# An overview of phonological interactions in Judeo-Baghdadi Arabic*

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**Abstract**

Judeo-Baghdadi Arabic is an endangered Jewish variety of Arabic (Semitic) spoken in Israel by Jewish immigrants from Baghdad. In this paper, we provide an overview of the phonological system of this variety, focusing on the complex range of interactions between its supra-segmental phonological processes. These interactions raise several issues that have been of theoretical interest to phonologists, including multiple cases of opacity, a non-trivial distribution of schwa, as well as morphological and sonority-based conditions on epenthesis. This is the first overview of interactions between phonological processes in this variety.

# 1 Introduction

Judeo-Baghdadi Arabic (JBA) is an endangered dialect of Arabic spoken in Israel by Jewish immigrants from Baghdad, Iraq. In Baghdad, this dialect was exclusive to the Jewish community, and was distinct from the Muslim and Christian dialects spoken there (Blanc, 1964; Mansour, 1991). There were two main waves of immigration from Iraq to Israel, one in the early 1950s and one in the 1970s, after which no Jewish community remained in Baghdad. In Israel, where the primary Jewish language is Hebrew, the Judeo-Baghdadi dialect is not passed on to children as a native language. The remaining native speakers of JBA are therefore those who have immigrated to Israel from Baghdad or those who were born in Israel and were exposed primarily to JBA in their early years. The number of remaining speakers is difficult to estimate. According to the 2022 survey of the Israeli Central Bureau of Statistics, there are 42,200 immigrants from Iraq currently living in Israel.[1] More than 98.8% of them are of age 65 or above, meaning that the language is critically endangered.

In addition to being endangered, JBA is also an under-researched dialect of Arabic. Blanc (1964), Mansour (1991), and Bar-Moshe (2019a) have laid the foundations for researching the

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[1]"*Population – Statistical Abstract of Israel 2022 – No.73*" by the Central Bureau of Statistics. The full report is available online at: https://www.cbs.gov.il/en/publications/Pages/2022/Population-Statistical-Abstract-of-Israel-2022-No.73.aspx

phonology and morphology of the dialect, by providing descriptions of many of its phonological and morphological properties, but there are still a lot of open issues to be investigated. In particular, there is no description or analysis of the interactions between phonological processes in JBA. This is the gap that our paper aims to fill.

We will provide an overview of phonological interactions in JBA on the basis of a new recorded database of the dialect. The database is publicly available at [REDACTED] and it contains more than 2,000 productions made by the first author of this paper, who was born in Israel immediately after the first immigration wave from Iraq and was exposed primarily to JBA in early life. Our analysis is a rule-based analysis (Chomsky and Halle 1968), and it will focus on several main processes that apply regularly across the language, whose interactions are highly complex. The first process is stress, which interacts with a range of vowel-related structural processes affecting syllable structure, including lengthening, syncope, epenthesis, and shortening. Another process discussed is vowel reduction. Those processes and their interactions raise several issues that have been of interest to theoretical phonologists, including opaque interactions of stress with syncope and epenthesis, a complex distribution of schwa that is revealed to come from multiple sources (underlying, epenthetic, reduced), morphological and sonority-related conditions on vowel epenthesis, and compound process interactions such as fed-counterfeeding, which are known to pose a challenge to a variety of phonological theories.

In section 2, we present some morphological information about JBA that will serve as the basis for the phonological analysis developed in the paper. In sections 3-5 we present the six phonological processes, divided into pairs of interrelated processes per section. Then, having established the processes, we map their interactions in section 6. Section 7 concludes.

## 2 Morphological background

This section provides information about several morphological properties of JBA as background for the phonological analysis that will be developed in the following sections. For further details about the morphology of this dialect, see Blanc (1964), Mansour (1991), and Bar-Moshe (2019a).

First, as a Semitic language, native JBA words consist of a combination of a consonantal root and a vocalic pattern, potentially with additional prefixes and suffixes. The verbal system of the language, which will be our focus, is divided into several templates traditionally called *Binyanim*. JBA uses nine out of the ten Binyanim that are widespread across colloquial dialects of Arabic, given in (1) using the classical enumeration of Binyanim.[2]

(1) The verbal templates of JBA[3]

[2]Throughout the paper, we use slashes (//) to indicate underlying representations (URs) and square brackets ([]) to indicate surface representations (SRs), as is standard in generative phonology. Pipes (||) are used to indicate intermediate representations. Our transcriptions are given in the International Phonetic Alphabet (IPA), with the exception of stress, which is indicated by acute accent (á), and the back unrounded open-mid vowel, which is indicated by [o] (rather than the IPA symbol [ɔ]).

[3]In Binyan IX, the final two consonants are identical, but undergo degemination word-finally. A double consonant surfaces before a vowel (e.g., [sfəɣɣéːti] '*you.f became yellow*').

| # | Template | Example | Gloss |
|---|---|---|---|
| I | CáCaC | [kátab] | ‘*he wrote*’ |
| II | CáCCaC | [ħámmal] | ‘*he lifted*’ |
| III | Cá:CaC | [sá:faɣ] | ‘*he travelled*’ |
| IV | N/A | N/A | N/A |
| V | tCáCCaC | [tʕáɣɣaf] | ‘*he got to know*’ |
| VI | tCá:CaC | [tqá:tal] | ‘*he fought*’ |
| VII | nCáCaC | [nfátaħ] | ‘*he was opened*’ |
| VIII | CtáCaC | [ftáham] | ‘*he understood*’ |
| IX | CCáCC (rare) | [sfáɣ] | ‘*he became yellow*’ |
| X | stáCCaC | [stáʕʤal] | ‘*he hurried*’ |

The verbal templates in (1) can combine with morphemes marking the subject and the objects of the sentence. These morphemes linearly precede or follow the stem. Subject markers are realized as either prefixes, suffixes, or circumfixes, while object markers always occur at the end of the verb. The resulting linear sequences can be schematized as follows:

(2) Structure of the JBA verb
SUBJECT-STEM-SUBJECT-OBJECT

Two example inflectional paradigms are given in (3) and (4), one for the perfect aspect and one for the imperfect aspect.[4]

(3) Perfect paradigm for /katab/ ‘*write*’

| Inflection | | Affix | SR |
|---|---|---|---|
| 1 | SG | -tu | ktábtu |
| | PL | -na | ktábna |
| 2 | MSG | -t | ktábt |
| | FSG | -ti | ktábti |
| | PL | -təm | ktábtəm |
| 3 | MSG | ∅ | kátab |
| | FSG | -ət | kátbət |
| | PL | -u | kátbu |

(4) Imperfect paradigm for /ktəb/ ‘*write*’

| Inflection | | Affix | SR |
|---|---|---|---|
| 1 | SG | ʔa- | ʔáktəb |
| | PL | n- | nə́ktəb |
| 2 | MSG | t- | tə́ktəb |
| | FSG | t- -i:n | tkətbé:n |
| | PL | t- -u:n | tkətbó:n |
| 3 | MSG | j- | jə́ktəb |
| | FSG | t- | tə́ktəb |
| | PL | j- -u:n | ikətbó:n |

Several phonological processes take place in the imperfect paradigm in (4): long high vowels are lowered (/i:/→[e:], /u:/→[o:]) and a glide is vocalized before a consonant (/j/→[i]). Additionally, schwa-related processes (discussed later) take place, as in /j-ktəb-u:n/ → [ikətbó:n], where the underlying position of schwa is changed on the surface.

A perfect paradigm with direct object markers is given in (5), for the verb [kátab] ‘*he wrote*’. Some object markers exhibit phonologically-conditioned suppletive allomorphy and have two allomorphs, a vowel-initial allomorph that occurs after a consonant and a consonant-initial allomorph that occurs after a vowel.[5]

[4] Here and below, the numbers 1, 2, and 3 indicate person, SG and PL stand for singular and plural, respectively, MSG indicates the masculine singular, and FSG the feminine singular.

[5] JBA also has indirect object markers and double object markers, not discussed here.

(5) Perfect paradigm with object markers

| Inflection | | Affix | SR |
|---|---|---|---|
| 1 | SG | -ni | ktábni |
| | PL | -na | ktábna |
| 2 | MSG | -ak/k | ktábak |
| | FSG | -ək/ki | ktábək |
| | PL | -kəm | ktábkəm |
| 3 | MSG | -u/nu | ktábu |
| | FSG | -(h)a | ktába |
| | PL | -əm | ktábəm |

As in other Arabic dialects, certain kinds of consonantal roots give rise to stems that deviate from the regular phonological pattern of the language. In JBA, there are four root-type categories:

(6) Root types

1. *Strong triradicals*, which contain three different consonants (e.g., $\sqrt{ktb}$, as in [kátab] '*he wrote*').
2. *Weak triradicals*, which contain a glide consonant that is typically not realized. These are divided into three subcategories, depending on the position of the glide in the root:
   - $1^{st}$ *weak* (e.g., $\sqrt{jbs}$, as in [ibástu] '*I dried*')
   - $2^{nd}$ *weak* (e.g., $\sqrt{qwl}$, as in [qáːl] '*he told*')
   - $3^{rd}$ *weak* (e.g., $\sqrt{nsj}$, as in [nása] '*he forgot*')
3. *Geminated triradicals*, whose second and third consonants are identical (e.g., $\sqrt{ħbb}$, as in [ħábbu] '*they loved*').
4. *Quadriradicals*, which contain four consonants (e.g., $\sqrt{lmlm}$, as in [lámlam] '*he collected*').

The combination of different root types with different verbal templates, as well as with diverse configurations of subject and object markers, creates the contexts for several phonological processes that apply regularly across the language, as we discuss in the next section.

# 3 Stress and vowel syncope

The first two processes we discuss are stress and vowel syncope. We discuss them together because, as we will see, they are deeply interrelated, and one cannot be fully understood without the other.

Consider the perfect verbal paradigm of /katab/ '*write*' in (3), repeated in (7).

(7) Perfect paradigm for /katab/ '*write*'

| Inflection | | Affix | SR |
|---|---|---|---|
| 1 | SG | -tu | ktábtu |
| | PL | -na | ktábna |
| 2 | MSG | -t | ktábt |
| | FSG | -ti | ktábti |
| | PL | -təm | ktábtəm |
| 3 | MSG | ∅ | kátab |
| | FSG | -ət | kátbət |
| | PL | -u | kátbu |

On the surface, the penultimate syllable is always stressed, but the position of the stressed vowel varies: it occurs between the first and second consonants of the word in the $3^{rd}$ person inflections, but between the second and third consonants in the $1^{st}$ and $2^{nd}$ person inflections. A simple account of this pattern is that forms such as [kátbu] and [ktábtu] are derived from underlying /katab-u/ and /katab-tu/, respectively. Stress assignment applies, marking different vowels as stressed (|kátab-u| and |katáb-tu|, respectively). Then, the remaining stressless vowel is deleted, deriving the correct surface forms. Such an analysis is possible on the assumption that basic stress assignment in JBA is sensitive to weight and works exactly as in other colloquial dialects of Arabic (see Abdo, 1969; Brame, 1974; Kenstowicz and Abdul-Karim, 1980; Watson, 2002), as shown in (8). Clause (8b) explains why stress is assigned to the penultimate vowel in |katáb-tu|, while clause (8c) explains why it is antepenultimate in |kátab-u|.

(8) Stress assignment

a. Assign stress to the ultimate syllable if it is superheavy (CV:C or CVCC) - e.g., [tkətbéːn] '*you.*FSG *write*'.

b. Otherwise, assign stress to the penultimate syllable if it is heavy (CV: or CVC) or word-initial - e.g., [ktábna] '*we wrote*'.

c. Otherwise, assign stress to the antepenultimate syllable - e.g., /katab-u/ → |kátabu| → [kátbu] '*they wrote*'.

Syncope of stressless vowels reflects the broader JBA generalization that stressless short vowels are only found word-finally (though opaque cases of stressless short vowels in other positions are discussed later). This generalization can be accounted for by the vowel syncope rule in (9), which deletes any stressless vowel in a non-final open syllable (stressless vowels in closed syllables are not syncopated but get reduced, as we discuss in section 4.2).

(9) Syncope rule

$$\underset{\text{[-stress]}}{\breve{\mathrm{V}}} \rightarrow \emptyset \ / \ \_\ ]_\sigma\ \sigma$$

The rule-based derivations in (10) show how the correct forms are derived by ordering stress assignment before syncope.

(10) Derivations with stress preceding syncope

| UR | /katab-u/ | /katab-tu/ |
|---|---|---|
| Stress | kátabu | katábtu |
| Syncope | kátbu | ktábtu |
| SR | [kátbu] | [ktábtu] |

This ordering analysis accounts for the entire paradigm in (3): the first vowel of the stem syncopates before the (non-superheavy) C-initial suffixes (-tu, -na, -t, -ti, -təm), which make the penultimate syllable heavy, whereas the second vowel syncopates before the V-initial suffixes (-ət and -u), which make the penultimate syllable light. The ordering of stress before syncope also accounts for the imperfect paradigm in (4). Here, stress is sometimes assigned to the ultimate superheavy syllable by clause (8a) of the stress algorithm, as in words like [tkətbóːn] '*you.*PL *write*' from underlying /t-ktəb-uːn/. Syncope (in this case of the vowel /ə/) creates a long consonant sequence (|t-ktb-úːn|) that is ultimately broken up by schwa epenthesis (see section 4.1).

Consider now verbs with object markers, which behave differently from the subject-marked verbs discussed so far, as reflected in the minimal pair in (11):

(11) Minimal pair: subject vs. object marker
 a. /katab-$u_{subj}$/ → [kátbu] '*they wrote*'
 b. /katab-$u_{obj}$/ → [ktábu] '*he wrote it*'

These two verbs seem to have phonologically identical URs but a different surface position for the stressed vowel. This difference can be explained by noting that direct object markers seem to defy the regular stress pattern of the language, in that they require stress to fall on the syllable immediately preceding them even when that syllable is light and penultimate (e.g., [kətb-ə́t-u] '*she wrote it*', from /katab-ət-u/). On the assumption that stress has the systematic exception in (12), the contrast in (11) is derived by ordering stress before syncope as with subject suffixes, as shown in (13).

(12) Exception to the stress algorithm in (8)
Stress is assigned to the syllable immediately preceding an object marker; otherwise (if there is no object marker in the word), stress is assigned regularly as in (8).

(13) An ordering account of the difference between subject and object markers

| UR | /katab-$u_{subj}$/ | /katab-$u_{obj}$/ |
|---|---|---|
| Stress | kátabu | katábu |
| Syncope | kátbu | ktábu |
| SR | [kátbu] | [ktábu] |

The interaction between stress and syncope makes stress an opaque process, in Kiparsky's (1971) sense: even when stress is assigned to the antepenultimate syllable, it becomes penultimate on the surface as a result of syncope, which reduces the number of syllables after stress assignment. If this is the right analysis of the interaction between the two processes, then this is a special case of opacity. Typical opaque processes become opaque only in specific environments where they interact with another process, but otherwise apply transparently (as we will see in the following sections). JBA's stress is special in that its third clause (8c) is opaque *across-the-board*: stress assigned regularly to the antepenultimate syllable *never* appears on the antepenultimate syllable on the surface.[6] Nevertheless, there is evidence for assuming antepenultimate stress assignment coming from the interaction of stress and syncope.

# 4 Vowel epenthesis and reduction

## 4.1 Epenthesis

The basic vowel epenthesis pattern of JBA has been described by Mansour (1991) and Bar-Moshe (2019a): the language inserts the vowel schwa (ə) to break impermissible consonant clusters.

We first discuss biconsonantal clusters. In coda position, the application of schwa epenthesis depends on the sonority of the consonants in the cluster. A cluster with a final sonorant consonant (*m, n, l, r, ɣ*) is broken up by epenthesis, but a sonorant-obstruent cluster is not. This is illustrated using nouns from the nominal templates /CaCC/ and /CəCC/ in (14).[7]

(14)

| | No epenthesis | | | | Epenthesis | |
|---|---|---|---|---|---|---|
| a. | kálb | *'dog'* | | e. | láħəm | *'meat'* |
| b. | mə́lħ | *'salt'* | | f. | sˤádəɣ | *'chest'* |
| c. | ʃáɣb | *'drinking'* | | g. | ɣásəl | *'washing'* |
| d. | ʔə́nf | *'nose'* | | h. | qə́fəl | *'lock'* |

Differently from codas, the range of onsets is more permissive at the word edge and even complex onsets that violate the Sonority Sequencing Generalization (Selkirk, 1984) are possible without epenthesis (e.g., [nkátbət] '*it.*F *was written*', [lmáʕtu] '*I sparkled*').

Consonant sequences with more than two consonants can arise in multiple ways, most notably from the widespread syncope process discussed in section 3, in either word-initial or word-medial position. Dialects of Arabic are known to have different strategies for dealing with triconsonantal sequences (Selkirk, 1981; Ito, 1989; Kiparsky, 2003; Watson, 2007), including epenthesis after $C_1$, epenthesis after $C_2$, or no epenthesis at all. In JBA, when a CCC sequence arises, schwa epenthesis generally takes place after $C_1$. A first example of such epenthesis is the behavior of the perfect verbal paradigm of Binyan VII shown in (15), where the Binyan VII prefix /n-/ surfaces as [nə-] in inflections where it would have been followed by two stem consonants created through the syncope of the first vowel of the stem.

(15) Perfect paradigms for /katab/ '*write*' in Binyan I and Binyan VII

[6] This generalization is exception-less in verbs, adjectives and native nouns, and only has a handful of exceptions in loan nouns, representing less than 2% of the unique entries in Elias' 2016 JBA-English dictionary.

[7] The generalization regarding clusters with two obstruents is not well understood. For example, epenthesis takes place in [xə́bəz] '*bread*' but not in [lə́bs] '*clothing*'.

| Inflection | | Affix | /katab/ | /n-katab/ |
|---|---|---|---|---|
| 1 | SG | -tu | ktábtu | nə̲ktábtu |
| | PL | -na | ktábna | nə̲ktábna |
| 2 | MSG | -t | ktábt | nə̲ktábt |
| | FSG | -ti | ktábti | nə̲ktábti |
| | PL | -təm | ktábtəm | nə̲ktábtəm |
| 3 | MSG | ∅ | kátab | nkátab |
| | FSG | -ət | kátbət | nkátbət |
| | PL | -u | kátbu | nkátbu |

Examples of epenthesis into word-medial CCC sequences are given in the perfect paradigms in (16), where the relevant schwas are underlined. In these paradigms, the basic stem ends with a /CCaC/ sequence before the application of phonological processes. When adding a vowel-initial suffix, the stem's /a/ is syncopated, resulting in a CCC sequence that is then broken up by schwa epenthesis. The evidence that these schwas are epenthetic is that they do not correspond to any vowel in the basic 3MSG form of the verbs (below we will argue that the schwa appearing in the first syllable of the $1^{st}$ and $2^{nd}$ person inflections is a reduced /a/ rather than an epenthetic schwa).

(16) Word-medial epenthesis in the perfect paradigms of /staqbal/ '*welcomed*' and /lamlam/ '*collected*'

| Inflection | | Affix | /staqbal/ | /lamlam/ |
|---|---|---|---|---|
| 1 | SG | -tu | stəqbáltu | ləmlámtu |
| | PL | -na | stəqbálna | ləmlámna |
| 2 | MSG | -t | stəqbált | ləmlámt |
| | FSG | -ti | stəqbálti | ləmlámti |
| | PL | -təm | stəqbáltəm | ləmlámtəm |
| 3 | MSG | ∅ | stáqbal | lámlam |
| | FSG | -ət | stáqə̲blət | lámə̲lmət |
| | PL | -u | stáqə̲blu | lámə̲lmu |

Paralelling the situation with word-final clusters, medial CCC sequences do not trigger epenthesis if $C_1$ is a sonorant and $C_2$ is an obstruent (e.g., /stanðˤaɣ-u/ → [stánðˤɣu] '*they waited*').

The epenthesis pattern just described has two systematic morphological exceptions. First, if $C_2$ in a CCC sequence is the morphological *t* that marks Binyan VIII, schwa is generally inserted after rather than before $C_2$, as in (17a). The second exception is that in Binyanim VIII and X, if $C_1$ is the strident *ʃ* as in (17b) or *s* as in (17c), epenthesis does not take place at all.

(17) Systematic morphological exceptions to epenthesis in CCC clusters

a. Binyan VIII: /ʤtamaʕ-tu/ → |ʤtmáʕtu| → [ʤtə̲máʕtu] '*I met with*'[8]

b. Binyan VIII: /ʃtaɣal-tu/ → |ʃtɣáltu| → [ʃtɣáltu] '*I worked*'

c. Binyan X: /stafaːd-u/ → |stfáːdu| → [stfáːdu] '*they benefited*'

[8] One exception to this exception is the verb [ftáham] '*he understood*', in which schwa is inserted into its regular position, after $C_1$ (e.g., [fəthámtu] '*I understood*').

Four-consonant sequences are resolved by epenthesis between $C_2$ and $C_3$, as in other dialects of Arabic (/t-ktəb-eːn/ → |t-ktb-éːn| → [tkətbéːn] ‘*you.*FSG *write*’). A systematic morphological exception, paralelling the exception in (17c), is that epenthesis into CCCC sequences applies before rather than after $C_2$ if $C_2$ is the strident *s* of Binyan X (e.g., /t-staħəj-uːn/→ |t-stħ-úːn| → [təstħóːn] ‘*you.*PL *are ashamed*’ – the final *j* is a weak root consonant that gets deleted).

## 4.2 Vowel reduction

Schwa epenthesis explains the distribution of surface schwas in the language only partially, because some surface schwas are unpredictable and must be assumed to be lexical. For example, the final stem vowel of the imperfect inflection of Binyanim VII and VIII, as in [jənʃáɣəb] ‘*drinkable*’, is not predictably epenthetic, because it appears even when the final two consonants could have formed a licit coda cluster (e.g., the sonorant-obstruent cluster *ɣb* would have been a possible coda cluster for [jənʃáɣəb], as shown by words like [ʃáɣb] ‘*drink*’). Another example of an unpredictable schwa comes from the perfect 3FSG subject suffix -ət, as in [ʃtáɣət] ‘*she bought*’, following the same reasoning. Additionally, this schwa receives stress before an object marker ([ʃtɣə́tu] ‘*she bought it*’). This would be surprising on the assumption that the schwa is epenthetic, because epenthetic schwas are invisible to stress assignment, as we saw in section 3. It seems, then, that some schwas in the language are present underlyingly and some are predictble and derived by epenthesis.

A question arises whether *all* predictable schwas come from epenthesis. In particular, there are surface schwas that correspond to an underlying /a/ in positions where epenthesis is expected. For example, in (18), if the underlined /a/ is syncopated, a CCCC sequence would arise, and schwa epenthesis would be expected after $C_2$, matching the result on the surface. On this analysis, the syncope rule proposed in section 3 would be generalized to also apply to stressless vowels in closed syllables. This is a simple analysis in that it derives the surface distribution of schwa from a combination of two independently observed processes – syncope and epenthesis.

(18) A syncope-plus-epenthesis analysis of [stəqbálna] ‘*we welcomed*’ (to be rejected)
/sta̲qbal-na/ → |stqbálna| → [stə̲qbálna]

An alternative analysis is that in closed (non-final) syllables, a short stressless /a/ undergoes reduction to schwa rather than deletion, and the language has a rule of reduction in addition to the rules of syncope and epenthesis:

(19) Reduction rule
$\underset{\text{[-stress]}}{\breve{a}} \rightarrow \text{ə} \;/\; \_\_\; C\; ]_{\sigma}\; \sigma$

(20) A reduction analysis of [stəqbálna] ‘*we welcomed*’
/sta̲qbal-na/ $\xrightarrow[\text{Reduction}]{}$ [stə̲qbálna]

There is evidence that a reduction process applies in JBA in addition to syncope and epenthesis, coming from cases that could not be analyzed as a combination of syncope and epenthesis. These are cases where a surface schwa appears in environments where epenthesis is not supposed to take place. Some relevant examples are the following verbs with quadriradical roots:

(21) Reduction in quadriradical roots
a. /lamlam-u-nu/ → [lə̲məlmóːnu] ‘*they collected it*’

b. /bahdal-u-nu/ → [bə̠hədló:nu] '*they disgraced him*'

Here, the first schwa is not expected to be epenthesized, given the following reasoning. If syncope had applied in closed syllables, the outcome of its application to /lamlam-u-nu/ would have been |lmlm-ú:-nu|. In CCCC sequences, schwa is epenthesized after $C_2$, so the expected result of epenthesis would have been the incorrect output *[lməlmó:nu]. Since the onset cluster [lm] is possible in the language (e.g., [lmáʕtu] '*I sparkled*'), there is no reason to insert an additional vowel after $C_1$. If, however, reduction applies to an underlying stressless /a/ in a closed syllable, the first vowel of /lamlam-u-nu/ is correctly expected to change into schwa (eventually, reduction is opaque because the first syllable is open on the surface, as a result of the additional applications of syncope and epenthesis; see section 6).

The overall consequence of the analysis for the distribution of schwa in JBA is that there are three sources for surface schwas: epenthetic, reduced /a/, and underlying. Epenthetic schwas are inserted to break impermissible consonant clusters, and reduced schwas correspond to an underlying /a/ that appears in a stressless closed syllable. Underlying schwas are those whose surface occurrence is unpredictable and are thus not derived by phonological rules. The three sources for schwa are difficult to discern from the surface directly, because the schwas all sound the same and are judged to be identical by speakers. Nevertheless, we have seen that each source is supported by some aspect of the complex surface distribution of schwa.

# 5 Shortening and lengthening

The distribution of vowel length in JBA is similar to the distribution of length observed in other colloquial dialects of Arabic (Abu-Salim, 1986; Younes, 1995; Watson, 2002; McCarthy, 2005). Vowel length is not entirely predictable, as evidenced by the following minimal pairs:

(22) Minimal pairs: unpredictable vowel length

| | | | | | |
|---|---|---|---|---|---|
| a. | [bˤátˤa] | '*he waited*' | ∼ | [bˤá:tˤa] | '*her armpit*' |
| b. | [ħákət] | '*she spoke*' | ∼ | [ħá:kət] | '*she knitted*' |
| c. | [qáʕad] | '*he sat*' | ∼ | [qá:ʕəd] | '*is sitting*' |

In addition, the vocalic templates of perfect verbs in Binyan I and Binyan III differ only in vowel length: compare [kátab] '*he wrote*' (Binyan I) with [sá:faɣ] '*he travelled*' (Binyan III).

A first generalization about the distribution of vowel length is that there are no stressless long vowels in the language. This generalization can be accounted for by assuming that underlying long vowels are shortened when stressless, as already observed in previous descriptions of the dialect (Blanc 1964:33, Mansour 1991:79, Bar-Moshe 2019a:20, Bar-Moshe 2019b:112). The relevant shortening rule is stated in (23), and it accounts for the vowel-length alternations in (24). In both examples in (24), adding a suffix causes stress to fall on a different vowel than the underlyingly long vowel. As a result, the long vowel is shortened.

(23) Vowel Shortening rule

$$\underset{\text{[-stress]}}{\mathrm{V}} \rightarrow \text{[-long]}$$

(24) Shortening of stresless vowels

| | | | | | |
|---|---|---|---|---|---|
| a. | [sá:faɣ] | '*he traveled*' | ∼ | [safáɣna] | '*we traveled*' |
| b. | [qá:lət] | '*she said*' | ∼ | [qalə́tlo] | '*she said to him*' |

Notice that when a stressless long /aː/ shortens in an open syllable, as in (24), it does not delete even though the context for syncope is met. This interaction between shortening and syncope is discussed in section 6.

A second generalization about vowel length is that vowels that immediately precede a morpheme boundary are always long when stressed. This generalization is true across categories, as illustrated in (25) for nouns and prepositions, and in (26) for verbs.

(25) Lengthening in nouns and prepositions[9]

| | | | | | |
|---|---|---|---|---|---|
| a. | [qáfa] | *'back'* | ∼ | [qfáːkəm] | '*your.*PL *back*' |
| b. | [ʕáza] | *'trouble'* | ∼ | [ʕzáːnu] | '*his trouble*' |
| c. | [dáwa] | *'drug'* | ∼ | [dwáːk] | '*your.*MSG *drug*' |
| d. | [wája] | *'with'* | ∼ | [wijáːha] | '*with her*' |

Table (26) shows the verb [kátab] '*he wrote*' with the same subject suffixes as before, but with an additional column where each subject suffix is followed by the 3$^{rd}$ person masculine singular direct object marker. This object marker exhibits phonologically-conditioned suppletive allomorphy, in that it is realized as [-u] after a consonant but as [-nu] after a vowel. As the rightmost column shows, whenever the subject marker ends with a short vowel (i.e., -tu, -na, -ti, -u), that vowel surfaces as long before the object marker (in addition, the high vowels undergo lowering).

(26) Lengthening (and lowering) in affixes

| | | Affix | /katab/ | + DO.3.MSG |
|---|---|---|---|---|
| 1 | SG | -tu | ktábtu | ktəbtóːnu |
| | PL | -na | ktábna | ktəbnáːnu |
| 2 | MSG | -t | ktábt | ktábtu |
| | FSG | -ti | ktábti | ktəbtéːnu |
| | PL | -təm | ktábtəm | ktəbtə́mu |
| 3 | MSG | ∅ | kátab | ktábu |
| | FSG | -ət | kátbət | kətbə́tu |
| | PL | -u | kátbu | kətbóːnu |

As already observed by McCarthy (2005), the generalization that vowels are always long before a morpheme boundary (when stressed) cannot be accounted for by shortening, because shortening by itself does not explain why there are no short vowels before a morpheme boundary in a position where they would be stressed. For example, while there are short-long alternations such as [qáfa]∼[qfáːkəm], as we have seen in (25), there are no short-short alternations such as the hypothetical [qáfa]∼*[qfákəm] in the language (neither there are short-short alternations such as [qáfa]∼*[qáfkəm], where the morpheme-final vowel is not lengthened and gets syncopated, or alternations such as [qáfa]∼*[qáfakəm], where the same vowel is not syncopated). In rule-based phonology, this generalization can be accounted for using a rule that lengthens vowels right before a morpheme boundary:

(27) Vowel Lengthening rule

V → [+long] / _ +

[9] We ignore the alternation between [a] and [i] in [wája]∼[wijáːha].

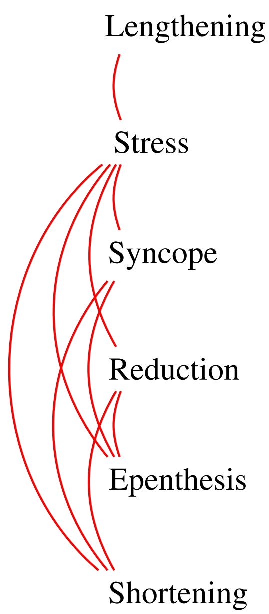
On this analysis, forms like [ktəbnáːnu] could then be derived from URs like /katab-na-nu/, with a short vowel at the end of the subject suffix -na that gets lengthened before a morpheme boundary by the lengthening rule.

In the next section we turn to discuss the interactions between the main processes discussed so far in this paper.

# 6 Rule interactions

The six main processes discussed in this paper are the supra-segmental processes of stress, syncope, epenthesis, shortening, and lengthening, and the segmental process of vowel reduction. These processes are highly interdependent and exhibit a complex range of interactions with one another. In this section we map those interactions within an ordered rule-based theory, presenting the evidence for each pairwise rule ordering that we could establish. The orderings are diagrammed in (28), where each necessary rule ordering is indicated by an arc, following Halle and Mohanan's (1985) similar visualization for English.

(28) Crucial rule orderings




*Stress precedes syncope, reduction, and shortening*. We have already seen in the preceding sections that syncope, reduction, and shortening only apply to stressless vowels and therefore must apply after stress is determined.

*Lengthening precedes stress*. Stress is assigned to lengthened vowels in positions were short vowels do not receive stress. For example, in [qfáːkəm] '*your back*', from underlying /qafa-kəm/, applying stress before lengthening would have yielded stress on the first vowel and protected it from syncope, contrary to fact.

*Stress precedes epenthesis*. Epenthetic vowels do not receive stress in positions where they should according to the stress algorithm in (8). For example, in [bˤátˤənkəm] '*your.*PL *stomach*', the penultimate syllable is heavy and should be stressed (cf. [qəbbə́tkəm] '*your.*PL *room*', where the penultimate schwa is underlying). Nevertheless, stress in [bˤátˤənkəm] falls on the antepenultimate vowel on the surface, as though stress assignment ignores the epenthetic vowel. This interaction requires an ordering of stress before epenthesis:

(29)

| UR | /bˤatˤn-kəm/ |
|---|---|
| Stress | bˤátˤn-kəm |
| Epenthesis | bˤátˤən-kəm |
| SR | [bˤátˤənkəm] |

The interaction in this derivation is opaque and has recently been labeled *countershifting* (Rasin, 2022), because applying epenthesis before stress would not have fed or bled stress assignment but would have rather caused stress to apply to a different syllable (i.e., epenthesis would have *shifted* stress).

*Syncope precedes epenthesis.* In words like [tkətbéːn] '*you.*FSG *write*', from underlying /t-ktəb-iːn/, syncope applies to the underlying stressless schwa as it is in an open syllable. This creates a CCCC sequence (|tktbíːn|) that is broken up by schwa epenthesis after $C_2$. Therefore, syncope feeds epenthesis (in this and the following derivations, we only show the relevant stages, for simplicity):

(30)

| UR | /t-ktəb-iːn/ |
|---|---|
| Syncope | t-ktb-íːn |
| Epenthesis | t-kətb-íːn |
| SR | [tkətbéːn] |

The interaction of epenthesis with both stress and syncope can be seen in the derivation of [lámәlmәt] '*she collected*':

(31)

| UR | /lamlam-ət/ |
|---|---|
| Stress | lámlam-ət |
| Syncope | lámlm-ət |
| Epenthesis | láməlm-ət |
| SR | [láməlmət] |

After stress is assigned to the antepenultimate syllable, syncope applies and creates a CCC sequence that triggers epenthesis. Epenthesis then creates a penultimate heavy syllable, which should have received stress, making stress opaque.

*Reduction precedes epenthesis.* This can be seen in the derivation of [tbəhədlóːn] '*you.*PL *disgrace*':

(32)

| UR | /t-bahdəl-uːn/ |
|---|---|
| Stress | t-bahdəl-úːn |
| Syncope | t-bahdl-úːn |
| Reduction | t-bəhdl-úːn |
| Epenthesis | t-bəhədl-úːn |
| SR | [tbəhədlóːn] |

Here, reduction applies to a stressless /a/ in a closed syllable. Afterwards, epenthesis applies and makes this syllable open on the surface. This is a counterbleeding interaction in which epenthesis removes the environment for reduction after reduction has already applied. If epenthesis had applied before reduction, the result would have been *[tbahədlóːn].

This derivation exhibits another interesting interaction between syncope and epenthesis. Syncope feeds epenthesis, but at the same time, epenthesis also creates a new context for syncope, because the epenthetic schwa opens the initial syllable. Nevertheless, syncope underapplies. Such interactions have been labeled *fed-counterfeeding* by Kavitskaya and Staroverov (2010), who have also shown that they pose a challenge to multiple theories of phonology.

*Syncope precedes shortening*. Underlying long vowels that get shortened do not undergo syncope in an open syllable. An example is [ɣaséːn] '*two heads*' (cf. [ɣáːs] '*head*'):

(33)

| UR | /ɣaːs-iːn/ |
|---:|:---:|
| Stress | ɣaːs-íːn |
| Syncope | - |
| Shortening | ɣas-íːn |
| SR | [ɣaséːn] |

Here, the context for syncope is met on the surface, but syncope does not apply. Assuming that syncope is ordered first, the correct output is derived. This is an opaque counterfeeding interaction.

*Reduction precedes shortening*. Underlying long vowels that get shortened do not undergo reduction in a closed syllable, as in [tsafɣóːn] '*you.*PL *travel*' (cf. [tsáːfəɣ] '*you.*MSG *travel*'). this is another counterfeeding interaction:

(34)

| UR | /t-saːfəɣ-uːn/ |
|---:|:---:|
| Stress | t-saːfəɣ-úːn |
| Syncope | t-saːfɣ-úːn |
| Reduction | - |
| Shortening | t-safɣ-úːn |
| SR | [tsafɣóːn] |

*No interaction*. There is no direct interaction between lengthening and any of the non-stress rules, so their relative ordering can only be determined transitively. Additionally, there is no interaction between epenthesis and shortening or between syncope and reduction, and their relative orderings cannot be determined.

Full derivations illustrating interactions between all six processes are given in (35) and (36). At the beginning of the derivation, vowels are lengthened before a morpheme boundary, affecting the position of stress, which is assigned after lengthening. Then, short stressless vowels are syncopated in open syllables; in closed stressless syllables, /a/ is reduced to schwa. Finally, schwa epenthesis applies to break impermissible consonant clusters, and long stressless vowels are shortened.

(35) Derivation of [ktəbnaljáːnu] '*we wrote it for him*'

| UR | /katab-na-lja-nu/ |
|---:|:---:|
| Lengthening | katab-naː-ljaː-nu |
| Stress | katab-naː-ljáː-nu |
| Syncope | ktab-naː-ljáː-nu |
| Reduction | ktəb-naː-ljáː-nu |
| Epenthesis | - |
| Shortening | ktəb-na-ljáː-nu |
| SR | [ktəbnaljáːnu] |

(36) Derivation of [bəhədlóːnu] ‘*they disgraced him*’

| UR | /bahdal-u-nu/ |
|---:|:---:|
| Lengthening | bahdal-uː-nu |
| Stress | bahdal-úː-nu |
| Syncope | bahdl-úː-nu |
| Reduction | bəhdl-úː-nu |
| Epenthesis | bəhədl-úː-nu |
| Shortening | - |
| SR | [bəhədlóːnu] |

# 7 Conclusion

A simple analysis of the phonological system of JBA posits several rules that apply regularly across the language, almost without exception, and interact in non-trivial ways. The interactions involve multiple degrees of opacity, including a stress process that is opaque across-the-board, compound interactions such as fed-counterfeeding, and surface schwas that are generated from distinct sources. The resulting system raises several questions that we have not answered in this paper: do JBA speakers indeed internalize the rules and their interactions as the analysis suggests? If so, how is such a complex system acquired? Can the distributional patterns of the language be captured by theories of phonology other than rule-based phonology, such as serial extensions to parallel Optimality Theory (Prince and Smolensky, 1993/2004) that can deal with opacity (e.g., McCarthy 2000, 2016; Kiparsky 2000, 2015; Jarosz 2014)? We hope that further empirical and theoretical research on JBA would contribute to our understanding of the mechanisms underlying this language in particular, and to our understanding of the human phonological capacity in general.

# References


Abdo, Daud A. 1969. *On stress and Arabic phonology: a generative approach*. Beirut: Khayat’s.

Abu-Salim, Issam M. 1986. Vowel shortening in Palestinian Arabic: a metrical perspective. *Lingua* 68:223–240.

Bar-Moshe, Assaf. 2019a. *The Arabic dialect of the Jews of Baghdad: phonology, morphology, and texts*, volume 58 of *Semitica Viva*. Wiesbaden: Harrassowitz.

Bar-Moshe, Assaf. 2019b. Phonetic analysis as a supportive tool for phonemic understanding: Two case studies from the Jewish dialect of Baghdad. In *Arabic dialectology: Methodology and field research*, ed. Werner Arnold and Maciej Klimiuk, 111–36. Harrassowitz Verlag.

Blanc, Haim. 1964. *Communal dialects in Baghdad*. Cambridge: Harvard University Press.

Brame, Michael. 1974. The cycle in phonology: stress in Palestinian, Maltese, and Spanish. *Linguistic Inquiry* 5:39–60.

Chomsky, Noam, and Morris Halle. 1968. *The sound pattern of English*. New York: Harper and Row.

Elias, William. 2016. *The Jewish Arabic dialect of Baghdad - JAB*. Tel Aviv: Phonometrics.

Halle, Morris, and K. P. Mohanan. 1985. Segmental phonology of Modern English. *Linguistic Inquiry* 16:57–116.

Ito, Junko. 1989. A prosodic theory of epenthesis. *Natural Language and Linguistic Theory* 7:217–259.

Jarosz, Gaja. 2014. Serial Markedness Reduction. In *Proceedings of the 2013 Annual Meeting on Phonology*, ed. John Kingston, Claire Moore-Cantwell, Joe Pater, and Robert Staubs. Washington, DC: Linguistic Society of America.

Kavitskaya, Darya, and Peter Staroverov. 2010. When an interaction is both opaque and transparent: the paradox of fed counterfeeding. *Phonology* 27:255–488.

Kenstowicz, Michael, and Kamal Abdul-Karim. 1980. Cyclic stress in Levantine Arabic. *Studies in the Linguistic Sciences* 10:55–76.

Kiparsky, Paul. 1971. Historical linguistics. In *A survey of linguistic science*, ed. W. O. Dingwall, 576–642. University of Maryland Linguistics Program, College Park.

Kiparsky, Paul. 2000. Opacity and cyclicity. *The Linguistic Review* 17:351–367.

Kiparsky, Paul. 2003. Syllables and moras in Arabic. In *The syllable in Optimality Theory*, ed. Caroline Féry and Ruben van de Vijver, 147–182. Cambridge: Cambridge University Press.

Kiparsky, Paul. 2015. Stratal OT: A synopsis and FAQs. In *Capturing phonological shades within and across languages*, ed. Yuchau E. Hsiao and Lian-Hee Wee, 2–44. Cambridge Scholars Publishing.

Mansour, Jacob. 1991. *The Jewish Baghdadi dialect: studies in the Judaeo-Arabic dialect of Baghdad*. The Babylonian Jewry Heritage Center, Or-Yehuda.

McCarthy, John. 2000. Harmonic serialism and parallelism. In *Proceedings of the North East Linguistic Society*, ed. Masako Hirotani, Andries Coetzee, Nancy Hall, and Ji-yung Kim, 501–524. Rutgers University: Graduate Linguistic Student Association.

McCarthy, John J. 2005. The length of stem-final vowels in Colloquial Arabic. In *Perspectives on Arabic linguistics XVII–XVIII: Papers from the 17th and 18th Annual Symposia on Arabic Linguistics*, ed. Mohammad T. Alhawary and Elabbas Benmamoun, 1–26. Amsterdam and Philadelphia: Benjamins.

McCarthy, John J. 2016. The theory and practice of Harmonic Serialism. In *Harmonic Grammar and Harmonic Serialism*, 47–87. London: Equinox.

Prince, Alan, and Paul Smolensky. 1993/2004. *Optimality Theory: Constraint interaction in generative grammar*. Wiley-Blackwell: Oxford.

Rasin, Ezer. 2022. Shifting interactions and countershifting opacity: A note on opacity in Harmonic Serialism. *Linguistic Inquiry* 53:836–851.

Selkirk, Elisabeth. 1981. Epenthesis and degenerate syllables in Cairene Arabic. *MIT Working Papers in Linguistics* 3:209–232.

Selkirk, Elisabeth. 1984. On the major class features and syllable theory. In *Language sound structure: Studies in phonology presented to Morris Halle by his teacher and students*, ed. Mark Aronoff and Richard T. Oehrle, 107–136. Cambridge: MIT Press.

Watson, Janet CE. 2002. *The phonology and morphology of Arabic*. Oxford: Oxford University Press.

Watson, Janet CE. 2007. Syllabification patterns in Arabic dialects: long segments and mora sharing. *Phonology* 24:335–356.

Younes, Munther A. 1995. On vowel shortening in palestinian arabic. *Perspectives on Arabic Linguistics: Papers from the Annual Symposium on Arabic Linguistics* VII:157–172.