Research Article

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Stress and epenthesis in a Jordanian Arabic dialect: Opacity and Harmonic Serialism

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Abstract: This article investigates aspects of stress assignment in a Jordanian Arabic dialect (JA). Cases of opaque stress are discussed with reference to Harmonic Serialism (HS) within the framework of Optimality Theory (OT). Two sources of opaque stress are under consideration. On the one hand, a syllable in an antepenultimate position is stressed where a Heavy penultimate is expected to receive stress. On the other hand, a light penultimate syllable is stressed where an antepenultimate Heavy syllable is expected to receive stress. All cases of opaque stress in the dialect involve an epenthetic vowel in the penultimate syllable or in the ultimate syllable in the two structures, respectively. An account of such opaque structures requires faithfulness to the location of stress before epenthesis; a scenario perfectly handled with reference to HS.

Keywords: convergence, harmonic serialism, Jordanian Arabic, opaque stress

1 Introduction

In a quantity-sensitive stress system, syllable weight is crucial in stress placement. In general, heavy syllables are usually considered prominent in their feet and eventually on the metrical grid. Jordanian Arabic (JA) is an example of a quantity-sensitive stress system where stress is assigned to a word-final super heavy ('SH) syllable made of a long vowel and a coda consonant, or a short vowel followed by two consonants. If no such syllable is at the end of a word, stress will fall on a heavy ('H) penult made up of a long vowel, or a short vowel followed by a consonant. Otherwise, stress will fall on the antepenultimate syllable by default.

Despite the rather straightforward stress assignment principles above, JA has two major cases of opaque stress placement. First, a syllable in the antepenultimate position is stressed where a Heavy penultimate is expected to receive stress ('σHσ vs expected σ'Hσ). Second, a light penultimate syllable is stressed where an antepenultime heavy syllable is expected to receive stress (H'Lσ vs expected 'HLσ). All cases of opaque stress in this dialect involve an epenthetic vowel in the penultimate syllable or in the ultimate syllable in the two structures, respectively.

In this article, we propose that HS can account for opaque stress-epenthesis interactions among languages where epenthetic vowels appear to avoid stress. Other proposals within OT for handling cases of opaque stress involve rejecting stress on epenthetic vowels (Kager 1999a), faithfulness to a base (Kager 1999a, b), output–output faithfulness (Benua 1997), or faithfulness to a sympathetic candidate (McCarthy 1999). HS provides a unified account of both cases of opaque stress in JA.

Harmonic Serialism (McCarthy 2000, 2002, 2008a, b, 2009) is a version of Optimality Theory (Prince and Smolensky 1993/2004) combining serial derivation with constraint interaction. HS imposes a requirement on

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GEN limiting the candidate set generated. A candidate may differ from the input only by the application of a single operation. The optimal candidate in each pass through GEN and EVAL becomes an input to the next pass. This creates a derivation-like sequence of candidates each of which is more harmonic with the final output. The derivation stops when the input is identical to the output. This gradual improvement of candidates towards the optimal enables the grammar to make reference to intermediate stages, base forms, or sympathetic candidates (Kager 1999a, b, McCarthy 1999).

The rest of this article is organized as follows. Section 2 introduces the dialect under scrutiny, and detail stress assignment rules active in the dialect. Section 3 introduces cases of opaque stress in JA and how the phenomenon was handled in the literature. Section 4 presents the basics of HS and proceeds to account for opaque stress in JA. Section 5 offers a summary and concluding remarks.

2 Jordanian Arabic

Arabic is a Central Semitic language of the Afroasiatic language family spoken primarily in the Arab world (Al-Jallad 2018). Arabic spread from the Arabian Peninsula to North Africa and the Levant at the end of the seventh century. In general, Arabic dialects share some cross-dialectal generalizations (Kiparsky 2002). Nevertheless, not all varieties are mutually intelligible. Intelligibility or the lack of it depends on history, geography, and cultural influences (Watson 2002, 2011a, b).

Various distinct dialects are spoken in Jordan forming a dialect continuum mutually understood by most Jordanians. These are traditionally divided into Sedentary and Bedouin dialects. Sedentary dialects belong to the Levantine dialects continuum, while Bedouin dialects belong to either the Northwest Arabian dialects spoken in the Southern parts of Jordan, or to the Najdi dialects spoken in the Northern parts of the country. Sedentary dialects are socially divided into Urban or Rural and are used in major urban centers and surrounding smaller villages and towns. Bedouin dialects are spoken in the far eastern and southern parts of the country (Abdel-Jawad 1986, Al-Khatib 1988, Al-Sughayer 1990, Abu-Abbas 2003, Sakarna 2005). Each dialect may be further divided into distinct varieties the discussion of which is beyond the scope of this research (Zuraiq and Abu-Joudeh 2013, Al-Harahsheh 2014, Abu Ain 2016, Omari and Herk 2016, Alrabab'ah 2018). Jordanian Arabic in this article will be used to refer to a group of dialects spoken in an urban center in the northern part of the country, mainly the city of Irbid and nearby Ajloun and Jerash. These dialects share stress assignment principles.

2.1 Overview of stress assignment in JA

This overview is based on the elaborate discussion of stress in JA by Al-Ghazu (1987) and Abu-Abbas (2003, 2008). In Arabic, CVVC, CVVCC, or CVCC are super-heavy, CVV and CVC syllables are heavy, and a syllable with a short vowel and no coda, i.e., CV is light. In short, a superheavy syllable has three or more moras, a heavy syllable has two, and a light syllable is one that includes a single mora. A short vowel contributes one mora, a long vowel contributes two, a coda consonant contributes one mora, and onset consonants are weightless (Al-Jarrah 2008, Bokhari 2021).

Syllable quantity plays a major role in stress assignment in all Arabic dialects including JA (Al-Jarrah 2002, Abu-Abbas 2003, 2008, Huneety 2015). Stress is assigned to the rightmost superheavy (SH) syllable provided that it is not separated from the right edge of the word by more than two syllables, i.e., preantepenultimate syllables are never stressed in JA. In the absence of a (super)heavy syllable under the condition above, i.e., in the ultimate or penultimate syllable, the antepenultimate is stressed. Consider the examples in (1) below. These examples include various possible structures in JA starting from monosyllabic words all the way to words with five syllables:

(1) stress in JA

a	Monosyllabic words	Gloss
	'maat	died
	'le:l	night
	'kul	eat (imperative)
	'kalb	a dog
	'ktaab	a book
	'rbaaʕ	quarters
b	Disyllabic words	Gloss
	initial stress in words ending with CV	
	'sa.wa	together
	'ʔa.na	I
	'blaad.na	our countries
	initial stress in words ending with CVC	
	'ʔi.sim	name
	'mak.bas	stapler
	'naa.jim	asleep
	'ʤaar.hum	their neighbor
	'ʔa.kil	food
	'kalb.hum	their dog
	initial stress in words ending with CVV	
	'faa.tuu	they entered
	'ba.nuu	they built
	final stress in words ending with CVVC	
	da.'maar	destruction
	sa. 'laam	peace
	mis.'maar	a nail
	baa.'be:n	two doors
	waag.'faat	standing up (fem. pl.)
	final stress in words ending with CVCC[1]	
	ka. 'tabt	I wrote
	ra. 'faʕt	I lifted
c	Trisyllabic words	Gloss
	initial stress in words ending with CV.CV(C)	
	'sa.ma.ka	a fish
	'wa.ra.ga	a piece of paper
	'ʔa.la.mak	your pain
	'wa.la.duh	his son
	'muħ.ta.ram	respectable
	initial stress in words ending with CV.CVV[2]	
	'mak.ta.bii	my office
	'ra.ħa.luu	they moved (left)
	'ka.ta.buu	they wrote
	'ra.sa.muu	they drew
	penultimate stress in words ending with CVV.CV(C)	
	ma.'kaa.tib	offices

1 Such structures involve an optional epenthetic vowel between the last two consonants (Abu-Abbas 2024).

2 Such structures involve shortening of the final vowel (McCarthy 2005). This fact does not affect the discussion.

	ma.'raa.sim	ceremonies
	mun.'ʃaa.rah	a saw
	ʔi.'ʃaa.rah	a sign
	penultimate stress in words ending with CVC.CV(V,C)	
	xaa.'tim.hum	their ring
	mal.'ʕab.naa	our playing ground
	fi.'him.naa	he understood us
	gaa.'wam.hum	he resisted them
	mus.'taʕ.ʤal	urgent
	la. 'bint.hum	for their daughter
	final stress in words ending with CVV(C)	
	ma.saa.'ʤiin	prisoners
	ħa.ra.'kaat	moves
	miʤ.tam.'ʕiin	gathered
	wa.la.'deːn	two boys
	mil.taz.'maat	committed (fem. pl.)
d	Words with more than three syllables	Gloss
	muħ.'ta.ra.ma	respectable (fem.)
	maz.'ra.ʕa.tuh	his farm
	mu. 'baa.ra.zeh	sword play
	mu.raa.sa.'laat	correspondences
	ma.daa.'ris.kum	your schools
	muʃ.ta.ra.'jaat	purchases
	mu.baa.ra.'jaat	competitions
	ʔa.maa.'kin.hum	their places
	mus.taʕ.'ma.ra.tii	my colony
	ʔis.tiʕ.laa.'maat.hum	their inquiries

Data show that onsets are obligatory while codas are optional. The dialect tolerates CV, CVC, CCV, CVCC, CVV, CVVC, and CCVVC syllable structures. Within a syllable, long vowels are never followed by a CC cluster, i.e., CVVCC syllables are prohibited. Initial and final CCC clusters are also prohibited. Initial CC clusters are allowed irrespective of sonority (/ktaab/'a book',/rbaaʕ/'quarters'). Final CC clusters are allowed if they have a falling sonority value (/kalb/'a dog'). Otherwise, an epenthetic vowel will break the cluster (/'ʔa.kil/'food' from underlying/'ʔa.kil/). Medial CVCC syllables are permitted when the two consonants have falling sonority values (la. 'bint.hum 'for their daughter'. Otherwise, an epenthetic vowel is added to break the cluster (/fi.kir.hum/ 'their thought' from/fikr.hum/) (Na'eem et al. 2020).

The data in (1) confirm the stress assignment rules in JA. A preantepenultimate syllable is never stressed. This leaves the last three syllables from the right edge as stress bearers in the dialect. A word-final superheavy syllable is stressed. If one is not found, a penultimate heavy syllable is stressed. Otherwise, the antepenultimate syllable receives stress by default.

2.2 Active constraints

Accounting for the stress patterns in (1), the following constraints are assumed active in the dialect.[3]

3 An equally valid account ignores superheavy syllables and involves viewing word final consonants as extrametrical, and introducing Weight-By-Position constraint. For details, refer to the study by Abu-Abbas (2003).

(2) Active constraints

a. Trochaic (TF) Prince and Smolensky (1993/2004)
Feet are left headed

b. WSP Prince and Smolensky (1993/2004)
Heavy syllables are stressed.

c. FOOT BINARITY (FTBIN) Prince and Smolensky (1993/2004)
Feet are binary at some level of analysis (μ, σ)

d. NONFINALITY (NONFIN) Prince and Smolensky (1993/2004)
No head of Prosodic Word is final in Prosodic Word *'F *'σ

e. EDGEMOST
A peak of prominence lies at the right edge of the word. (Prince and Smolensky, 1993/2004)

f. PARSE σ > μμ Al-Jarrah (2008)
A syllable that weighs more than two moras must be parsed into a higher prosodic constituent

g. PARSE σ ≤ μμ Al-Jarrah (2008)
A syllable that weighs two moras or less must be parsed into a higher prosodic constituent

h. LAPSE-R Al-Jarrah (2008)
Successive unparsed syllables at the right edge of a word in not allowed

All feet are trochaic, and the following constraint hierarchy holds:

(3) Constraint hierarchy

FTBIN ≫ PARSE σ > μμ ≫ LAPSE ≫ WSP ≫ NONFIN ≫ PARSE σ ≤ μμ ≫ EDGEMOST

The interaction of the constraints accounts for all stress patterns in the data in (1) as exemplified in tableaux (4–12) all of which are self-explanatory.

(4) L'SH

Input: damaar	FTBIN	WSP	PARSE σ > μμ	NONFIN('F, 'σ)	PARSE σ ≤ μμ
a. ☞da('maar)				*'F and * 'σ	*
b. ('da.maar)		*!		*'F	
c. ('da)maar	*!	*	*		

Candidates (4b,c) violate the higher-ranked WSP and FTBIN, respectively, while candidate (4a) satisfies both and is thus optimal.

(5) HH'SH

Input:/miʤ.tam.'ʕiin/	FTBIN	WSP	PARSE σ > μμ	NONFIN	PARSE σ ≤ μμ
a. ☞ miʤ.tam('ʕiin)				*'F and *'σ	**
b. miʤ('tam)ʕiin			!*		**
c. ('miʤ)tam.ʕiin			!*		*

Candidate (5a) is optimal since a final superheavy syllable is stressed. The other two candidates fail to parse the final syllable which has more than two moras.

(6) L'HL

Input:/fi.him.na/	FTBIN	WSP	PARSE σ > μμ	NONFIN	PARSE σ ≤ μμ
a. ☞ fi('him)na					**
b. fi(him.'na)		*!		*'F and *'σ	*
c. fi. ('him.na)				*'F	**
d. ('fi.him)na		*!			*

A heavy penultimate syllable is stressed in (6a). The closest rival is (6b) which loses due to a violation of NONFIN since a final foot is stressed.

(7) H'HH

Input: xaatimhum	FTBIN	WSP	PARSE σ > μμ	NONFIN	EDGEMOST	PARSE σ ≤ μμ
a.☞xaa('tim)hum					*	**
b. ('xaa).tim.hum					**!	**
c. xaa('tim. hum)				* 'F		*
d. xaa.tim. ('hum)				* 'F		**

With multiple heavy syllables, EDGEMOST will determine the winning candidate. Candidates (7a, b) are equally optimal without EDGEMOST which will favor ((7a).

(8) 'HLL

Input: maktabi	FTBIN	LAPSE	WSP	NONFIN	EDGEMOST
a.☞('mak.ta)bi					**
b. mak('ta.bi)			*!	*'F	*
c. ('mak).ta.bi		*!			**

Candidate (8a) is optimal with a disyllabic foot. The closest rival is (8c) which is ruled out by a fatal violation of LAPSE.

(9) LLL

Input: samaka	FTBIN	WSP	PARSE σ > μμ	NONFIN	PARSE σ ≤ μμ	EDGEMOST
a.☞ ('sa.ma)ka					*	**
b.sa('ma.ka)				*'F	*	*

With all light syllables, NONFIN will favor (9a).

(10) H'LLL

Input: muħtarama	LAPSE	WSP	NONFIN	EDGEMOST
a.☞muħ('ta.ra)ma		*		σσ#
b. ('muħ.ta)rama	*!			
c. muħ.ta('ra.ma)	*!	*	*'F	σ#

LAPSE is crucially ranked over WSP to favor (10a) over (10b).

(11) HH'H

Input: miʤtamʕiin	PARSE σ > μμ	LAPSE	WSP	NONFIN	PARSE σ ≤ μμ
a.☞miʤ.tam('ʕiin)		*		*'F and *'σ	**
b. miʤ('tam)ʕiin	!*				*
c. ('miʤ)tam.ʕiin	!*	*			*

The need to parse syllables with more than two moras into feet is crucially ranked higher than NONFIN.

(12) HH'LLL

Input: mustaʕmarati	PARSE σ > μμ	LAPSE	WSP	NONFIN	PARSE σ ≤ μμ
a.☞mus.taʕ('ma.ra)ti			*		***
b. mus.('taʕ.ma)ra.ti		!*			***
c. mus.taʕ.ma('ra.ti)			*	!*'F	***

Longer words further establish the need to rank LAPSE higher than WSP. In candidate (12b), a heavy syllable is stressed but leaves two unparsed syllables at the right edge of a word. Candidate (12a) is optimal although a heavy syllable is not stressed. Unparsed syllables at the left edge are tolerated in the dialect.

Thus far we have seen that in JA stress falls on one of the last three syllables. The final syllable is stressed only if it is superheavy. This is a result of having two PARSE constraints targeting syllables with more than two moras and syllables with two or less moras. These two constraints are split by a NONFINALITY constraint that penalizes final stressed syllables and final stressed feet (5–7). It was also essential to introduce a LAPSE constraint which penalizes two successive unparsed syllables at the right edge of the word. This constraint is dominated by PARSE σ > μμ (11).

3 Problematic data

Despite the discussion presented in the previous section, JA still exhibits stress patterns that require further stipulations. Consider data in (13):

(13) Opaque stress

	Input	Output	Gloss
a	saaʕad-at	'saa. ʕa.dat	she helped
	saʔal-ku	sa. 'ʔal.ku	he asked you (pl.)
	katab-na	ka. 'tab.na	we wrote
	ʔakal-na	ʔa. 'kal.na	we ate
	gaawam-at	'gaa.wa.mat	she resisted
b	bint-na	'bi.nit.na	our daughter
	ʔakl-na	'ʔa.kil.na	our food
	ʔi.sm.na	'ʔi.sim.na	our name
c	gaawam-t	gaa.'wa.mit	I resisted
	saa.ʕad-t	saa.'ʕa.dit	I helped

Data in (13a) are accounted for by the constraint hierarchy established thus far for JA as exemplified in (14 keeping in mind that feet in JA are trochaic (TF))

(14) katab-na

katab-na	TF	PARSE σ > μμ	LAPSE	WSP	NONFIN	PARSE σ ≤ μμ
a.☞ka('tab).na						
b.('ka.tab)na				!*		**
c.(ka.'tab)na	!*					

However, data in (13b, c) cannot be accounted for by the hierarchy established so far. In (13b), a light antepenultimate syllable is stressed where a heavy penultimate syllable is optimized by the hierarchy as (15) shows:

(15) Incorrect optimal candidate for ʔism-na

ʔism-na	PARSE σ > μμ	LAPSE	WSP	NONFIN	PARSE σ ≤ μμ
a.☞ ʔi. ('sim).na					**
b. ('ʔi.sim).na			!*		**

A suboptimal (15a) wins over the optimal (15b).

In (13c), a light penultimate syllable is stressed where an antepenultimate syllable is optimized by the hierarchy as shown in (16):

(16) Incorrect optimal candidate for gaawam-t

gaawam-t	PARSE σ > μμ	LAPSE	WSP	NONFIN	PARSE σ ≤ μμ
a.☞ ('gaa.wa).mit					*
b. gaa. ('wa.mit)			!*	*	*

A suboptimal (16a) wins over the optimal (16b).

The constraint hierarchy will predict the correct optimal candidate only if the epenthetic vowel is ignored for the purposes of stress assignment. In other words, what we need is a theory that allows faithfulness to the stressed vowel in a form prior to epenthesis, i.e., an intermediate stage in the derivation.

3.1 Proposals with traditional OT

Different theoretical tools have been proposed to account for the opaque interaction of epenthesis and stress. To solve the problem posed by examples in (13b), Kager (1999a, b) proposes a constraint that would ban assigning stress to an epenthetic vowel. Note that the heavy syllables in /'bi.nit.na/ from /bint.na/, /'ʔi.sim.na/ from/ʔism-na/, and /'ʔa.kil.na/ from /ʔakl-na/ all have an epenthetic vowel that is inserted to break up an otherwise illicit consonant cluster. The constraint proposed by Kager is formalized in (17):

(17) HEAD-DEP(IO)

Every vowel in the output prosodic head has a correspondent in the input.

What this constraint demands is for every stressed vowel in the output there must be a corresponding vowel in the input. This constraint is responsible for ruling out output form like /bi.'nit.na/ since the stressed vowel in the heavy syllable is epenthetic and thus has no correspondence in the input. This constraint must necessarily dominate WSP as shown in (18) for /ʔism.na/:

(18) HEAD-DEP(IO) and /bint.na/

ʔism-na	PARSE σ > μμ	LAPSE	Head-Dep I/O	WSP	NONFIN	PARSE σ ≤ μμ
a. ʔi. ('sim).na			!*			**
b. ☞ ('ʔi.sim).na				*		**

Although appealing HEAD-DEP(IO) will not be able to account for the stress pattern in (13c) since stress does not fall on the syllable with the epenthetic vowel. To solve the cases of opaque stress encountered in (13c), we need stress assignment to disregard the epenthetic vowel as a whole and not simply avoiding assigning stress to such vowels. In /ʔa.'ka.lit/ and /gaa.'wa.mit/, disregarding the epenthetic vowel means that we have a final heavy syllable in both examples. According to the stress assignment rules in JA, these heavy vowels will attract stress. What we need then is a mechanism formalized as a constraint that would trigger a correspondence relation between the actual output and a related form of the output before epenthesis, i.e., what we need is a correspondence relation between /ʔa.'ka.lit/ and /gaa.'wa.mit/ on the one hand and /ʔa.'kalt/ and /gaa.'wamt/ on the other, respectively. This correspondence relation will have to preserve the stressed vowel between the two output forms. The forms /ʔa.'kalt/ and /gaa.'wamt/ cannot be called bases of the output forms since they are not found as separate output forms in the dialect.

McCarthy (1997, 1999) proposes a theory of Sympathy to account for the above opaque cases of stress. Sympathy constraints require faithfulness to a failed candidate '*sympathy candidate*' marked by (֍), which is defined as the optimal candidate that obeys a designated faithfulness constraint called '*the selector constraint*' marked by (✯). The selector constraint is language-specific. Faithfulness then plays two roles in the theory of Sympathy. The failed candidate, which is the object of sympathy, is selected by an IO faithfulness constraint. And this candidate's effect on the outcome is mediated by inter-candidate faithfulness (McCarthy 1999, 336).

Relating sympathy theory to our data in (13c), what we need is a correspondence relation that would be responsible for retaining the stressed syllable in the input forms before epenthesis could take place, i.e., we need a correspondence relation between /ʔa.'kal-t/ and /gaa.'wam-t/ on the one hand and the actual output forms on the other. In his development of an argument against sympathy, Kiparsky (2000) suggests that to account for opaque stress in Arabic, it would be necessary to introduce ֍ IDENT-STRESS that requires faithfulness to a candidate that has no epenthesis (/ʔa.'kalt/ and /gaa.'wamt/. These are the candidates that satisfy the selector constrain that bans epenthesis (19):

(19) ✯IDEP-IO (V)

Every vowel in the output has a corresponding vowel in the input (no epenthesis).

֍ IDENT-STRESS necessarily dominates WSP as tableaux (20–21) exemplify, where a constraint against complex margins (*CM) is necessary to prevent the sympathetic candidate from surfacing.

(20)

Input: ʔakl-na	*CM	֍ IDENT-STRESS	WSP	✯IDEP-IO (V)
a. ☞ 'ʔa.kil.na			*	*
b. ʔa.'kil.na		*!		*
c. ֍ 'ʔakl.na	*!			

According to (20), candidate (20a) surfaces as the optimal output since it satisfies the dictates of the ֍ IDENT-STRESS in having its stress on the syllable that corresponds to the syllable in the sympathetic candidate /'ʔakl.na/ which was chosen by the selector constraint IDEP-IO (V). The closest rival to (20a) is (20b) which loses despite its satisfaction of WSP.

(21)

Input: ʔakal-t	*CM	❀ IDENT-STRESS	WSP	✭IDEP-IO (V)
a. ☞ ʔa.'ka.lit				*
b. 'ʔa.ka.lit		*!		*
c. ❀ ʔa.'kalt	*!			

According to (21), candidate (21a) surfaces as the optimal output since its closest rival (21b) violates the higher-ranked ❀ IDENT-STRESS by having stress on the first syllable rather than the penultimate syllable which corresponds to the stressed syllable of the sympathetic candidate (21c) which itself is ruled out due to a fatal violation of the higher ranked *CM. It is worth noting here that candidate (21b) bests the optimal candidate (21a) in terms of the dictates of NONFINALITY. This suggests that ❀ IDENT-STRESS must dominate the NONFINALITY constraint. Candidate (21a) has a final stressed foot while (21b) does not violate this constraint. In terms of the EDGEMOST constraint, the optimal candidate in (21a) bests its rival (21b) since only one syllable separates the stressed syllable in (21a) from the right edge of the word, while two syllables separate the stressed syllable in (21b) from the right edge of the word.

Sympathy theory was severely criticized by Idsardi (1997) and Kiparsky (2000). Idsardi (1997) notes that the theory suffers several severe shortcomings. First, the theory cannot handle the normal application of some processes. Second, chaos ensues when sympathy is added to OT; non-problematic data suddenly become problematic. This has an adverse effect on learnability. Third, adding sympathy vastly increases the grammar space in unpredictable ways. Kiparsky (2000) notes that sympathy misses the generalization that epenthesis is invisible to all word phonology. The same Selector constraint will choose a different sympathy candidate to handle other processes that involve epenthesis. Kiparsky (2006) also shows that sympathy predicts non-occurring types of constraint interactions (such as mutual non-bleeding), that it cannot characterize certain actually occurring types of constraint interactions, and that it is incompatible with Richness of the Base.

What both Head-Dep and Sympathy require is faithfulness to a feature in a sub-optimal candidate. This idea is developed in HS.

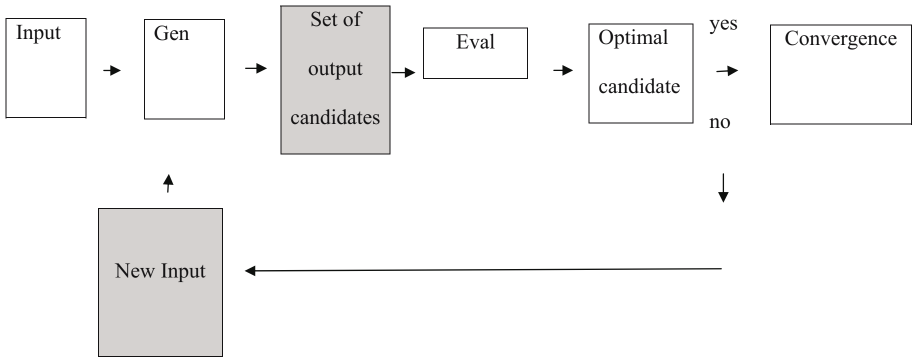
4 Harmonic serialism

4.1 Theoretical background

In Classic Parallel Optimality Theory (P-OT) (Prince and Smolensky 1993/2004, McCarthy and Prince 1993a, b), the generative component GEN produces the candidate set. The set of candidates is infinite because candidates can differ from the input in many different ways; which means one or more operations can be applied to a given input to produce each candidate. Harmonic Serialism (HS) (McCarthy 2000, 2002, 2006, 2010a, b, 2016) is a serial take on the traditional (P-OT), fundamentally different in the idea of gradualness. In P-OT, Gen is able to create candidates that are different from the input and from each other in many ways. All of these candidates are then submitted to EVAL to optimize one of them based on the hierarchy of constraints active in the dialect. HS reduces the power of GEN so that only candidates that are minimally different from the input are produced. These candidates are then evaluated by EVAL to pick an optimal candidate. Every candidate deviates from the input in only one property. Each pass through GEN and EVAL is called a step. The candidate set at each step includes the unchanged input to that step and all of the ways of making a single change in that input. This optimal candidate will then become the input of the same constraint hierarchy and a new set of candidates will be produced by GEN with only a single deviation from the new input. These new candidates are then evaluated by the constraint hierarchy and an optimal candidate will be chosen in this new step. This will continue until the optimal candidate chosen by a step can no longer be modified as it is identical to the actual final optimal candidate. This is when the derivation is said to converge.

What this process achieves is gradual harmony. After each step, the optimal candidate is more similar to the final optimal candidate. In any given step, there can be only one unfaithful operation but as many faithful operations as possible. A general outline of HS is in (22)

(22) Structure of HS



A set of output candidates is generated by GEN. These candidates are minimally different from the input and from each other. A set of ranked constraints will pick an optimal candidate in what is called (step1). If this optimal candidate is identical to the final output in the language, convergence takes place and the derivation is complete. If the optimal candidate in (step 1) is not identical to the final output, it re-enters GEN and a new set of candidates is generated and evaluated by the constraint set in what is called (step 2). These passes from GEN to EVAL continue until the output of the step is identical to the final output. The optimal candidate chosen in a step will always be more harmonic to the final output compared to the previous step.

4.2 Application of HS to JA opaque stress

Opaque stress in JA (13b, c) results from the need to assign stress before epenthesis. In other words, epenthesis is intrinsically ordered after stress assignment. Two processes are intrinsically ordered if the proper applicability of one depends on the prior application of the other (McCarthy 2016). In HS, this occurs when the markedness constraint implicated in the second process (epenthesis) is not violated until the first process (stress) has been applied. Epenthesis in JA is needed to break illicit coda clusters (*COMPLEX CODA, *COMP-Coda) in violation of DEP-IO which militates against epenthesis.

Opaque stress in (13b) involves two steps before convergence (23.1-3). The first step creates feet and assigns stress. The second splits the illicit coda cluster before convergence.

(23.1) bint-na ⇨ 'bi.nit.na step 1

/bint-na/	PARSE σ > μμ	LAPSE	*COMPCoda	WSP	NONFIN	PARSE σ ≤ μμ	DEP-IO
a. ☞ ('bint).na			*			*	
b. ('bint.na)			*		!*		
c. bint.na			*	!*		**	

The first pass through GEN and EVAL creates feet and assigns stress which could actually be split into two steps. The first creates feet and the other assigns stress. Accordingly, (23.1a) is chosen as the intermediate optimal candidate. Candidates with an epenthetic vowel ('bi.nit).na or bi.('nit).na are not produced by GEN since they involve two changes from the input: foot formation and epenthesis.

(23.2) bint-na ⇨ 'bi.nit.na step 2

('bint).na	PARSE σ > μμ	LAPSE	*COMPCoda	WSP	NONFIN	PARSE σ ≤ μμ	DEP-IO
a. ☞ ('bi.nit).na				*		*	
b. ('bint.na)			!*		!*		

From step 1, ('bint).na becomes the input of step 2. Foot structure and stress are already part of the input. Changes in foot structure and stress location will no longer be suggested by GEN as potential candidates. The hierarchy will only make one change to this new input which is epenthesis. Candidate (23.2a) is optimal since it satisfies *COMPCoda.

(23.3) bint-na ⇨ 'bi.nit.na step 3 (convergence)

/'bi.nit.na/	PARSE σ > μμ	LAPSE	*COMPCoda	WSP	NONFIN	PARSE σ ≤ μμ	DEP-IO
a. ☞ ('bi.nit).na				*		*	
b. 'bint.na			!*				

The steps converge, and the input is identical to the optimal output. No more gradual harmony is possible. Opaque stress in (13c) also involves the same two steps before convergence (24.1-3).

(24.1)/gaawam-t/ ⇨ gaa.('wa.mit) step 1

gaawam-t	PARSE σ > μμ	LAPSE	*COMPCoda	WSP	NONFIN	PARSE σ ≤ μμ
a.☞ gaa.('wamt)			*	*	**	*
b. ('gaa).wamt	!*		*	*	*	*
c. gaa.wamt	!*		*	**		*

The first pass through GEN and EVAL creates feet and assigns stress. Candidate (24.1a) is the intermediate optimal output since the competitors violate the higher-ranked PARSE σ > μμ. Again, GEN does not produce candidates with epenthetic vowels since that will involve two changes to the input.

(24.2)/gaawam-t/ ⇨ gaa.('wa.mit) step2

gaa.('wamt)	PARSE σ > μμ	LAPSE	*COMPCoda	WSP	NONFIN	PARSE σ ≤ μμ	DEP-IO
a. ☞ gaa.('wa.mit)				*	*	*	*
b. gaa.('wamt)			!*		**	*	

From step (1), gaa.('wamt) becomes the input of step (2) with stress already assigned. Epenthesis will split the coda cluster, and (24.2a) is the optimal candidate.

(24.3)/gaawam-t/ ⇨ gaa.('wa.mit) step 3

gaa.('wa.mit)	PARSE σ > μμ	LAPSE	*COMPCoda	WSP	NONFIN	PARSE σ ≤ μμ	DEP-IO
a.☞ gaa.('wa.mit)				*	*	*	*
b. gaa.('wamt)			!*		**	*	

The steps converge, and the input is identical to the optimal output. No more gradual harmony is possible.

The fact that in JA stress assignment takes place before epenthesis implies that some other languages will have the opposite ranking. In Egyptian Arabic (Farwaneh 1995), stress epenthesis interaction is opposite to that in JA. Epenthesis in Egyptian takes place prior to stress assignment.

(25) Egyptian Arabic (Farwaneh 1995, 134): Penultimate stress

/madrasa/	mad.rá.sa	school
/martaba/	mar.tá.ba	mattress

In words with sequences of three medial consonants (CCC), a vowel is epenthesized following C2. If the epenthetic vowel is penultimate, it is stressed just like an underlying vowel:

(26) Egyptian Arabic: Epenthesis in medial CCC clusters (Farwaneh 1995, 135)

/bint-na/	bin.'ti.na	our daughter
/ʔardˤ-na/	ʔar.'dˤi.na	our land
/katabt-lu/	ka.tab.'ti,lu	I wrote to him

In (26), a syllable with an epenthetic vowel is stressed in support of the fact that epenthesis takes place before stress assignment.

5 Conclusion

Stress–epenthesis interaction in JA results in opaque surface stress patterns. Two cases were under investigation in this article. Stressing an antepenultimate syllable where a heavy penultimate is expected, and stressing a light penultimate syllable where an antepenultimate syllable is expected to receive stress. Both cases involve an epenthetic vowel required by the dialect to break illicit coda clusters. Reference to an intermediate stage where stress is assigned prior to epenthesis was critical for a proper account of these cases of opaque stress. Harmonic Serialism is outlined and proven adequate for a proper account for opaque stress in JA. The theory of HS is a crossover between traditional parallel OT and derivational, rule-based theory that is still gaining grounds particularly due to its ability to account for opaque structures.

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