

The Phonological Restructuring of Verb's Form II and III Agentive Nouns in Almarj Dialect: A Stratal Optimality Theory

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إعادة تنظيم الأصوات لأسماء الفاعل من الصيغتين الثانية والثالثة للفعل في لهجة مدينة المرج: نظرية المفاضلة الطباقية

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Abstract

The main aim of this article is to provide a comprehensible theoretical explanation of the derivation of the agentive nouns in Almarj dialect of Cyrenican Libyan Arabic (CLA). The main focus will be on Form II and Form III verbs. In Modern Standard Arabic, Form II and Form III verbs' agentive nouns are formed by simply adding the prefix /mu-/ to the verb base, and result in constructing an agentive noun such as mukassir (smasher). However, Almarj dialect derives agentive nouns in different systematic process, where the vowel /u/ in /mu/ prefix is deleted, and this deletion results in forming an initial consonant cluster (e.g., mkassir). This type of clusters is not licensed in Almarj dialect; therefore, this form is repaired by adding shwa /ə/ at initial position to construct [əmkassir]. This deriving mechanism employed by Almarj dialect is known as Duke-of-York derivation, however, it defies Optimality Theory principles. Therefore, this article tries to solve the derivational opacity when deriving agentive nouns in Almarj dialect by using Stratal Optimality Theory. Applying Stratal Optimality Theory, this article addresses the opacity challenges by dividing the ranking constraints into three levels: Stem level that maintains morphological structure, Word Level that encourages vowel's deletion, and Post-lexical Level that repairs the cluster by forcing the insertion of the vowel. This study may provide a better understanding of the process of the derivational opacity encountered when driving agentive nouns in Almarj dialect. In addition, shedding light on the importance of the syllable weight in the dialect.

Keywords: Almarj dialect of Cyrenican Libyan; Stratal Optimality Theory; Syllable Weight; Agentive Nouns; Derivational Opacity; Syncope; Prothesis.

المخلص

يهدف هذا المقال إلى تقديم شرحاً نظرياً تفصيلياً لآلية اشتقاق أسماء الفاعل المَزِجَة في لهجة مدينة المَرْج الليبية من اللهجة البَرْقاوية، مع تركيز خاص على الحالات التي تكون فيها عملية الاشتقاق صعبة. في اللغة العربية، تُبنى أسماء الفاعل من الصيغتين الثانية والثالثة بأسلوب واضح من خلال إدراج البادئة /م/ مضمومة، والتي يمكن أن ينتج عنها صيغ مثل مُكْسِر ومُسَاعِد. أما لهجة مدينة المرج، فتُظهر اختلافاً كبيراً في هذا الوزن الصَرْفِي، حيث يُحذف الصوت القصير (الضمة) في بداية الكلمة غالباً لينتج عنه التقاء السواكن في بداية الكلمة (مثلاً: مكسر). هذا النوع من التقاء صوت رنان وآخر انجاسي لا يُقبل به في لهجة المرج بسبب قواعد التلاقي الصوتي. وبناءً على ذلك، تُدرج الحركة المحايِدة (الشوا) في بداية الكلمة لتُكوّن الصيغة (مكسر). تُعدّ عملية الاشتقاق (ديوك يورك) هذه مثالا على عدم الشفافية الصوتية الناتجة عن منع تطبيق القاعدة الصوتية، والتي تُمثّل تحدياً لموازاة نظرية المفاضلة. استناداً إلى نظرية المفاضلة الطباقية، يتناول المقال هذا الغموض الصوتي أو عدم الشفافية الصوتية باستخدام ثلاثة مستويات من قواعد تصنيف الصوت: مستوى الجذع الذي يحمي البنية الصرفية، ومستوى الكلمة الذي يدعم حذف الصوت الصائت (الحركة)، ومستوى التركيب (الجملة) الذي يتطلب إدراج صوت صائت لإصلاح الالتقاء الغير مسموح به. تُسهم الدراسة الحالية في فهم أفضل للغموض الاشتقاقي، دور وزن المقطع الصوتي، والتفاعل بين علم الصرف وعلم الصوتيات في اللغات السامية.

الكلمات المفتاحية: لهجة مدينة المَرْج الليبية؛ نظرية المفاضلة الطباقية؛ عدم الشفافية والغموض الاشتقاقي؛ أسماء الفاعل؛ وزن المقطع الصوتي.

1. Introduction

Arabic language is considered as one of the most studied languages due to its rich languages. Arabic language branches from West Semitic languages, and there are 300 million people speaks Arabic across the world (Holes, 2004; Owens, 2006; Watson, 2002). Interestingly, Arabic as a single language has considerably vast range of varieties, which can be challenging to the concept of the linguistic unity (Ferguson, 1959; Ryding, 2005; Owen 2013). The most noticed feature in Arabic is diglossia, where the Standard Modern Arabic is mainly used in formal settings, and regional dialect is used for everyday interaction. These spoken regional varieties can be mutually understood; however, they have different essential structures. This situation gives rise to both challenges and opportunities for investigation phonology and morphology aspects (Ferguson, 1959; Ryding, 2005; Versteegh, 2014).

Within this wide range of dialects, Libyan Arabic garnered relatively little attention in research compared to well-studied varieties such as Levantine, Egyptian, and Moroccan Arabic (Owens, 1984; Benkato, 2014; Pereira, 2010). This dearth of research is noteworthy, given Libya's location between the western and eastern Arabic-speaking regions, thereby resulting in a distinct layering of historical strata (Owens 2006). According to Mitchel (1957: 472), "the Arabic of Cyrenaica possesses features of considerable theoretical interest that have been largely neglected in the broader Arabic dialectological literature."

The Maghrebi Arabic dialects, spoken throughout North Africa, are distinguished by particular characteristics (Heath, 2002; Dell & Elmedlaoui, 2002; Watson, 2007). One of the most significant characteristics is the frequent omission of short vowels in unstressed open syllables (vowel syncope). This procedure frequently results in complex consonant clusters that are unique in eastern Arabic dialects (Kiparsky, 2003; Watson, 2002).

Within Libya, the Cyrenaica area, which lies between several cities and towns from Albrega to Amsaed, shows a variety of features. It maintains ancient Bedouin linguistics characteristics that no longer exist in western dialects. However, it can conduct distinguished phonological reductions similar to other Maghrebi dialects (Benkato, 2014; Mitchel, 1952; Owens, 1984).

The essential question to be addressed by this study is what are the linguistics consequences of driving agentive nouns from augmented verb forms, explicitly Forms II and III, in Almarj dialect. In Classical Arabic and MSA, agentive nouns are constructed simply by adding /mu-/ prefix to the stem of the verb, for example, the agentive noun of the verb Kassir (smashed) is mukassir (smasher) (Ryding, 2005; Watson, 2002; Holes, 2004). However, Almarj dialect process undergoes radical and systemic restructuring. In the prefix /mu/, the short vowel /u/ is deleted, resulting in an initial consonant cluster (mkassir). However, this kind of cluster is prohibited in the dialect, therefore, a short vowel [ə] is inserted at the initial position of the word yielding the form [əmkassir] (Mitchel, 1952: 385; Owens, 1984: 72; Moftah, 2018: 156).

These sequences of phonological operations where we delete one vowel and then add another is a case of a Duke-of York derivation, in which a process seems to undo itself (Pullum, 1976; cf. Kiparsky, 2000; McCarthy, 2003). Bermudez-Otero (2018:112) argues that these types of derivations can be demanding to understand and may pose serious challenges to traditional Optimality Theory. Accordingly, this results in a sort of opacity, which means that the initial processes are not evident in the final form. For example, the surface of the word [əmkassir] fails to clearly display that a vowel was deleted previously, resulting in analysis problems (Owens, 1984; Benkato, 2014). This article provides a comprehensive theoretical model of this phenomenon. It does not present new findings yet rather reanalyses existing descriptions and patterns from literature and apply it to Almarj dialect using modern theoretical frameworks (Kager, 1999; McCarthy, 2008). Particularly, this article employs Stratal Optimality Theory (SOT) to explain the interaction between vowel deletion and insertion (Halle & Marantz, 1993, 1994; Embick & Noyer, 2007). This research also considers Almarj dialect in the context of Semitic languages and Arabic dialects (McCarthy, 1979, 1981; Watson, 2002, 2007).

The remaining part of the article is organised as follows. Section 2 explores prior studies on Cyrenaican Arabic and vowel syncope. In section 3 the methodology of the study will be explained in details. Section 4 will be dedicated to the obtained data and verbs forms. Section 5 will discuss the syllable structure and the rule of interaction and shed light on the influence of deletion on insertion. Section 6 examines the derivational opacity in light of Stratal Optimality Theory. Section 7 discusses syllable weight theoretical implication and computational multi-level. Section 8 provides a comprehensible conclusion, limitations, and recommendations.

2. Literature Review

The study of the Libyan Arabic dialect gone through many stages during the last century. In early works, very limited word lists were employed in studying the grammar of Libyan dialect (Maltzan, 1873; Rahlmann, 1897). Later scholars made a considerable effort to study the dialect with more advanced theoretical framework (Owens, 1984; Benkato, 2014; Moftah, 2018). Therefore, it will be useful to study the phonological system of the Libyan dialect, employing both the early conventions and recent theoretical framework to gain a better understanding about the dialect (Watson, 2002; Kiparsky, 2003; McCarthy, 2008).

2.1 Descriptions of Cyrenican Arabic

The seminal work of T.F. Mitchell's in 1952 set the foundations of the modern Libyan Arabic studies, and his work paved the way for later scholars to comprehend the grammar of the Libyan dialect. Mitchell (1952) provided a descriptive account of agentive nouns in Cyrenaican Arabic, he focused on Bedouin dialects in Aljebl-Alakhder that is spoken by several cities including almarj. He stated that "active participial (agentive noun) in Cyrenaican Arabic exhibits a number of peculiarities not found in better-studied eastern dialects" (Mitchell, 1952:380).

In addition, Mitchell recognized the phenomena of the prothetic vowel in the dialect. He argued that the short prothetic vowel [ə] in intermediate position is moved to initial position creating an onset cluster when the first segment is sonorant. This results in a surface form [əmkassir], which is the main focus of the current study. Mitchell studies were based on descriptive and structuralist approach which was a dominate framework that time; however, his work laid the empirical groundwork for the later theoretical studies of prothesis and syncope phenomenon (Owens, 1984; Moftah 2018).

Mitchell (1957) developed his work to further include more phonological features of Cyrenaican Arabic, such as stress, syllable structure, and guttural sounds behaviour (Mitchell, 1957:474-480). He pointed out that the appearance of the prothetic vowel [ə] is not arbitrary, but it is determined by the sonority of the cluster at the beginning of the word (Mitchell, 1957:476). This deep analysis provided a significant contribution to the phonological field literature, because it predicted sonority interaction with other segments. His later work on comparative studies on Afro-Asiatic languages provided a valuable source of comparative paradigm (Mitchell, 1960).

In another study, Jonathan Owens (1984) later work is considered as one of the most reliable reference of Eastern Libyan Arabic grammar, where he established the first adequate documentation of the dialect. He stated that Eastern Libyan Arabic suffered from the lack of proper documentation compared to other Arabic dialects; therefore, more focus on the grammar of this dialect can be beneficial for more understanding of Arabic linguistics (Owens, 1984: ix). Owens work focused mainly on Benghazi variety; however, his results can be generalized to incorporate Almarj dialect and other Cyrenaican regions, and that is because all Bedouin dialects in Cyrenaican regions share the same linguistic features (Owens, 1984:3-7).

Owens (1984) explained the mechanism of the short vowel deletion. He states that "vowel deletion occurs in initial, unstressed, open syllables when the vowel is high (/i/ or /u/)" (Owens, 1984:71). This rule is particularly significant for comprehending the behavior of the /mu-/ prefix. According to Owens (1984: 72), "deletion of the prefix vowel in Forms II and III participles creates initial clusters that are regularly repaired by prothesis of [ə]".

He additionally provides examples to demonstrate the distinction between forms to which this approach applies and those to which it does not. For instance, [əktab] 'book' is not subject to syncope due to the presence of the low vowel /a/, whereas [əmkassir]'smasher' exhibits both syncope and prothesis (Owens, 1984:73).

In addition, Owens classifies Eastern Libyan Arabic as a "VC-dialect," meaning that consonants are associated with the coda position of a syllable rather than the onset of the following syllable. (Owens, 1984: 85-92; cf. also Broselow, 1992; Kiparsky, 2003). As he explains, "in VC-dialects, the syllabification algorithm preferentially attaches consonants to the coda position of a preceding syllable rather than the onset of a following syllable, a parameter setting that has significant consequences for the treatment of consonant clusters" (Owens, 1984: 87).

This explanation reasoning the inability of the consonant /m/ in [mkassir] to form a syllable independently and it required an insertion of a vowel before it (cf. Ito, 1989; Prince & Smolensky, 1993/2004).

In later study, Owens (2006) studied Eastern Libyan Arabic considering a broader historical framework. He linked several linguistic behaviour of the dialect with Hilali dialect, where they share some linguistics features (Owens, 2006: 245-286). This broader historical framework prospective explained that Almarj dialect adopt certain features related to Hilali dialect as the maintaining of the interdental sounds and the surface realization of the sound /q/ as [g]; yet at the same time, it has its own unique features as vowel deletion (Owens, 2006: 256; Benkato, 2014: 78-82).

2.2 Acoustic Phonetics analysis and Contemporary Theoretical Framework

Recently, scholars have employed acoustic phonetics and sociolinguistics to analyze and investigate Eastern Libyan Arabic dialect. Moftah (2018) studied vowel syncope in Arabic Libyan Tobruq dialect, his detailed study of Tobruq dialect revealed several structural similarities with Cyrenaican Arabic. Moftah (2018) stated that, the non-existence of instrumental, and the lack of adequate acoustic analysis of vowel syncope in the dialect created a profound gap in understanding the mechanism of vowel syncope.

Moftah (2018) conducted a study on 24 native speakers of the Tobruq dialect and analyzed the recordings of (12 males and 12 females), where the group age consisted of three groups (18-30,31-50, and 50+). The findings demonstrate that unstressed short high vowels (/i/ and /u/) in open starting syllables are deleted at extremely high rates (more than 95%) in casual speech. In contrast, low vowels (/a/) are rarely omitted (Moftah, 2018: 112-128). As stated, "the deletion rate for /u/ in the /mu-/ prefix of Form II and III agentive nouns reached 97.3% in the casual speech style, falling only to 78.4% in careful speech, indicating that syncope is a highly robust phonological process in this variety" (Moftah, 2018: 115).

Moftah (2018) additionally utilises Stratal Optimality Theory to analyse stress and syncope, resulting in a novel theoretical framework for Eastern Libyan morphophonology. The study exhibits that, syncope and stress assignment occurs at various prosodic levels, supporting a stratal analysis (Moftah, 2018: 189-215). This result is in line with the approach employed in the present research.

Furthermore, acoustic research sheds additional light on the nature of the prothetic vowel. Earlier accounts assumed that this vowel was invariably a schwa (Mitchell, 1952; Owens, 1984). However, Moftah (2018: 156-162) demonstrates that its realisation may differ, depending on the phonetic context: "the prothetic vowel shows F1 and F2 values consistent with [ə] when the following consonant is coronal, but raises to [ɪ] when the following consonant is dorsal, suggesting a degree of vowel harmony that has not previously been documented." Although this variation is highly significant, the current study adopts [ə] as the default form, following previous research.

2.3 Opacity in Arabic Phonological Theory

The relationship between vowel deletion (syncope) and vowel insertion (epenthesis or prothesis) in Arabic language varieties has been extensively examined in phonological theory. This interaction is essential as it facilitates the evaluation of various hypotheses of phonological opacity (Kiparsky, 2000, 2003; McCarthy, 2003, 2007; Baković, 2011). Kiparsky (2000: 352) clarifies that "parallel Optimality Theory, with its simultaneous evaluation of all constraints, struggles with the derivational opacity generated by interacting processes such as syncope and epenthesis, which create Duke-of-York derivations where the surface form gives no direct evidence of the intermediate steps."

Arab dialects show consonant clusters in various manners. Complex initial clusters are prohibited in Cairene Arabic and are required to be resolved through the insertion of a glottal stop or a vowel (Broselow, 1992; Davis & Zawaydeh, 1997; Watson, 2002). According to Watson (2002: 86), "Cairene Arabic resolves initial consonant clusters by prefixing a glottal stop followed by a high vowel that harmonizes with the following vowel: [ʔimkassir] from /mu-kassir/'. This form differs from its corresponding counterpart in Almarj in two main aspects. The first aspect is that Cairene Arabic avoids initial clusters by adding a glottal stop, while Almarj uses regular shwa instead. The second difference is that Cairene dialect necessitates vowel addition in environments that would be tolerated in other dialects (Broselow, 1992: 56-61; Watson, 2002: 88-92).

In contrast to both Cairene and Almarj dialects, Moroccan dialect allows consonant clusters, where the vowel is deleted entirely and the resulted consonant cluster is permitted without any need of repair strategies. According to Heath (2002), Moroccan Arabic dialect licenses up to three consonant clusters in initial position without applying vowel prothesis (e.g., [ktəb] 'he wrote'. Accordingly, the corresponding structure of Almarj [əmkassir] in Moroccan dialect is [mkassər], where the initial consonant cluster is maintained and no epenthesis is performed (Dell & Elmedlaoui, 2002: 89).

These differences experienced by Arabic dialects provide an evidence of how phonological constraints can be prioritized differently in each dialect, specifically the constraints that govern the complexity of syllable onset (Kiparsky, 2003; Watson, 2007). Arguably, Cyrenaican Arabic, which represented in Almarj dialect, exhibits medial degree of consonant cluster tolerance among Arabic varieties (Owens, 1984, Moftah, 2018, Benkato, 2014). It licenses the onset cluster according to its sonority level, where onset clusters with steady sonority are permitted (e.g., [ktab]), and onset clusters beginning with sonorants are prohibited. These banned clusters are said to be subject to vowel prothesis, where shwa is added to the syllable's initial position (Mitchell, 1952: 383; Owens, 1984: 72).

Owens (1984) explained that Almarj dialect is systematically applying Sonority Sequencing Principles that allows onset clusters as [kt-] and disallows others as [mk], where the dialect clusters are determined by sonority sequencing. The cluster [kt-] is tolerated because it reveals rising sonority sequence, and the cluster [mk] is prohibited because it has falling sonority sequence. This critical sonority disparity is essential for investigating Almarj dialect forms, and it will be discussed further in section 5 adopting *SONORITY-FALL constraint.

Several theoretical frameworks tried to provide adequate justifications for opacity in Optimality Theory. McCarthy (1999, 2003) introduced Sympathy Theory, where non-optimal candidates are considered as an alternative even when parallel evaluation is activated. When a non-optimal candidate satisfies faithfulness constraint is known as a sympathetic candidate, and it mandates the surface output to satisfies faithfulness to certain features of sympathetic candidate (McCarthy, 1999: 333). Sympathy Theory has been used to explain number of challenging cases of opacity in Arabic varieties (McCarthy, 2003: 87-93). However, it may fail to provide an adequate explanation of Duke-of-York derivation encountered by Almarj dialect.

Another framework to describe derivation in Optimality Theory is Harmonic Serialism (Prince & Smolensky, 1993/2004; McCarthy, 2000/2010). This approach indicates that in every stage only one modification can be performed, and the structure must be optimal in every stage. Harmonic Serialism dictates that input can go through only one adjustment due to Gen restrictions, and harmonic improvement is achieved in each step of derivation process (McCarthy, 2010). It can be stated that Harmonic Serialism treats Duke-of-York derivation process as a chain of sequenced stages, starting with syncope and followed by epenthesis. However, this approach faces critical challenges in explaining why similar operations occur in specific contexts (McCarthy, 2010).

Stratal Optimality Theory can offer an efficient solution by merging concepts and analysis from both Lexical Phonology and Morphology, while simultaneously utilizes constraint-based investigations (Kiparsky, 1982/2000/2015, Mohanan, 1986; Bermúdez-Otero, 2018). According to Stratal Optimality Theory account, analysing grammar requires to dividing it into three distinctive levels namely: Stem Level, Word level, and Post-Lexical Level, where each level has its own set of constraint ranking order (Kiparsky, 2015). Accordingly, this theory allows the implantation of individual constraints at different stages. Following this concept, Word-Level licenses the syncope process, while prothesis occurred at Post-Lexical Level phase (Bermudez-Otero, 2018). This layered strategy has been adopted to study opacity in Arabic and other languages as well, where it provided efficient results in investigating Duke-of-York derivation cases (Kiparsky, 2003; Bermúdez-Otero, 2018; Moftah, 2018). Stratal Optimality Theory accounts for Almarj dialect will be systematically discussed in section 6.

3. Methodology

The current research aims to provide a systematic comprehensive analysis without presenting or employing any new data, merely using previously discussed data. As result, it is exclusively based on Theoretical Modeling and Formal Reinterpretations (see Kager, 1999; McCarthy, 2008; Prince & Smolensky, 1993/2004). Rather than eliciting new data, the current research emphasizes on evaluating previously documented phonological patterns pertaining to Almarj dialect. This method is prevalent in theoretical phonology, where the purpose is to explain established patterns in lieu of discovering uncover new ones (Bermúdez-Otero, 2018, McCarthy, 2008, Kiparsky, 2015).

3.1 Corpus Synthesis and Standardization

The data for this study originated from a merged corpus based on previous research on Cyrenaican Arabic, particularly Mitchell (1952, 1957), Owens (1984), and Moftah (2018). Several additional examples are derived from comparative studies, including Watson (2002, 2007), Pereira (2010), and Benkato (2014). According to Owens (1984: viii), "the available descriptions of Eastern Libyan Arabic, while not as extensive as those of Egyptian or Levantine varieties, provide sufficient detail for the purposes of phonological analysis when synthesized and cross-checked against one another."

The corpus employed in this study was gathered by including all data concerned with verb Form I, Form II and Form III and their derived agentive nouns from previous studies. Adopting the methodologies of established phonological studies, the research selected only forms that reveal unique phonetic representations (Durand. Gut, & Kristoffersen ,2014; Kager 1999). The study did not include forms that have no apparent phonetics details as vowel quality and consonant length (Muftah, 2018: 78-82).

Sources selected for this research investigations use different styles of phonetic transcription; therefore, for the sake of clarity, all phonetic transcription are standardized according to the guidelines of the International Phonetic Alphabet (IPA) and the Association of Phonétique Internationale's (IPA 1999), where they adopted the updated version of Arabic (Watson, 2002, Holes, 2004). The symbol [ə] replaces the prothetic vowel "ë" used in Mitchell's work as illustrated in Table 1. In addition, the phonetic symbols of the long vowels in this study are [a:] or [æ:], and when describing the vowel raising behaviour the symbol [æ] is employed.

Table 1: IPA Transcription Conventions Standardization

Original Source	Original Transcription	Standardized IPA	Context
Mitchell (1952)	Bĕn	[bən]	'son'
Mitchell (1952)	Kĕtab	[kətab]	'he wrote'
Mitchell (1952)	Mkĕssir	[əmkassir]	'smasher'
Owens (1984)	əmkassir	[əmkassir]	'smasher'
Owens (1984)	kta:b	[kta:b]	'book'
Moftah (2018)	ɪmkassir	[əm.kas.sɪr]	'smasher'

This clarified phonetics transcription of the selected dataset paves the way for adequate investigations of the paradigm, where the study analyses the derivational process from the abstract root to the surface realization of the derived agentive noun adopting the theoretical framework of generative morphology (Kenstowicz, 1994; Hayes ,2009).

3.2 The selection of Stratal Optimality Theory

The current study adopts the framework of the Stratal Optimality Theory (SOT). This constraint-based framework utilizes the integration of concepts of two linguistic domains: morphology and lexical-phonology (Kiparsky, 1982; Booij, 1997; Mohanan, 1986). Accordingly, SOT divides the grammar into three interconnected levels: Stem Level, Word level, and Post-Lexical Level. According to (Kiparsky, 2015), each level operates under level-specific constraint ranking system. The final output of one of the grammar levels serves as the input of the subsequent levels (Bermúdez-Otero, 2018).

According to Kiparsky (2015: 37), even though stratal architecture genuine dedication and compliance to the rules of constraint violation and ranking in Optimality Theory, each level priorities its own set of constraints ranking. Choosing SOT framework can be appropriate for the current study as it accounts for each level distinctive operation of ranking systems at different representations. Bermúdez-Otero (2018) distinguishes between syncope at the word level and prothesis at the post-lexical level. As previous research has demonstrated (Kiparsky, 2003), this form of layered framework is especially well-suited to the analysis of Semitic languages.

Bermúdez-Otero (2018) and Kiparsky (2015) identify three primary reasons for adopting SOT. Initially, it accounts for why syncope and prothesis exist in different environments. Secondly, because intermediate forms such as [mkassir] are generated directly, it eliminates the need for abstract derivational methods used in parallel OT. Thirdly, the framework has been effectively applied in analogous contexts in Arabic (Kiparsky, 2003; Moftah, 2018; Watson, 2002).

3.3 The Analytical Procedure

The analysis comprises three major stages, based on well-established phonological approaches (Kager, 1999; McCarthy, 2008; Hayes, 2009):

Stage 1: Distributional Analysis.

This stage determines the specific conditions under which syncope and prothesis emerge. It emphasise on certain phonological contexts, such as unstressed short high vowels in the case of syncope and falling-sonority clusters in the case of prothesis. Minimal and near-minimal pairings are employed to demonstrate relevant distinctions (Kenstowicz, 1994, Hayes, 2009). For instance, [mu.ʔal.lim] 'teacher' is contrasted with [əm.kas.sır] 'smasher' to discover the significant variables (cf. Owens, 1984: 73; Moftah, 2018: 132-135).

Stage 2: Syllable Structure Mapping.

This stage adopts Moraic Theory (Hayes, 1989; Hyman, 1985; Broselow, 1992) to examine syllable weight. Syncope deletes weak syllables, whereas prothesis repairs structures that fail to produce well-formed syllables (Itô, 1989; Prince & Smolensky, 1993/2004). According to Hayes (1989: 258-265), syllables are classified as light (CV) or heavy (CVC, CVV). Words into syllabified, assigning moras are assigned, and stress patterns are subsequently established (Selkirk, 1982; Blevins, 1995; Owens, 1984: 85–90; Moftah, 2018: 92–98).

Stage 3: The Testing of the Interaction Rule

This phase explores the connection between prothesis and syncope (Kiparsky, 1973; Kenstowicz, 1994). The findings show that syncope establishes the favourable conditions for prothesis to the extent that the omission of the vowel yields the cluster which brings about the vowel epenthesis. This process results in a counter-bleeding interaction, where it removes the specific conditioning environment, yet it preserves its phonological impacts (Kiparsky, 1973: 87; McCarthy, 2003: 75–78). Hence, such a pattern of opacity exhibits the challenge of parallel OT, as it demands to produce the framework to elucidate a deleting element which becomes unobserved on the outer layer (McCarthy, 2003: 76).

The implementation of these three processes iteratively occurred on the dataset. Initially, distributional investigation discovers phonological forms. Secondly, the analysis of syllable structures demonstrates these forms through applying prosodic conditions. Third, rule interaction analysis explains how the processes are connected. This approach combines traditional generative phonology (Chomsky & Halle, 1968; Kenstowicz, 1994) with concepts from Optimality Theory (Prince & Smolensky, 1993/2004; McCarthy, 2008).

4. Data Synthesis and Paradigm Construction

In order to comprehend the peculiar and ambiguous behavior of augmented agentive nouns, it is initially essential to determine the regular or conservative pattern of the language. In Almarj Cyrenaican Arabic, the Form I agentive noun represents this regular pattern. In comparison with Form I, Forms II and III apparently demonstrate the structural variations that contribute to the incorporation of syncope and prothesis (Owens, 1984; Mitchell, 1952; Moftah, 2018).

4.1 The Conservative Baseline: Form I Agentive Nouns

In the majority of Arabic varieties, Form I active participles are morphologically consistent and typically adhere to the conventional fā'il pattern (Ryding 2005; Watson 2002; Holes 2004). The variety of Almarj has an identical

linguistic system. Mitchell (1952: 381) and Owens (1984: 70) note that there is a simple change in the fā'il structure and this operation does not include syncope or prosthesis that frequently accompanies the structure of augmented forms.

Table 2: Form I Sound Root Agentive Nouns in Almarj Arabic

Root	Verb Base (Almarj)	Agentive Noun (Underlying)	Agentive Noun (Surface IPA)	Gloss
K-T-B	<i>katab</i>	/ka:.tib/	['kæ:.tib]	'writer'
D-R-S	<i>daras</i>	/da:.ris/	['dæ:.ris]	'student/teacher'
F-H-M	<i>faham</i>	/fa:.him/	['fæ:.him]	'understander'
SH-R-B	<i>šarab</i>	/ʃa:.rib/	['ʃæ:.rib]	'drinker'
A-K-L	<i>Akal</i>	/ʔa:.kil/	['ʔæ:.kil]	'eater'

Sources: Mitchell (1952: 381), Owens (1984: 70), Moftah (2018: 135)

Kiparsky (2003) and Broselow (1992) states that Form I possesses a steady phonological system and this is attributed to its prosodic structure. In comparison with the augmented forms, Form I does not encompass prefixes such as /mu/. The word starts immediately with a root consonant which is followed by a heavy syllable (CVV) including the long low vowel /a:/ (Watson, 2002: 87). As Owens (1984: 86) notes "the initial CVV syllable in Form I participles is inherently heavy, containing two moras, and therefore attracts primary stress under the Cyrenaican stress rule."

Stress in Cyrenaican Arabic is determined by syllable weight and often assigned to the rightmost heavy syllable (Owens, 1984: 86; Moftah, 2018: 92-98; Mitchell, 1960: 376). Since the initial syllable of Form I participles is heavy, it receives the primary stress whether it is the only or the ultimate heavy syllable in the word. Moftah (2018: 95) demonstrates acoustically that "the primary stress in Form I participles invariably falls on the initial heavy syllable, with a mean duration increase of 35% compared to unstressed syllables." This indicates that the vowel in the first syllable is neither short, high nor unstressed. As a result, it does not fulfil the structural criterion to be classified as syncope (Owens, 1984: 72; Moftah, 2018: 132).

The syncope environment of Almarj Arabic dialect can be formally represented as below:

(1) Syncope Environment in Almarj Arabic

V → ∅ / [__ C (C) #

Conditions:

- (a) V = short high vowel (/i/ or /u/)
- (b) V is in an open syllable
- (c) V is unstressed
- (d) V is word-initial (or in the initial syllable of a prosodic word)

None of these requirements are met by Form I active participle. The /a:/ vowel cannot be considered as a close vowel. It takes place in a heavy syllable, bears primary stress, and emerges in the initial position instead of in a light open syllable. Accordingly, syncope does not manifest in such structures (Owens, 1984: 72; Moftah, 2018: 133).

In contrast to regular roots, weak roots mandates certain phonological repair strategies, where Almarj dialect revealed a clear constrain system (McCarthy, 1981; Watson, 2002). Even though the input can cause ill-formed structure, these phonological repair strategies revealed important insights on Almarj dialect grammar as it adheres to fā'il pattern (Owens, 1984: 70-71; Mitchell, 1952: 382).

Hollow Roots

Hollow root is the root that has a glide in medial position (e.g., S-Y-R 'walk', N-W-M 'sleep'). The medial glide forms a vowel sequence that is not licensed in Almarj dialect's fā'il pattern, resulting in form as */sa:.ir/ (Ryding 2005:188). In Modern Standard Arabic, this problem is solved by adding a glottal stop in medial position instead, generating a structure such as /sā'ir/ 'walker'. This strategy inserts the glottal stop as a repair procedure, where the glottal stop serves as a default onset to separate vowels sequence (McCarthy, 2007: 87-92). However, this strategy of the glottal stop insertion is not allowed in Almarj dialect because of the faithfulness of *GLOTTAL-STOP constraint (Moftah, 2018: 166-172; Benkato, 2014: 82). In Almarj dialect, instead of glottal stop the glide /j/ is inserted in medial position, forming an agentive noun as ['sae:.jir] to represent / sa:.ir/ 'walker'. Employing the glide /j/ instead of the glottal stop as a repair strategy in Almarj dialect contrast with MSA and other eastern dialects in the treatment of this phenomenon (Owens, 1984: 71).

Defective Roots

A defective root is the root that has a semivowel at final position of the verb (e.g., N-S-W 'forget', R-D-Y 'accept'). In MSA, this type of root has specific patterns determined by the verb grammatical case (Ryding 2005:190). On Contrary, Almarj applies a different technique when deriving agentive nouns from defective verbs. Almarj dialect

uses a single invariant form of all defective verbs with no regard to the grammatical case, replacing the final /j/ with the long vowel /i:/ as in [raedi:] 'acceptor' (Owens, 1984: 71; Mitchell, 1952: 382). This technique is also documented in other Magherbi dialects as a morphological leveling strategy (Heath, 2002; Benkato, 2014).

Geminate Roots

Geminate roots are roots that contain double consonants (e.g., H-S-S 'feel' and H-B-B 'love'). However, in masclan nouns this gemination is not permitted, where one of the double consonants is reduced. For example, */ma:.dd/ surfaces as [mae:d] 'extender'. On the other hand, the feminine version remains geminated as the suffix contains a vowel to prevent coda consonant cluster as in [mae:d.da] 'extender' (f) (Owens, 1984: 71; Mitchell 1952: 382-383). The reduction of gemination can be justified by the constraints ranking in Almarj dialect grammar. Almarj dialect follows the higher-ranking constraints *GEMINATE-CODA that over rank MAX-IO (maintain gemination), while *GEMINATE-CODA constraint in Almarj lower than DEP-IO constraint (vowel insertion to prevent complex coda and prevent final position gemination) (McCarthy, 2008: 156-160).

All Form I patterns preserve the conventional core syllable structure. In Stratal Optimality Theory, Form I verbs maintain the core template-based framework at Stem-Level, where markedness constraints ranked lower than MAX-IO and IDENT-IO (Kiparsky, 2003: 165). This issue is covered in detail in section 6.2.

4.2 The restructuring of Form II and Form III verbs

The main critical issue is revealed by the study of augmented verbs Form II and Form III in Almarj dialect. In Form II, the most prominent feature is the second root consonant gemination (C₂), conveying the meaning of causative or intensive actions, such as in 'kasar' 'smash' becomes 'kassar' 'to smash on purpose' (Ryding, 2005; 430-445). Form III is distinguished by the presence of the long vowel /a:/ after (C₁), such as in hajam 'attack (general action)' becomes hājam 'to attack (engaged against another)', usually conveying the meaning of directed or interactive meaning.

According to Broselow (1992: 57) and Hayes (1989: 260), the augmented forms containing the inflectional prefix /mu-/ emerges at the beginning of the verbal root, and this is considered contrary to Form I, since the mentioned prefix generates a light, open, monomoraic syllable (CV). Owens (1984:86) demonstrates that "the prefix /mu-/ in Forms II and III is prosodically weak: it contains a single short vowel in an open syllable, and it never receives stress in the surface form."

Table 3: Form II and III Augmented Agentive Nouns in Almarj Arabic

Root	Form	Verb Base (Almarj)	Agentive Noun (Underlying)	Surface Realization	Gloss
K-S-R	II	<i>kassar</i>	/mu-kassir/	[ə̌m.kas.sɪr]	'smasher'
D-R-S	II	<i>darras</i>	/mu-darris/	[ə̌m.dar.rɪs]	'teacher'
Q-T-L	II	<i>qattal</i>	/mu-qattil/	[ə̌m.gat.tɪl]	'killer'
SH-R-H	II	<i>farrah</i>	/mu-farrih/	[ə̌m.far.rɪh]	'explainer'
S-'D	III	<i>sā'ad</i>	/mu-sā'id/	[ə̌m.sæ:.ɪd]	'helper'
H-J-M	III	<i>hājam</i>	/mu-hājim/	[ə̌m.hæ:.dʒɪm]	'attacker'
Q-T-L	III	<i>Qātal</i>	/mu-qātil/	[ə̌m.gæ:.tɪl]	'fighter'
S-'D	III	<i>sā'ad</i>	/mu-sā'id/	[ə̌m.sæ:.ɪd]	'helper'

Sources: Mitchell (1952: 383-384), Owens (1984: 72-73), Moftah (2018: 138-141)

According to Broselow (1992: 57) and Hayes (1989: 260), the augmented forms containing the inflectional prefix /mu-/ emerges at the beginning of the verbal root, and this is considered contrary to Form I, since the mentioned prefix generates a light, open, monomoraic syllable (CV). Owens (1984:86) demonstrates that "the prefix /mu-/ in Forms II and III is prosodically weak: it contains a single short vowel in an open syllable, and it never receives stress in the surface form."

Since Form II encompasses a closed syllable (CVC) established by germination, the stem of the subsequent syllable becomes heavy, whereas Form III is characterised by long vowels, forming a CCV syllable. In this case, the rightmost heavy syllable carries the primary stress (Owens, 1984: 86; Moftah, 2018: 94-98). As opposed to the abovementioned, because of its status is structurally weak, the prefix vowel /u/ demonstrates a short and high feature positioning in the context of an unstressed and open syllable. This identical context initiates the strong syncope process in Almarj variety and the derivational process (Owens, 1984: 72, Moftah, 2018: 132-135).

Table 4: Syllable Weight and Stress Assignment in Form II Agentive Nouns

Form	Syllabification	Syllable Weights	Stress Assignment
Underlying	/mu.kas.sir/	L - H - H	Rightmost H = final syllable
After syncope	[mkas.sir]	(σ - H) - H	Stress on final syllable (preserved)
After prothesis	[əm.kas.sir]	H - H	Stress on first H?—check

Source: Owens (1984: 86), Moftah (2018: 94-98)

As Moftah (2018: 133) explains, "the prefix vowel /u/ in Forms II and III participles meets all four conditions for syncope: it is high, in an open syllable, unstressed, and word-initial. Deletion is therefore categorical in casual speech."

It is significant to highlight that syncope is entirely consistent across all cases of Form II and Form III. However, Moftah (2018: 135-138) discusses a number of restrictive contexts in which the prefix vowel /u/ is retained, as well as environments in which deletion remains variable such as the following:

(a) When the following consonant is guttural (/ħ/, /ʕ/, /h/, /ʔ/, /x/, /ɣ/): [mu.ħam.mil] 'loader' (from */mu-ħammil/) not *[əm.ħam.mil]

(b) In careful speech styles (deletion rates fall to approximately 78%, Moftah, 2018: 115) (c) In some feminine forms where a suffixal vowel protects the prefix (Owens, 1984: 74)

However, this assumption is not entirely correct, where actually guttural sounds does not block syncope in Almarj dialect. In the environment (a) proposed by Moftah (2018: 135-138) the verb [mu.ħam.mil] 'loader' must be receive syncope resulting in [əm.ħam.mil]. This misunderstanding may be caused by the use of MSA by speakers instead of Almarj dialect. In term of Almarj dialect syncope is entirely consistent across all cases of Form II and Form III.

5. Formal Analysis: Syllable Structure and Rule Interaction

For the purpose of understanding the reason of the selection of surface form [əmkassir], it is significant to meticulously assess the syllable structure and look at the connection of the phonological rules included in the process. The current section presents a prosodic analysis through relying on Moraic Theaory (Hayes, 1989; Hyman, 1985) and find out the mechanism of connection process between prothesis and syncope (Kenstowicz, 1994; Kiparsky 1973).

5.1 Distributional Analysis and Syllable Weight

As for Moraic Theory, the syllable structure has two forms. The heavy syllable (CVC or CVV) which is composed of two moras (μμ) and the light syllable (CV) is comprised of one mora (μ) (Hayes, 1989: 258; Hyman, 1985: 12). In Arabic Phonology, regarding the assignment of stress, CVV syllables encompassing long vowels and CVC syllables containing short vowels are both categorised as heavy, notwithstanding its internal structures are contrastive (Broselow, 1992: 56-58; Kiparsky, 2003: 155-158). As illustrated by Kiparsky (2003: 156), "the weight distinction in Arabic is quantity-sensitive, with CVV and CVC counting as bimoraic and CV as monomoraic." The underlying representation /mu.kas.sir/ has the following syllable weight mapping:

(3) Syllable Weight Mapping for /mu.kas.sir/

- Syllable 1: [mu] = CV = 1 μ (light, monomoraic)
- Syllable 2: [kas] = CVC = 2 μ (heavy, bimoraic)
- Syllable 3: [sir] = CVC = 2 μ (heavy, bimoraic)

In accordance with the Maximal Onset Principle (Selkirk, 1982; Blevins, 1995), syllabification assigns consonants to syllable onsets whenever feasible, provided that the resulting onset is phonotactically well-formed. In the present case, the medial /s/ constitutes the onset of the third syllable ([si-]) rather than the coda of the second syllable, resulting in a phonologically permissible CV syllable and avoiding a complex coda (cf. Itô 1989: 230-235). As a consequently, the word comprises three syllables: a light syllable in the initial position followed by two heavy syllables.

The following section provides an analysis of the stress rule in Cyrenaican Arabic variety (Owens, 1984: 86; Moftah, 2018: 94-98; Mitchell, 1960: 376):

(4) Cyrenaican Arabic Stress Rule

The primary stress of the word is placed on the rightmost heavy syllable (CVC or CVV). In case the word has no heavy syllables, stress occurs on the leftmost syllable (the first syllable).

When employing this criteria to /mu.kas.sir/, the rightmost heavy syllable is the last syllable [sir], which stands for CVC and hence heavy. Thus, primary stress sits on the penultimate syllable, leaving the first syllable [mu] unstressed. Moftah (2018: 96) corroborate this with acoustic analysis findings, indicating that "in Form II participles, the stressed syllable shows an average duration of 120ms, while the unstressed prefix vowel has a duration of only 45ms, making it highly susceptible to reduction and deletion."

The dialect systematically avoids light, unstressed syllables with high vowels, giving rise to pressure to enhance the prosodic well-formedness through deletion of the weak mora (Kiparsky, 2003: 162-165). As it is shown in section 6, this pressure is indicated via the markedness restriction *V [-stress, +high], which restrains high vowels from being stressed.

5.2 Derivational Rule Ordering

When this phenomenon is examined within the framework of Generative/Derivational Phonology (Chomsky & Halle, 1968; Kenstowicz, 1994), an obvious set of ordered phonological principles becomes apparent. While the current research ultimately utilizes an alternative theoretical context, analysing this process in the form of rule ordering sheds light on the correlation between syncope and prothesis (Kiparsky, 1973; McCarthy, 2003).

Rule 1: Syncope

(5) Syncope Rule (Almarj Arabic)

[+syllabic] → ∅ / [__ C₀ (C) #

Conditions:

- [+syllabic] = [+high, -low, -stress]
- The vowel appears in an open syllable
- The vowel occurs word-initially (in the first syllable of the prosodic word)

By applying Rule 1 to the input /mu-kassir/, the prefix vowel is eliminated, thereby leaving the bilabial nasal /m/ at the initial position of the word:

(6) Syncope Application

Input: /mu.kas.sir/

Apply Syncope: eliminate /u/ in the initial unstressed open syllable

Output: [mkas.sir]

The intermediate form [mkas.sir] triggers substantial phonotactic issues. The initial cluster [mk] is comprised of a comparatively high-sonority nasal followed by a voiceless stop which is lower in sonority. With regard to the Sonority Sequencing Principle (SSP), sonority needs to rise from the margin of syllable to the vowel nucleus (Selkirk, 1982; Blevins, 1995; Clements, 1990). According to Clements (1990: 287), "the SSP is a universal tendency requiring that sonority increase from the onset to the nucleus and decrease from the nucleus to the coda." Almarj dialect strictly disallows restricts word-initial consonant clusters with decreasing sonority. Because the initial /m/ is unable to serve as a component of a well-formed onset in this context, it is parsed as unsyllabified or extrasyllabic (Itô, 1989: 230-235; Prince & Smolensky, 1993/2004: 110-115). Therefore, the grammar employs an alternative repair strategy.

Rule 2: Prothesis

(7) Prothesis Rule (Almarj Arabic)

∅ → [ə] / # __ C₁C₂

Conditions:

- C₁C₂ is a word-initial consonant cluster
- The cluster violates *SONORITY-FALL (i.e., sonority decreases from C₁ to C₂)

When Rule 2 is applied to the intermediate form [mkassir], a prothetic vowel is inserted, resulting in a syllabic nucleus that permits the initial nasal to be properly syllabified while eliminating the prohibited word-initial consonant cluster.

(8) Prothesis Application

Input: [mkas.sir] (from syncope)

Apply Prothesis: insert [ə] before the initial cluster

Output: [əm.kas.sir]

The resulting surface form, [əm.kas.sir], conforms to the phonological rules. The first syllable [əm] has a heavy (CVC) structure, in which the nasal /m/ functions as the coda after the prothetic vowel. The remaining part of the word is syllabified as [kas.sir]. The two segments of the geminate /ss/ are split across adjacent syllables, with the first serving as the coda of the second syllable and the other functioning as the onset of the third syllable. There pertains consistency between this pattern [kas.sir] and geminates in Arabic phonology (Davis, 2011; Watson, 2002).

5.3 The Testing of the Interaction Rule

The relationship between the two rules shows a clear example of feeding order (Kiparsky, 1973; Kenstowicz, 1994). Rule 1 (Syncope) creates the phonological environment required for the application of Rule 2 (Prothesis). More specifically, the generation of the consonant cluster [mk] through syncope triggers prothesis. Prothesis would not occur without syncope, given that the underlying form [mu.kas.sir] does not contain a consonant cluster in an initial position. The feeding order interaction could be described in the following way:

(9) Feeding Relationship

Syncope → environment for Prothesis

Therefore: Syncope feeds Prothesis

Nevertheless, from the perspective of the ultimate surface form, this interaction is not instantly apparent. The surface output [əmkassir] features the prothetic vowel [ə] at the beginning of the word, given the impression that no vowel has been eliminated. Instead, it may seem that the original vowel has merely altered its quality from /u/ to [ə]. Hence, this resultant pattern constitutes a template of counter-bleeding opacity (Kiparsky, 1973: 87; McCarthy, 2003: 75–78). Generally, a constraint that prevents vowel deletion would remove the necessity for prothesis, as retaining the vowel would prohibit the generation of the problematic cluster. Yet due to the initial application of syncope, the resultant opacity serves as part of the representation of the final surface.

(10) Counter-Bleeding Opacity

Rule A (Syncope) applies.

Rule B (Prothesis) applies to the output of Rule A.

Rule B obscures the environment for Rule A (the unstressed high vowel) by altering the word-initial structure. As a result, the surface form offers no direct evidence that Rule A originally applied.

This form of opacity poses a significant challenge to parallel Optimality Theory. The surface form [əmkassir] contradicts both MAX-IO (deleting /u/) and DEP-IO (inserting [ə]). A parallel OT evaluation cannot adequately explicate why this form is the preferred choice over candidates for instance [mukassir], that violates merely DEP-IO, or [mkassir], that violates merely MAX-IO, unless it employs supplemental mechanisms including intermediate representations or sympathy constraints (McCarthy, 2003: 76-78).

As Kiparsky (2000: 352) asserts, "the Duke-of-York derivation is the acid test for phonological theory: any framework that cannot handle it gracefully is missing something essential about the nature of phonological computation."

The subsequent sections explain the process by which Stratal Optimality Theory addresses this opacity by categorising the grammar into structured levels using various constraint rankings. Following this framework, for instance, the intermediate form [mkassir] is formed at the Word Level and subsequently transferred to the Post-Lexical Level, at which prothesis occurs. According to Bermúdez-Otero (2018: 118-124), opacity arises naturally from the layered structure of the grammar, rather than from the application of specific processes.

6. Resolving Opacity: A Stratal Optimality Theory Account

Parallel Optimality Theory assesses all feasible candidates concurrently through employing a single constraint ranking. This creates an abstractness problem while encountering with counter-bleeding opacity (Kiparsky, 2000; McCarthy, 2003; Bermúdez-Otero, 2018). A parallel evaluation is adequately incapable of clarifying why the grammar favours a candidate that contravenes both MAX-IO (against deletion) and DEP-IO (against insertion), yet distinguishing between the real underlying form /mu-kassir/ as well as a hypothetical, unsubstantiated form /mə-kassir/ (Prince & Smolensky, 1993/2004; McCarthy, 2008). As Kiparsky (2015: 40) points out, "parallel OT forces the analyst to treat every opaque interaction as a global optimisation problem, often requiring ad-hoc sympathy constraints or indexed faithfulness that have no independent motivation."

According to Kiparsky (2000, 2015) and Bermúdez-Otero (2018), Stratal Optimality Theory (SOT) presents a more appropriate framework so as to analyse this phenomenon. Dividing the grammar into three distinct ordered levels – the Stem Level, Word Level, and Post-Lexical Level- Stratal Optimality Theory allows constraint rankings to vary across these levels. The organization into distinct strata clearly represents the intermediate stages of the derivation and provides a simple account of the Duke-of-York pattern. By combining the derivational insight of Lexical Phonology with the constraint-based architecture of Optimality Theory, Stratal Phonology accounts for opacity without relying on global look-ahead (Bermudez-Otero, 2018).

6.1 Constraint Inventory

The formal investigation is grounded on the following fundamental constraints that are frequently employed in the Optimality Theory literature (Prince & Smolensky, 1993/2004; McCarthy, 2008; Kager, 1999) and have been applied to Arabic language by Watson (2002), Kiparsky (2003), and Moftah 2018.

Faithfulness constraints (input-output correspondence):

- **MAX-IO:** Each of the segments in the input must correspond to a segment in the output (no deletion).
- **DEP-IO:** Each of the segments in the output must align with a segment in the input (no insertion).
- **IDENT-IO[high]:** The corresponding segments must possess the equivalent value for the feature [high].
- **IDENT-IO[low]:** The corresponding segments must contain the equal value for the feature [low].
- **IDENT-IO[stress]:** the corresponding segments must maintain the exact stress features.

Markedness constraints (surface well-formedness):

- ***V[-stress, +high]:** Open syllables cannot include unstressed short high vowels. The constraint is a particular variation of the more general *WEAK-V, though it is crucial since Almarj dialect exclusively eliminates high vowels, leaving low vowels preserved (Moftah, 2018: 132).
- ***COMPLEX-ONSET:** Syllable onsets must merely include one consonant.
- ***SONORITY-FALL:** In a complex onset, sonority cannot decline from the initial consonant to the second. This constraint is a more particular form of *COMPLEX-ONSET, capturing the phonotactic characteristics of Almarj dialect and centred upon the Sonority Sequencing Principle (Selkirk, 1982; Clements, 1990).
- ***COMPLEX-CODA:** Codas must merely comprise one consonant.
- ***GLOTTAL STOP:** Glottal stops are not permitted. This constraint is based on the non-occurrence of glottal stop prothesis in the Arabic variety spoken in Almarj (see Benkato, 2014: 82; Moftah, 2018: 166-172).
- **ONSET:** all syllables must commence with onsets.
- **WEIGHT-STRESS:** Heavy syllables are associated with stress. This describes the Cyrenaic stress pattern defined by Owens (1984: 86) and Moftah (2018: 94-98).
- **ALIGN-LEFT (PRWD, σ):** The left edge of a prosodic word must correspond to the left edge of a syllable. This constraint prohibits word-initial unsyllabified (extrasyllabic) consonants. (cf. Itô, 1989).

The ranking in which these constraints appear does not remain consistent across the grammar. According to Kiparsky (2015) and Bermúdez-Otero (2018), each stratum maintains its unique constraint hierarchy, indicating the reality that distinct phonological processes occur in various grammatical domains.

6.2 Stratum 1: The Stem Level

At the Stem Level, the grammar examines the initial morphological combination, verbal pattern, and agentive prefix: /mu-kassir/. This is the most profound lexical level, during which morphemes are originally constructed. At this phase, faithfulness to the underlying morphological framework takes precedence over markedness constraints, maintaining that the initial morphemes stay intact (Kiparsky, 2015: 42-45). Any deletion or insertion at this level would compromise the morphological integrity of prefix.

Stratum 1 Ranking:

MAX IO, DEP IO, IDENT IO[high] >> *V[stress, +high], *SONORITY FALL, ONSET

Tableau 1: Stem Level evaluation of /mu kassir/

Input: /mu-kassir/	MAX-IO	DEP-IO	IDENT[high]	*V[-stress,+high]	*SON-FALL
a. [mu.kas.sir]				*	
b. [mkas.sir]	*!				*
c. [ə̃m.kas.sir]	*!	*			
d. [m̩ə.kas.sir]	*!		*		

Candidate (a) that totally retains the underlying form entirely contravenes the markedness constraint *V[-stress,+high] since the prefix vowel /u/ represents a high, unstressed vowel within an open syllable. Nevertheless, this contravention is tolerated as faithfulness constraints are prioritised foremost at this level. Candidates (b) and (c) employ syncope prematurely, whereas candidate (c) also includes prothesis simultaneously. Consequently, both candidates incur fatal violations of MAX-IO, whereas candidate (c) is also in violation of DEP-IO. Candidate (d) alters the vowel quality from /u/ to [ə̃], thereby violating IDENT[high]. Hence, the optimal output of the Stem Level is known as the faithful version [mukassir]. This is in alignment with the finding that, at the most profound lexical level, the morphological prefix is entirely retained. (Owens, 1984: 74; Moftah, 2018: 140).

6.3 Stratum 2: The Word Level

The output of Stratum 1 ([mukassir]) acts as the essential input for Stratum 2, the Word Level. At this level, a significant re-ranking of constraints occurs: the markedness constraint versus weak vowels takes priority over the faithfulness constraints (Kiparsky, 2003:165; Moftah, 2018:189). This refers to the level in which syncope occurs. According to Kiparsky (2015: 47), "at the Word Level, phonotactic restrictions that refer to prosodic word boundaries become active, often triggering deletion or neutralisation that is not visible at deeper levels."

Stratum 2 Ranking:

*V[stress, +high] >> MAX IO >> DEP IO, *SONORITY FALL

Tableau 2: Word Level evaluation of [mukassir]

Input: [mu.kas.sir]	*V[-stress,+high]	MAX-IO	DEP-IO	*SON-FALL
a. [mu.kas.sir]	*!			
b. [mkas.sir]		*		*
c. [əm.kas.sir]		*	*!	

Candidate (a) is instantly eliminated since it violates the top-ranked constraint *V[-stress,+high]. Candidate (c) eliminates the vowel while simultaneously inserting a prothetic vowel. Because MAX-IO dominates DEP-IO, the grammar prioritises deletion over superfluous insertion, which makes candidate (c) less optimum rather than candidate (b). Candidate (b) violates MAX-IO through the successful deletion of a weak vowel. Even though this yields an impermissible consonant cluster that incurs violation of *SONORITY-FALL, such a constraint has not yet achieved dominance at the Word Level. Accordingly, the intermediate form [mkassir] is realized as the optimal output.

It is worth noting that this intermediate form should not be treated as merely a theoretical representation. Although its occurrence is relatively rare, this process may be observed in actual speech, particularly when words are pronounced accurately or emphatically. The rate of prothesis decreases to approximately 78% in careful speech, suggesting that [mkassir] may occasionally be pronounced (Moftah, 2018). This observation provides strong evidence for the stratal analysis by demonstrating that the intermediate form has a genuine, although limited, phonetic realization.

6.4 Stratum 3: The Post-Lexical Level

The intermediate form [mkassir] is then carried over to the Post-Lexical Level. At the final level, the grammar mainly prioritizes phonetic well-formedness and surface phonotactic constraints (Kiparsky, 2015; Bermudez-Otero 2018). Because the SONORITY-FALL constraint is not dominated any longer, the illicit consonant cluster is subject to a structural modification. At this level, vowel insertion is also allowed, as post-lexical phonology gives less importance to preserving the exact underlying form.

Stratum 3 Ranking:

*SONORITY FALL, ONSET, ALIGN LEFT >> DEP IO >> MAX IO

Tableau 3: Post Lexical Level evaluation of [mkas.sir]

Input: [mkas.sir]	*SON-FALL	ONSET	ALIGN-L	DEP-IO	MAX-IO
a. [mkas.sir]	*!		*		
b. [əm.kas.sir]				*	
c. [kas.sir]					*!

The first nasal-stop sequence in candidate (a) critically contravenes the rule against falling-sonority onset clusters [mk]. Additionally, it violates ALIGN-LEFT because the first /m/ is not part of the syllable structure. Candidate (c) entirely suppresses the nasal prefix in order to resolve the problem, although this situation is in violation of MAX-IO by stripping out the agentive prefix. Candidate (b) uses the default prothetic vowel, [ə]. While this is in contradiction to DEP-IO, the low-ranked status of DEP-IO at the Post-Lexical Level permits this structural repair. The generated form [əm.kas.sir] fulfils all of the top-ranked markedness requirements. The opening syllable [əm] constitutes a well-formed, heavy CVC syllable with /m/ representing a coda, whereas the subsequent syllables [kas.sir] match the requisite sonority pattern.

Therefore, the grammar accurately generates the ultimate surface form [əmkassir]. Stratal Optimality Theory further clarifies the Duke-of-York derivation by dividing the various phonological pressures over ordered grammatical domains, without the need for the grammar to indicate to hidden intermediate representations contained within an individual simultaneous evaluation.

Summary of the Stratal OT Analysis

Table 5 summarises the constraint rankings and outputs at each stratum.

Table 5: Stratal OT summary for Almarj agentive noun derivation

Stratum	Input	Dominant Constraints	Output	Rationale
Stem Level	/mu-kassir/	MAX, DEP, IDENT	[mukassir]	Preserve morphemic identity
Word Level	[mukassir]	*V[-stress,+high] MAX	>> [mkassir]	Delete weak high vowel
Post-Lexical Level	[mkassir]	*SON-FALL >> DEP	[əmkassir]	Repair illicit cluster via prothesis

The Stratal OT analysis illuminates the ambiguous pattern rather than reliance upon sympathy constraints or the unique limitation ranking proposed in Harmonic Serialism. The derivation is made clearer by compartmentalizing the grammar into various layers with distinct constraint rankings. The stratal model is

especially appropriate in situations where an identical surface form emerges from distinct constraint rankings at different levels, reflecting the temporal and modular structure of grammatical computation (Bermudez-Otero, 2018).

7. Discussion and Broader Theoretical Implications

The comprehensive investigation of agentive noun formation in Almarj dialect contributes to a broader understanding of Semitic morphophonology, phonological opacity, and the overall structure of grammar.

7.1 Prosodic Weight and Morphological Resilience

The contrast between the remarkable stability of Form I fā'il and the opaque restructuring of Forms II and III stresses a close connection between prosodic weight and the preservation of morphological structure (Kiparsky, 2003; Broselow, 1992; Hayes, 1989). The Form I pattern opens with a heavy, bimoraic syllable, thereby establishing a conservative morphological base (CVV). The prosodic strength of this structure serves to preserve the structural integrity of the pattern against phonological reduction. Acting as a protective barrier, the heavy initial syllable of Form I participle provides structural resistance to the erosion affecting lighter prefixes (Owens, 1984). Generally speaking, this structure illustrates a universal linguistic principle, viz. markedness constraints, which are responsible for vowel reduction and diachronic change; markedness constrains affect prosodically weak, monomoraic elements such as the unstressed /mu-/ prefix. This phenomenon is not unique to Arabic, as it has been documented in unstressed-syllable reduction across Romance, Germanic languages, as well as in other Semitic languages (Bybee, 2015; Kager, 1999).

From a diachronic perspective, the absence of the /mu-/ prefix in Form I participles is not seen as a synchronic contrast. Nonetheless, evidence from dialects that preserve reflexes of the prefix (such as MSA and careful-speech Cairene Arabic) demonstrates that its reduction reflects a continuous process of historical development. With respect to Almarj, the prefix has been reduced to a consonantal mora whose occurrence is restricted to the presence of a prothetic vowel. Akin to some Moroccan varieties where the agentive prefix has experienced complete integration, this stage can be regarded as an intermediate phase in the overall process of prefix loss (Heath, 2002).

7.2 The Psychological Reality of Stratal Computation

Bermudez-Otero (2018) and Kiparsky (2015) noted that the interaction between syncope and prothesis gives evidence for the psychological reality of stratal organization phonological processing. The clear distinction between lexically conditioned syncope, which concentrates on particular morphological affixes entailing /mu-/ prefix, and post-lexical prothesis, which resolves violations of sonority irrespective of word boundaries, shows that phonological processing cannot be adequately approached through one uniform level of analysis.

Experimental studies of speech production and perception further support this conclusion. Moftah (2018) reports a forced-choice identification study in which participants assessed whether [mkassir] and [əmkassir] were well-formed. Though [mkassir] is infrequently used, participants consistently deemed it "possible but awkward" and described it as an intermediate form. Furthermore, priming studies demonstrated that [mkassir] facilitated the processing of [əmkassir] more effectively than [mukassir], confirming the psychological reality of the intermediate representation (Moftah, 2018). These findings offer further support to the stratal structure, which holds that intermediate outputs are genuine grammatical forms rather than merely theoretical constructs.

More broadly, the interaction between templatic morphology and evolving surface phonotactic constraints is commonly attested by Semitic languages, positing that opaque derivations constitute an inherent aspect of the grammar rather than a distinctive phenomenon (McCarthy, 1981; Watson, 2002). Stratal Optimality Theory therefore serves as both a powerful analytical approach and an explanatory framework for phonological computation. Stratal Optimality Theory presents a cognitively plausible representation of the interface between lexicon and phonology, which is consistent with our knowledge of lexical access, speech production, and language acquisition (Kiparsky, 2015).

8. Conclusion

The formation of augmented agentive nouns in Almarj dialect of Cyrenaican Libyan Arabic represents a clear example of derivational opacity, paradigm restructuring, and the interaction of constraints. Despite their apparent surface simplicity, forms such as [əmkassir] result from a complex sequence of phonological processes in which the systematic deletion of a morphologically essential vowel prefix is followed by an epenthetic schwa inserted only to repair ill-formed, falling-sonority initial consonant clusters.

Through a formal reinterpretation of existing descriptive data rather than newly collected fieldwork data, this study provides evidence that parallel Optimality Theory cannot adequately capture the Duke-of York underlying the observed pattern. A comparable analysis would require using sympathy constraints or similar devices which lack both psychological motivation and the ability to account for the domain-specific properties of the interacting processes. Stratal Optimality Theory, by contrast, offers a more constrained and explanatory analysis. Organizing phonological computation through a sequence of ordered strata makes it possible for the grammar to satisfy morphological faithfulness at the stem level, weight-dependent syncope at lexical level, and sonority-based

phonotactic reconstruction at the post-lexical level. This formal analysis precisely derives the surface form and generates the intermediate form [mkassir], which receives independent validation by careful-speech pronunciations.

8.1 Limitation and Future Directions

While the present study offers a comprehensive analysis of agentive noun derivation in Almarj dialect, it is subject to several limitations and suggests areas for future research. First, the analysis draws mainly on data from published descriptions instead of original fieldwork research. Despite the strong empirical basis offered by these data, future research should collect additional acoustic and sociolinguistic data from Almarj speakers of different age groups, genders, and levels of education to further validate the identified patterns and explore dialectal variation. Secondly, the misinterpretation of guttural blocking effect posited by Moftah (2018) necessitates a more profound examination. Third, instrumental phonetic analysis is required to investigate the phonetic characteristics of the prothetic vowel, whether its realization is consistently a schwa or varies depending on the following consonant. Fourth, limited research has investigated the interaction between syncope and phrasal phonology, particularly prothesis across word boundaries. Hence, a more comprehensive Stratal OT analysis should incorporate an independent Phrasal Level to account for connected speech process.

From a theoretical perspective, the relationship between Stratal OT and Distributed Morphology also calls for further clarification. The present study proposes that each morphological cycle (root, stem, and word) is consistent with a phonological stratum. However, the specific alignment between DM phases (such as $\sqrt{\text{root}}$, $\sqrt{\text{P}}$, and VoiceP) and OT strata is not clear yet. Embick (2010) puts forward a cyclic spell-out model that aligns with the structure of lexical strata and could be applicable to Almarj dialect. The analysis of Form II gemination raises the broader question of whether gemination should be viewed as a phonological phenomenon or as a morphologically conditioned pattern. Within Distributed Morphology, it may be treated as a Readjustment Rule conditioned by the [+Caus] feature, a question that necessitates further theoretical investigation.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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