introduce new timing slots for mutation-triggering autosegments. Only those with an underlying timing slot have the possibility of being realized segmentally. All other autosegments must be associated with another segment or will go unpronounced. Second, as will be demonstrated below, the additional structure for the autosegment circumvents the problem of choosing which feature associates with the following segment. Both features are associated with a root node, but only the one that can spread to a following segment is visible on the surface. This novel underlying form for the Eclipsis autosegment (^{N}) is given in (14).

(14)



As for the phonology of Eclipsis, the underlying structure of Irish phonemes must be addressed. For the purposes of this analysis, I adopt a standard version of phonological underspecification (Archangeli, 1984), where voiceless consonants are underspecified for voice and non-nasals are underspecified for a nasal feature. This assumption allows for the patterns of Eclipsis to fall out from language-regular phonology. For example, since voiced consonants are prespecified for a voice feature, the voice feature of the Eclipsis autosegment cannot dock, and as a result, the nasal feature does. For voiceless consonants, both features can dock. Since Irish prohibits voiceless nasals (*[+NAS, -VOI]), we can rule out the possibility of only the nasal feature docking because the output would violate the requirement that all nasals be voiced. Furthermore, the docking of both the voicing and nasal features onto the voiceless consonants is ruled out by the fact that the docking of one feature will violate the constraint DEP(LINK) once, but the docking of both features would violate it twice. Finally, assuming that sonorant consonants are underspecified for a voicing feature, as it would be redundant, we can account for the lack of overt change for sonorant consonants by having a high ranked constraint against changing the underlying specification for a nasality feature (IDENT([+NAS])$_{\text{SONORANT}}$) and allowing the [+VOI] feature to dock without any surface change. Finally, by allowing vowels to be underlyingly specified for [+VOI], we can account for the epenthesis before vowels by having the IDENT([+NAS])$_{\text{SONORANT}}$ constraint ranked above a DEP(SEG) constraint. The tableaux in (15)-(18) illustrate how the proposed autosegment interacts with independently motivated phonological constraints to derive the full range of Eclipsis effects.

(15)

^{N} cɾʲɛ̠dʲ	*[+NAS, -VOI]	IDENT([+NAS])$_{SONORANT}$	MAX(AUTOSEGMENT)	DEP(SEG)	DEP(LINK)
☞ a. ɟɾʲɛ̠dʲ					*
b. ɲɾʲɛ̠dʲ					**!
c. ncɾʲɛ̠dʲ				*!	
d. cɾʲɛ̠dʲ			*!		
e. ɲɾʲɛ̠dʲ	*!				*

(16)

^{N} glˠɑn̠ˠ	*[+NAS, -VOI]	IDENT([+NAS])$_{SONORANT}$	MAX(AUTOSEGMENT)	DEP(SEG)	DEP(LINK)
☞ a. ŋlˠɑn̠ˠ					*
b. ŋglˠɑn̠ˠ				*!	
c. glˠɑn̠ˠ			*!		

(17)

^{N} ɾʲɪhʲ	*[+NAS, -VOI]	IDENT([+NAS])$_{SONORANT}$	MAX(AUTOSEGMENT)	DEP(SEG)	DEP(LINK)
☞ a. ɾʲɪhʲ					*
b. nɾʲɪhʲ				*!	
c. ɾ̃ʲɪhʲ		*!			*

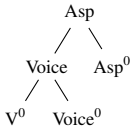
(18)

^{N} oːlˠ	*[+NAS, -VOI]	IDENT([+NAS])$_{SONORANT}$	MAX(AUTOSEGMENT)	DEP(SEG)	DEP(LINK)
☞ a. noːlˠ				*	
b. oːlˠ			*!		
c. õːlˠ		*!			*

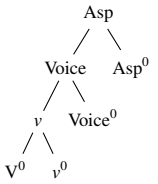
The present analysis demonstrates that a purely realizational account of Irish verbal Eclipsis is possible without the TWA. The conclusion can therefore be drawn that Eclipsis is itself the realization of an independent morpheme, but its exponent is prosodically deficient. Language-general phonology transforms this exponent into mutation through the interaction between the autosegment and the following segment.

3.2 *Root-and-Pattern Morphology* As for Moroccan Arabic causative Root-and-Pattern Morphology, we should again examine the morphosyntactic structure of the Moroccan Arabic verb. Following widely accepted assumptions about the clausal structure of (Moroccan) Arabic (Aoun et al., 2010), the basic verbal complex has the structure in (19). I assume that verbal agreement morphology in Arabic is the realization of Asp^0 (Hewett, 2023). Furthermore, following Harley (2017), I assume the causative morpheme is a "flavor" of v^0 which takes a VP complement. The structure of the causative verb is as in (20).

(19)



(20)



An interesting generalization about Moroccan Arabic morphology is that most morphemes are prefixes (Heath, 1987). The only exceptions are morphemes that express number features. For example, the habitual marker *ka-*, the passive morpheme *ttə-*, and person agreement morphemes are all prefixes in the verbal complex (21). On the other hand, plural verbal agreement is realized as a suffix (22).

(21) a. *ka-nə-ktəb*
HAB-1-write
"I write"

b. *ttə-ktəb*
PASS-write
"is written"

(22) *ka-nə-ktəb-u*
HAB-1-write-PL
"we write"

Given this generalization about Moroccan Arabic morphology, I will assume that the causative morpheme, which is underlyingly an unlinked mora, is a verbal prefix.

Having now established that the causative morpheme is the realization of causative v^0, which is underlyingly an unlinked mora, and is a verbal prefix, the Root-and-Pattern alternations seen between the basic verb and the causative can be derived solely through Moroccan Arabic phonotactic syllable structure constraints without any need to appeal to Alignment constraints. The first thing to note about Moroccan Arabic syllable structure and phonology is that schwa is always epenthetic (Heath, 1987; Bensoukas and Boudlal, 2012). To capture this, it must be the case that a DEP(ə) is the lowest-ranked constraint. Another important phonotactic constraint on Moroccan Arabic syllable structure is that schwa can only appear in closed syllables (*Cə_σ: Bernouss, 2009; Bensoukas and Boudlal, 2012). Finally, like all Arabic varieties, Moroccan Arabic disallows sequences of three consonants in a single syllable, all syllables must have onsets, and geminate consonants cannot be split by another segment (Noamane, 2018b). Putting all of these phonotactic restrictions together, an OT grammar, utilizing only independently necessary phonotactic constraints, can derive the correct forms for both the basic verb (23) and the causative (24).[3]

(23)

ktb	ONSET	*Cə_σ	GEMINTEG	*CCC	*COMPLEXCODA	DEP(ə)
☞ a. ktəb						*
b. ktb				*!		
c. kətb					*!	*
d. kət.bə		*!				**
e. ək.təb	*!					**
f. kə.təb		*!				**

(24)

μ-ktb	ONSET	*Cə_σ	GEMINTEG	*CCC	*COMPLEXCODA	DEP(ə)
☞ a. kət.təb						**
b. kkətb					*!	*
c. kək.təb			*!			**
d. kkə.təb		*!				**
e. ək.ktəb	*!					**
f. kktəb				*!		*

The present analysis demonstrates that Moroccan Arabic causative Root-and-Pattern Morphology can be analyzed under a strictly modular framework, without appealing to Morpheme-Alignment constraints. The relevant alternation falls out naturally from independently necessary constraints on the Moroccan Arabic syllabic system.

4 Discussion, Implications, and Further Directions

The analyses of Irish verbal Eclipsis and Moroccan Arabic causative Root-and-Pattern Morphology presented in the previous section are strictly modular and derive the surface phonology through purely concatenative morphological processes. As argued throughout this paper, Eclipsis and Root-and-Pattern Morphology pose several problems for linguistic theory. Having provided novel analyses of these phenomena, it must be considered whether the present account solves some of the aforementioned problems. This analysis makes a strong empirical prediction and testable hypothesis: any apparent instance of nonconcatenative morphology should reduce to the interaction of prosodically deficient exponents with independently necessary phonology.

With respect to the Problem of Representation, the current paper argues for an autosegment that consists of a [+NAS] and [+VOI] feature attached to a segmental root node (14), which is realized as Eclipsis when these features dock onto a following segment. Similarly, I reaffirm the position in the Root-and-Pattern literature that internal gemination in Arabic causatives results from an affixed mora. The present paper proposes a unified analysis for the Problem of Representation for these two examples of nonconcatenative morphology. Specifically, both phenomena are the result of a prosodically deficient autosegment that is incorporated into the lexical stem to be pronounced. Thus, the solution to the Problem of Representation

[3] The candidate set in examples (23) and (24) is not exhaustive. Still, enough candidates are given to demonstrate that the grammar successfully derives the intended outputs.

is simply that morphemes can have exponents that are any combination of phonological features, with or without additional phonological structure.

As for the Problems of Form and Modularity, the present paper shows that both Eclipsis and Root-and-Pattern alternations can be accounted for within a framework in which the morphological module supplies the phonological exponents of morphemes and linearizes them in a specific order. Then, language-general phonology applies to this underlying representation, yielding the observed nonconcatenative effects without the use of morphophonological constraints (including Morpheme-Alignment constraints, *contra* Bermúdez-Otero, 2012). Under this analysis, the surface form is derived solely in the phonology and through independently necessary phonological constraints. Therefore, the current proposal maintains modularity across the grammar by limiting the functions of morphology and phonology. Each module has its own set of operations and its own purpose. There is no global cross-module interaction, so morphology manipulates only morphosyntactic features, whereas phonology manipulates only phonological ones.

Finally, the Problem of Timing was not directly addressed in this paper. This provides the first area of future investigation. In future work, it must be investigated when these nonconcatenative processes apply in relation to the addition of purely concatenative exponents. This will, in turn, have implications for the debate over whether phonology operates in cycles alongside morphology and syntax, or proceeds entirely in parallel with no cyclicity. Another line of future investigation is to examine the entire dataset of Initial Consonant Mutation data in Irish and the entire Root-and-Pattern system of Moroccan Arabic (and other varieties of Arabic) to see whether the approach outlined here can cover the full range of data. Lastly, a promising future direction is to apply the proposal to other types of nonconcatenative morphology that have been used as examples challenging the need for modularity between phonology and morphology, including, but not limited to, grammatical tone, ablaut/umlaut, subtractive morphology, and infixation.

And so, the title of this paper poses a question: are Initial Consonant Mutation and Root-and-Pattern Morphology really different phenomena? Based on the proposed analysis, I would argue they are not. Both phenomena are instances of morphemes having prosodically deficient exponents that affect surrounding phonological material. Both phenomena have perfectly regular morphology, and the only thing that distinguishes one from the other is the choice/representation of the prosodically deficient exponent and the language's phonological grammar. If this finding is extended more generally, this could imply that all types of nonconcatenative morphology are simply different realizations of the same phenomenon (i.e., how phonology deals with prosodically deficient exponents). This would mean that language-specific or phenomenon-specific analyses of different types of nonconcatenative morphology are unnecessary and should instead be subsumed under one unified approach to all instantiations of the nonconcatenative phenomenon. Such a unified approach would significantly constrain the power of both the phonological and morphological components of the grammar, thereby simplifying the rules, operations, and representations the linguistic system must work with. If this view is correct, the result would be preferable to the current state of affairs, in which multiple theories of varying complexity are debated in the literature over how they handle different phenomena.

5 Conclusion

To conclude, in this paper, I have proposed a new analysis of Irish verbal Eclipsis and Moroccan Arabic causative Root-and-Pattern Morphology. I have argued that the traditional Trigger-Word and Morpheme-Alignment approaches to these phenomena are insufficient for accounting for the full range of patterns, make incorrect predictions about their distributions, and sacrifice modularity to provide analyses of the data. I have argued, instead, for a purely modular approach to these phenomena, in which morphology linearizes and combines morphemes, then supplies them with phonological representations. After morphology, phonology applies, utilizing only phonological constraints that are independently necessary in the language's phonology. This supports analyses of nonconcatenative morphology that argue for a purely concatenative morphological system with nonconcatenativity arising from the interaction of prosodically deficient phonological exponents with surrounding material through constraints on the language's general phonology. This analysis shows that nonconcatenative morphology, far from being a challenge for item-and-arrangement approaches to morphology, can be straightforwardly handled within these frameworks in the same way as concatenative morphology. Nonconcatenative morphology is not a special mechanism of grammar, but a surface illusion created by the interaction of ordinary morphology and phonology.

References

Aoun, J., Benmamoun, E., and Choueiri, L. (2010). *The Syntax of Arabic*. Cambridge University Press.

Archangeli, D. (1984). *Underspecification in Yawelmani Phonology and Morphology*. PhD thesis.

Bensoukas, K. and Boudlal, A. (2012). The Prosody of Morocaan Amazigh and Moroccan Arabic: Similarities in the Phonology of Schwa. In Borowsky, T., editor, *Prosody Matters: Essays in Honor of Lisa Selkirk*, pages 3–42.

Bermúdez-Otero, R. (2012). The Architecture of Grammar and the Division of Labor in Exponence. In Trommer, J., editor, *The Morphology and Phonology of Exponence*, pages 8–83. Oxford University Press.

Bernouss, M. (2009). Alignment Versus Sonority in CCC Structures: A Paradigmatic Explanation. *The Canadian Journal of Linguistics*, 54(1):157–166.

Boudlal, A. (2018). Root-and-Pattern Morphology Revisited: Verb Stem Bimoraicity and Stem-based Morphology in Moroccan Arabic. *Asinag*, 13.

Breit, F. (2019). *Welsh Mutation and Strict Modularity*. PhD thesis.

Bye, P. and Svenonius, P. (2012). Non-concatenative Morphology as Epiphenomenon. In Trommer, J., editor, *The Morphology and Phonology of Exponence*, pages 427–495. Oxford University Press.

Carnie, A. (1995). *Non-Verbal Predication and Head-Movement*. PhD thesis.

Chung, S. and McCloskey, J. (1987). Government, Barriers, and Small Clauses in Modern Irish. *Natural Language and Linguistic Theory*, 18(2):173–237.

Clements, G. N. (1985). The Geometry of Phonological Features. *Phonology Yearbook*, 2:225–252.

Doherty, C. (1996). Clause Structure and the Modern Irish Copula. *Natural Language and Linguistic Theory*, 14(1):1–46.

Embick, D. (2010). *Localism versus Globalism in Morphology and Phonology*. MIT Press.

Green, A. (2006). The Independence of Phonology and Morphology: The Celtic Mutations. *Lingua*, 116:1946–1985.

Halle, M. and Marantz, A. (1993). Distributed Morphology and the Pieces of Inflection. In Hale, K. and Keyser, S. J., editors, *The View from Building 20*. MIT Press.

Halle, M. and Marantz, A. (1994). Some Key Features of Distributed Morphology. *MIT Working Papers in Linguistics*, 21:275–288.

Hamp, E. (1951). Morphophonemes of the Keltic Mutations. *Language*, 27(3):230–247.

Hannahs, S. J. (2013). Celtic Initial Mutation: Pattern Extraction and Subcategorisation. *Word Structure*, 6(1):1–20.

Harley, H. (2017). The "Bundling" Hypothesis and the Disparate Functions of Little v. In D'Alessandro, R., Franco, I., and Gallego, A., editors, *The Verbal Domain*, pages 3–28. Oxford University Press.

Heath, J. (1987). *Ablaut and Ambiguity: Phonology of a Moroccan Arabic Dialect*. SUNY Press.

Hewett, M. (2023). Discontinuous First Person Agreement in Semitic and Postsyntactic Modularity. *Brill's Journal of Afroasiatic Languages and Linguistics*, 15:127–186.

Inkelas, S. (1989). *Prosodic Constituency in the Lexicon*. PhD thesis.

Inkelas, S. and Zoll, C. (2007). Is Grammar Dependence Real? A Comparison between Cophonological and Indexed Constraint Approaches to Morphologically Conditioned Phonology. *Linguistics*, 45(1):133–171.

Iosad, P. (2012). *Representation and Variation in Substance-Free Phonology: A Case Study in Celtic*. PhD thesis.

Iosad, P. (2014). The Phonology and Morphosyntax of Breton Mutation. *Lingue e Linguaggio*, 13(1):23–42.

Itô, J. and Mester, A. (1999). The phonological lexicon. In Tsujimura, N., editor, *The Handbook of Japanese Linguistics*, pages 62–100. Blackwell.

Kalin, L. (2022). Infixes Really are (Underlyingly) Prefixes/Suffixes: Evidence from Allomorphy on the Fine Timing of Infixation. *Language*, 98(4):641–682.

Kastner, I. (2019). Templatic Morphology as an Emergent Property: Roots and Functional Heads in Hebrew. *Natural Language and Linguistic Theory*, 37:571–619.

Lieber, R. (1983). New Developments in Autosegmental Morphology: Consonant Mutation. *Proceedings of the West Coast Conference on Formal Linguistics*, 2:165–175.

Loutfi, A. (2020). Deriving Morphological Causatives in Moroccan Arabic. *Macrolinguistics*, 8(1).

McCarthy, J. (1981). A Prosodic Theory of Nonconcatenative Morphology. *Linguistic Inquiry*, 12(3):373–418.

McCarthy, J. (1993). Templatic Form in Prosodic Morphology. *Proceedings of the Formal Linguistics Society of Mid-America*, 3:187–218.

McCarthy, J. and Prince, A. (1993a). Generalized Alignment. *Yearbook of Morphology 1993*.

McCarthy, J. and Prince, A. (1993b). *Prosodic Morphology: Constraint Interaction and Satisfaction*. University of Massachusetts Amherst Linguistics Department Faculty Publication Series.

McCloskey, J. (2005). A Note on Predicates and Heads in Irish Clausal Syntax. In Carnie, A., Harley, H., and Dooley-Collberg, S., editors, *Verb First: On the Syntax of Verb Initial Languages*. John Benjamins.

McCloskey, J. (2017). Ellipsis, Polarity, and the Cartography of Verb-initial Orders in Irish. In *Elements of Comparative Syntax: Theory and Description*, pages 99–151. De Gruyter.

Noamane, A. (2018a). Morphological Causatives in Moroccan Arabic: Word-based or Root-based. *Asinag*, 13:217–240.

Noamane, A. (2018b). On the Integrity of Geminates in Moroccan Arabic: An Optimality-Theoretic Account. *Journal of Applied Language and Culture Studies*, pages 133–164.

Ní Chiosáin, M. (1991). *Topics in the Phonology of Irish*. PhD thesis.

Prince, A. and Smolensky, P. (1993). *Optimality Theory: Constraint Interaction in Generative Grammar*.

Pruett, J. (2023). Representing Irish Mutation in Distributed Morphology and Optimality Theory. *Proceedings of the 58th Annual Meeting of the Chicago Linguistic Society*, pages 355–372.

Pyatt, E. (1997). *An Integrated Model of the Syntax and Phonology of Celtic Mutation*. PhD thesis.

Rizzi, L. (1997). The Fine Structure of the Left Periphery. In Haegeman, L., editor, *Elements of Grammar*. Kluwer Academic Publishers.

Tucker, M. (2011). Iraqi Arabic Verbs: The Need for Roots and Prosody. *Proceedings of the 28th West Coast Conference on Formal Linguistics*, pages 196–204.

Zukoff, S. (2022). The Mirror Alignment Principle: Morpheme Ordering at the Morphosyntax-Phonology Interface. *Natural Language and Linguistic Theory*, 41:399–458.

Ó Sé, D. (1990). Tense and Mood in Irish Copula Sentences. *Éiriu*, 41:61–75.