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Vowel Innovation in Arabic: Inductive Grounding and Pattern Symmetry

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1. Introduction[1]

This paper has two aims. The first is to show that vowel innovation is taking place in colloquial Arabic – colloquial Palestinian, in particular. The second is to provide a theoretical account of it. The vowel system of Old Arabic (e.g., Fischer & Jastrow 1980; Lipinski 1997), is seen in (1), that of colloquial Palestinian in (2). The modern colloquial's new long mid vowels are uncontroversial: they derive from Old Arabic diphthongs /ÆI/ and /ÆU/, shown by Old Arabic-colloquial pairs such as saḭf - seːf 'sword' and laṵn -

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loːn ‘colour’. The focus of this paper is the new short mid vowels. The inventory in (2) claims that the Old Arabic underlying vowel system is being expanded in the colloquial by emergent retracted tongue root (rtr) /ɛ/ and (rtr unspecified) /O/.[2] Where do the new short mid vowels come from? The account to be proposed in this paper is functionalist and claims that the innovation is driven by inductive grounding (Hayes 1998) within Optimality Theory (OT) (McCarthy & Prince 1993; Prince & Smolensky 1993; Archangeli & Langendoen 1997; Kager 1999).

(1) I U Iː Uː
Æ Æː

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[2]Non-generative studies have standardly analysed the Palestinian vowel system as comprising the vowels in (1), with other surface qualities the result of phonetic colouring (Schmidt & Kahle 1918/30; Bauer 1926/70; Cantineau 1960; Grotzfeld 1964, 1965; Wright 1971; Palva 1988; Nishio 1992). The standard generative view is that it is (1), plus /Eː Oː/ (Younes 1993). However, close investigation (Shahin 2002, and this present paper) indicates the inventory in (2). (Also see Herzallah 1990 on lack of /U/ in some dialects.)

(2)	I	U	Iː	Uː
	ɛ	O	Eː	Oː
	Æ		Æː	

The remainder of this paper is organised as follows. The next section lays out relevant representational assumptions, explains relevant properties of the colloquial phonology, and introduces inductive grounding. Then, §3 presents data showing the vowel innovation. Next, §4 and §5 present the accounts of the /ɛ/ and /O/ innovation. Finally, §6 concludes this paper.

2. Background

2.1 Representational assumptions and phonological properties

The segmental representations of the Palestinian underlying vowels, from Shahin (2002), are seen in (3). Mid vowels are specified for [HIGH] and [LOW], following Schane (1984) and Kaye et al. (1985). Evidence for active [HIGH], [LOW], and [LAB] in the language comes, respectively, from r-de-emphaticisation, vowel reduction, and rounding harmony. The first two are explained in §3. Rounding harmony (Kenstowicz 1981; Abu Salim 1987), seen in forms such as /kUtb/ kʊtʊb ‘books’, rounds the epenthetic vowel when the underlying root vowel is round.

(3)

I	E	Æ	O	U
$_{0}$Place	$_{0}$Place	$_{0}$Place	$_{0}$Place	$_{0}$Place
|	|	|	/ \	/ \
[DOR]	[DOR]	[DOR]	[LAB] [DOR]	[LAB] [DOR]
|	/ \	|	/ \	|
[HI]	[HI] [LOW]	[LOW]	[HI] [LOW]	[HI]

The postvelar consonants of the language are seen in (4).[3] They are the gutturals (on the left in (4)) and the emphatics (on the right). Their phonological behaviour, supported by articulatory and acoustic data, shows they are all specified for [RTR] (under the articulator feature [TONGUE ROOT]) (Shahin 2002).

(4) χ ʁ ħ ʕ h ʔ m̙ b̙ l̙ ð̙ t̙ s̙ r̙ k̙

By rtr harmony, short vowels surface rtr under adjacency to a postvelar consonant, as does /U/ preceding the glottal stop in /sUʔÆːl/ sʊʔæːl ‘question’. (The emphatics are specified for further features by which they trigger emphasis spread (Younes 1982; Card 1983; Herzallah 1990; Davis

[3]Some urban dialects have d̙ instead of ð̙.

1995; McCarthy 1997), Arabic's other postvelar harmony.) Two further phonological properties are relevant: short vowels surface rtr also in a closed syllable; rtr harmony spreads throughout the word, affecting short vowels, as in /fIlm/ fɪlɪm 'film, movie' and /ʁInImÆ/ ʁɪnɪmə 'goat'. The enriched surface vowel inventory, with non-rtr~rtr contrasts, is seen in (5). Schwa is the underlying short low vowel (/Æ/) that has lost its [LOW] specification by vowel reduction.

(5) non-rtr: i e æ o u ə
rtr: ɪ ɛ a ɔ ʊ

2.2 Inductive grounding

Inductive grounding within OT (Hayes 1998) claims that much of phonology – in fact, everything that is phonetically grounded – stems from on-line computation by the language user, based on the user's phonetic knowledge of perceptual and articulatory difficulty, gathered from experience. Inductive grounding provides a means for accounting for phonological phenomena which are grounded, that is, for those phonetically based but cognitively controlled aspects of sound structure. The role of phonetics in phonology has been a contentious issue (see, e.g., the 1991 volume of *Phonetica* and the

LabPhon volumes of Kingston & Beckman 1990, Docherty & Ladd 1992, Keating 1994, Connell & Arvaniti 1995, and Broe & Pierrehumbert 2000).

Several works (e.g., Ohala 1978, 1990, 1992; Steriade 1997, 2000), have argued that much of phonology can be either best or only explained by admitting phonetics into phonology. Other works, comprising much of the recent phonological literature, stress where patternings are grounded (cf. Archangeli & Pulleyblank 1994) but provide no mechanism for the phonetics-phonology interface. Hayes's framework provides such a mechanism.

In inductive grounding, the user's knowledge of perceptual and articulatory difficulty, gathered from experience, is compiled in a phonetic map (see also Steriade 1997). Based on that map, effective, that is, grounded, constraints are induced and operationalised, in some ranking, in the grammar. Effective constraints ban what is difficult. Induced constraints are not part of UG. (This counters the position of classical OT (Prince & Smolensky 1993; McCarthy & Prince 1993), that all constraints are from UG.) As constraints are generated based on what is difficult for the user, user-optimality drives much of grammar optimality.

I will argue that colloquial Arabic vowel innovation is based on perceptual difficulty, thoroughly established elsewhere as an important factor in phonological patterning and language change (see, e.g., Flemming 2001; Holt 1997; Silverman 1997; Tobin 1997; Boersma 1998; Haspelmath 1999).

This paper extends the application of inductive grounding to paradigmatic phenomena, namely, the segments present in an underlying inventory. In Hayes (1998), it is applied only to syntagmatic phenomena (e.g., voicing in various segmental contexts).

3. Vowel innovation data

Palestinian short mid vowels are observed in several forms, such as those in (6).

(6)

a. m̘ʕ̘ət̘en̘ɑ́ːʃ	‘we didn’t give’	k. bɔrdkæːn	‘oranges’
b. ħɛlɪm	‘dream’	l. ʁɛnɪmə	‘goat’
c. sɛnə	‘year’	m. fɛkəʕ	‘(3ms) popped’
d. bɛdui	‘bedouin (ms)’	n. m̘ɔh̘ɔr̘	‘colt’
e. sido	‘grandpa’	o. ʤɛrrəb	‘(3ms) tried’
f. boməli	‘pomelo’	p. dɛmm	‘blood’
g. lobiə	(type of small pea)	q. mɛlɪk	‘king’
h. məmɛllenæːʃ	‘(1pl) didn’t fill (something)’	r. mɛθələn	‘for example’
i. ʕɔlə	(fem. name)	s. ʤɛnɪb	‘side’
j. ʤɛnnə	‘paradise’	t. ʁɛlɪbə	‘bother’ (N)

However, not all of them are underlying, that is, not all are the innovated vowels we are concerned with here. Finding the real ones takes some hunting. They are identified when two obscuring factors are considered: vowel shortening and phonetic lowering. As seen in (7), long vowels shorten under stress shift (Abdo 1969). As illustrated in (8), high vowels lower to mid when adjacent to a postvelar. (This lowering is analysed as phonetic because it is perceptually and acoustically gradient; the lowered high vowels are phonetically diphthongs.) Filtering out the obscuring phenomena reveals the innovated vowels in (6) to be those in (9).

(7)	ʕ̙ət̙éːn̙ə	‘we gave’	vs.	m̙ʕ̙ət̙en̙ɑ́ːʃ	‘we didn’t give’
(8)	/ħIlm/ ħɛlɪm	‘dream’	vs.	/fIlm/ fɪlɪm	‘movie’

(9)	a. sɛnə	‘year’	h. bɔrdkæːn	‘oranges’
	b. bɛdui	‘bedouin (ms)’	i. fɛkəʕ	‘(3ms) popped
	c. sido	‘grandpa’	j. ʤɛrrəb	‘(3ms) tried’
	d. boməli	‘pomelo’	k. dɛmm	‘blood’
	e. lobiə	(type of small pea)	l. mɛlɪk	‘king’
	f. məmɛllenæːʃ	‘(1pl) didn’t fill (something)’	m. mɛθələn	‘for example’
	g. ʤɛnnə	‘paradise’	n. ʤɛnɪb	‘side’

In (9h), the possibility of the ɔ being phonetically lowered /U/ adjacent to emphatic /r̙/ is ruled out by the properties of r-de-emphaticisation (Younes 1994). In this language, the trill is underlyingly emphatic. (There is no underlying non-emphatic /r/.) It is de-emphaticised in certain contexts, including preceding a coronal consonant. This means it is r, not r̙, in (9h), so the ɔ in that word cannot be lowered /U/ because the trill is not postvelar. (Note that the rtr quality of that ɔ is expected, since short vowels surface rtr in a closed syllable.) In (9j), the possibility of the ɛ being the underlying short low vowel is ruled out by further properties of r-de-emphaticisation, as will be explained shortly.

In forms with innovated vowels, there is no source for the mid height, as the forms contain no postvelar consonant (though we are taking a raincheck on (9j)). Forms like (9a-b) are critically important: for them, there is no source for the rtr quality of the mid vowel (as those words have solely open syllables).

The conclusion from the above data is that this Arabic colloquial has innovated short mid vowels, and the front one is underlyingly rtr. As the account I will propose claims that the /O/ innovation is driven by the /ɛ/

innovation, we now examine the /ɛ/ in detail, to identify its source and establish with more certainty its phonological status.

Data comparisons, as between (10) and (11), show that /ɛ/ is derived from the Old Arabic short low vowel. (In (11), no rtr analysis of the short low vowel is implied by the use of ‘a’.)

(10) Colloquial Palestinian

a. sɛnə ‘year’

b. mɛlɪk ‘king’

c. ʤɛrrəb ‘(3ms) tried’

(11) Old Arabic

a. sana ‘year’

b. malɪk ‘king’

c. ʤarrab ‘(3ms) tried’

Further comparisons, as in (12), prompt a functionalist hypothesis regarding the source of this innovation: as mid vowels are shorter than low vowels (Lehiste 1970), mid height has been introduced to increase the perceptual distinctiveness of short /Æ/ vs. long /Æː/. As rtr vowels are shorter than non-rtr vowels (see §4), rtr quality further enhances the distinction. I propose that ɛ is so phonetically different from æ as to result in restructuring of the underlying vowel inventory (Bybee-Hooper 1979) for lexicon optimisation (see, e.g., Prince & Smolensky 1993; Inkelas 1994; Holt 1997, Kager 1999), so UR matches the phonetic input.

(12)	a. hɛlə	'goodness'	vs.	hæːlə	(fem. name)
	b. mɛlɪk	'king'	vs.	mæːlɪk	'owner'
	c. ʤɛnɪb	'side'	vs.	ʤæːnɪb	'side, sidepiece'

However, could it be the new ɛ is not underlying /ɛ/, in fact, not even new, but a phonetically raised variant of the short low vowel, an instance of the phonetic variation in vowel quality typically ascribed to Arabic in descriptive studies? (See note 2.) Though no full minimal pair is evident – yet (the closest I've observed is sɛlɪk 'boiled' (Adj) vs. salək '(3ms) boiled') – vowel reduction and r-de-emphaticisation diagnostics clarify that the ɛ at issue cannot be a phonetic variant of the short low vowel, but that it is lexical, a new underlying vowel.

Recall that /r̙/ de-emphaticises in certain contexts. Besides preceding a coronal, it de-emphaticises in a form with an underlying stem-internal non-low front vowel (Younes 1994), as in χɪrfæːn (*χ̙ɪr̙f̙ɑːn̙) 'lambs' and ʁeːrək (*ʁ̙eːr̙ək̙) 'other than you (ms)'. In the colloquial variety of this paper's data, emphasis harmony affects a range of underlyingly non-emphatic sounds, and usually extends to both word edges. This is seen from forms like ʔɪtkɪbhæːʃ '(2fs) don't spill it (fem.)!' vs. ʔ̙ɪt̙ħ̙ʊt̙h̙ɑːʃ '(2fs) don't put it (fem.)!'. The underlying midness of /ɛ/ in forms like ʤɛrrəb can thus be tested by observing for possible emphasis effects, including under suffixation. In the relevant forms, as illustrated in (13), there is no emphasis harmony; there is no emphasis whatsoever. This indicates de-emphaticised r, the source of which, in (13), must be an underlying mid /ɛ/. Were the ɛ underlyingly the low vowel, /r̙/ would not be de-emphaticised and *məʤɛr̙r̙əb̙n̙ɑːʃ would be grammatical.

(13) məʤɛrrəbnæːʃ (*məʤɛr̙r̙əb̙n̙ɑːʃ) 'we didn't try'

As for vowel reduction, the second diagnostic, in this language the short low vowel reduces to schwa when unstressed. Thus, if ɛ is the low vowel, it is expected to reduce to schwa in that environment. However, as illustrated in (14), in the forms at issue it does not.

(14) fɛ́kəʕ ‘it popped’ vs. məfɛkáʕɪʃ (*məfəkáʕɪʃ) ‘it didn’t pop’

Finally, data such as those in (15) illustrate the current interspeaker and intraspeaker variability in production of the mid short vowels. These forms were gathered from speakers from various locations: Gaza, Al-Bireh (near Ramallah), and Jerusalem. The speaker from Jerusalem, who produced (15a-b), apparently has a conservative dialect. The form in (15d) was produced alongside mədʒɛrrəbnæːʃ on the same occasion by each of two different speakers. The mid vowels are clearly an innovation in progress. Forms such as (15b-c) indicate that new /O/ is derived from /U/.

(15) a. halə ‘goodness’ e. maθələn ‘for example’

b. bʊrdʔæːn ‘oranges’ f. damm ‘blood’

c. lubiə (type of small pea) g. faʔəʕ ‘(3ms) popped’

d. mədʒɛr̘r̘əb̘n̘ɑːʃ ‘we didn’t try’

4. Account of /ɛ/

I propose that the mechanism for the restructuring of the vowel inventory for phonologisation of /ɛ/ is inductive grounding. Based on perceptual experience, speakers generalise over phonetic tokens to construct a phonetic map of perceptual difficulty for shortness or length for various vowel qualities. This is based on raw auditory information. Comparison of spectrograms with cochleagrams based on the standard understanding of cochlear response (Zwicker 1961) indicates that the primary difference between acoustic and auditory spectral information is that information in the 0-1500 Hz range is amplified in audition (Johnson 1997). The information we are concerned with for vowel quality is within or not far past that range. Thus, for our trace of the inductive grounding of /ɛ/, acoustic information will suffice.

Acoustic data are presented in Table 1. The duration data are re-presented in graph format in Figures 1-2, the F_1, F_2 data in Figures 3-4. These data come from a sampling of Palestinian Arabic, a sampling of the perceptual input of the speakers who are innovating /ɛ/. Four tokens each of the long and short vowels in real word carrier forms controlled for segmental and prosodic context, following Lehiste (1970), were taperecorded from a male native speaker, age 35 years, from Ramallah. The data were digitised at 22.05

sampling rate and analysed using Multi-Speech 3700® by Kay Elemetrics. Duration values are averages based on segmentation using the procedures of Peterson & Lehiste (1960). No other duration data for this language is currently available. However, since the speech of the consultant for the acoustic data of this paper is absolutely typical, I assume the duration values to be representative. The F_1 and F_2 values are averages of the values obtained per segment from manual measurement of wideband spectrogram and narrowband spectra displays. A check of the values against those from an extensive acoustic database of Palestinian colloquial from two speakers (Shahin 2002) shows these values to be generally in line with those of the previous study.[4]

[4]However, acoustic distinctiveness between [æ] and [a] was not found in the previous study.

Table 1. Duration and F_1, F_2 values of tokens of the Palestinian vowels

	duration (msec)	F_1 (Hz)	F_2 (Hz)
iː	224	290	2341
eː	217	429	1880
æː	189	619	1578
oː	194	474	1067
uː	257	318	1001
i	73	309	2067
ɪ	59	368	1819
e	166	410	1601
ɛ	71	547	1601
æ	106	539	1526
a	72	607	1523
ə	60	515	1432
o	92	464	1249
ɔ	63	439	1100
u	135	321	1161
ʊ	71	392	984

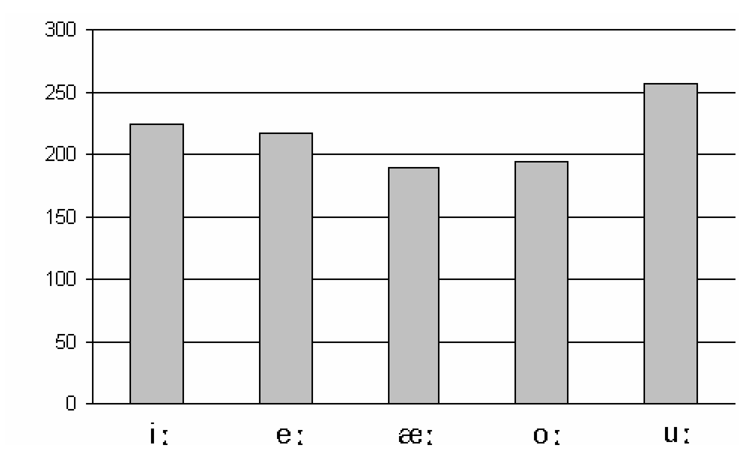

Figure 1. Duration (in msec) of tokens of the Palestinian long vowels (from Table 1)

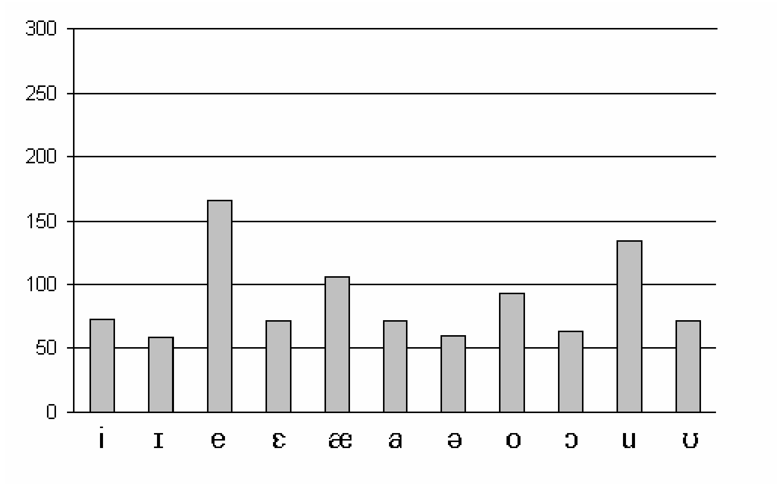

Figure 2. Duration (in msec) of tokens of the Palestinian short vowels (from Table 1)

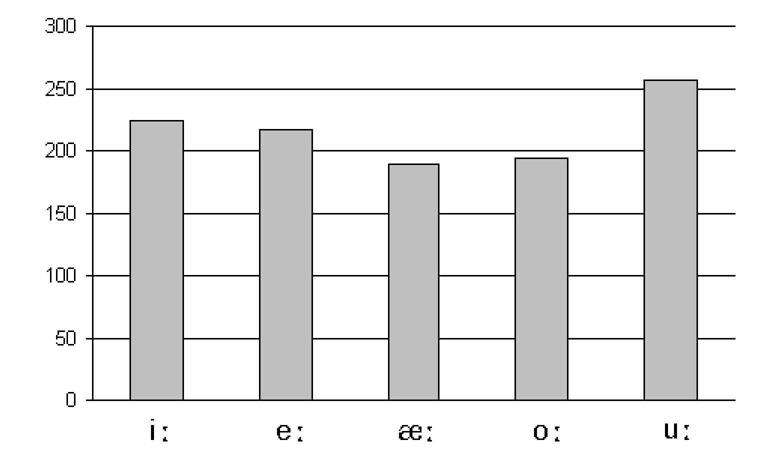

Figure 3. F_1, F_2 (in Hz) of tokens of the Palestinian long vowels (from Table 1)

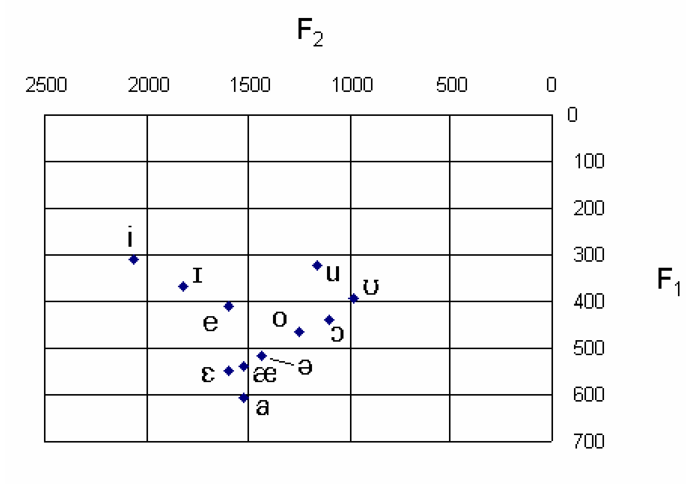

Figure 4. F_1, F_2 (in Hz) of tokens of the Palestinian short vowels (from Table 1)

Example (16) illustrates the procedure used to determine plausible perceptual difficulty scores for the vowels. Perceptual difficulty was taken to be based on combined duration and quality values. The longer the vowel, the greater the perceptual ease, the shorter, the greater the perceptual difficulty. The farther the vowel from the nearest vowel in the F_1, F_2 plane, the greater the ease, the closer, the greater the difficulty. Based on Table 1, duration was taken to have a ceiling of 260 msec. The percentage of 260 of a vowel's duration was calculated to determine, first, the vowel's ease based on duration. For example, long [iː], at 224 msec, has a duration 86% of 260, for a duration value of 86/100. Quality values were determined by first considering F_1 and F_2 separately. A 100 Hz F_1 difference from the nearest vowel neighbour was taken as the aim for F_1 distinctiveness, 200 Hz for F_2. Quality values for long vs. short vowels were determined separately. For example, quality values for long [iː], with long [eː] its nearest neighbour, are 139/100 for F_1, 461/200 for F_2. Combined and converted to over 100, this yields an overall quality value of 185/100. Combined with the duration value and converted to over 100, this yields 136/100, rounded to 1.4/1 as overall score for perceptual ease. Inverted for the opposite, the perceptual difficulty score for [iː] is -.6: [iː] is not at all hard to perceive.

(16)	[iː]	224ms = 86% of 260 msec	= 86/100 duration value
		F_1 difference 139 Hz, 139/100	= 139/100 F_1 value
		F_2 difference 461 Hz, 461/200	= 231/100 F_2 value
			= 370/200
			= 185/100 overall quality value
			+ 86/100 duration value
			= 271/200
			= 136/100
			= 1.4 (/1) perceptual ease
			= -.6 (/1) perceptual difficulty

In this manner, the perceptual difficulty scores for all the vowels were determined to be those in (17). Cells for which Palestinian has no vowels are shaded. Vowels that are structurally low or rtr are identified, where 'structurally' means their phonological behaviour shows they are specified for those features ([LOW], [RTR]). After Hayes, the features themselves are understood as categorisations of the (phonetically rich) phonological form.

(17) Phonetic map of perceptual difficulty (combined duration and quality)

	i	ɪ	e	ɛ	æ	a	ə	o	ɔ	u	ʊ
([low]?			√	√	√	√		√	√		)
([rtr]?		√		√		√			√		√)
short	.4	.5	.3	.7	.7	.7	.7	.6	.6	.3	.6
long	-.6		-.7		-.8			1		0	

The next step in the inductive grounding procedure, following Hayes, is profuse user generation of constraints, only some of which are used in the phonology. For Palestinian, the features [HIGH], [LOW], [LAB], [RTR], [LONG], and [SHORT] arbitrarily combine to yield a large set of constraints by formal substitution of elements, as in (18). Of the full set, I assume that *feature constraints, such as *High (*[HIGH] in (18)), die at birth, since I assume no language operationalises constraints against context insensitive occurrence of the features used to compile its underlying inventory. Based on Palestinian's ban of low labial and long rtr vowels (the former crosslinguistic (Kaun 1995), the latter language-specific (Shahin 2002)), the *LowLab and *LongRtr constraint families survive no matter what and are undominated in the ranking.

(18) *[LONG] [HIGH], *[LONG], *[HIGH], *[LONG] [LOW], *[LOW],
*[LAB] [LONG], *[LAB], *[SHORT] [HIGH], *[SHORT],
*[SHORT] [LOW], *[SHORT] [LAB], *[LONG] [RTR] [HIGH],
*[RTR], *[LONG] [RTR] [LOW], etc.

This means that 11 constraints remain to be evaluated for potential use in the phonology: *HiRtr, *LowRtr, *LabRtr, *ShortRtr, *ShortHiRtr, *ShortLowRtr, ShortLabRtr, *ShortHiLabRtr, *ShortLowLabRtr, *LongShort, and *ShortLong. Their survival depends on how they fare when they are evaluated for effectiveness. How well do they ban what is difficult? Following Hayes, this is determined based on whether what they ban is more difficult than what they do not ban, according to the phonetic map of the language.

The constraint effectiveness metric in (19) is applied. In pairwise comparisons between each segment banned by the constraint with each segment it does not ban, each comparison in which the banned segment has a higher perceptual difficulty score than the unbanned segment is a correct prediction for the constraint. As explained by Hayes, a perfect constraint, one which bans only hard things, has a score of 1/1 = 1. 'Perverse' constraints, which ban only relatively easy things, have a score of 0/1 = 0. Example (20) shows the comparisons for *HiRtr. That constraint makes 13 correct predictions, 15 incorrect predictions, for an effectiveness score of 13/28 = .464.

(19) Effectiveness = Correct predictions/(Correct predictions + Errors)
(Hayes 1998)

(20) *HiRtr

	i	e	æ	a	ə	o	u
ɪ	√	√	×	×	×	×	√
ɛ	√	√	×	×	×	√	√
ɔ	√	√	×	×	×	×	√
ʊ	√	√	×	×	×	×	√

= .464 effectiveness

Constraints survive if they are more effective than their neighbours in the constraint space. Pertinent definitions, from Hayes (1998), are given in (21). (Regarding (21a), it seems to me that (the aim is that) the formal elements are those of phonology cognition and that the set of possible constraints is, then, finite.)

(21) Hayes (1998) definitions

a. *Constraint space*: the complete (infinite) set of possible constraints. It is generated by locating all legal combinations of primitive formal elements of a particular phonological theory.

b. *Neighbours in a constraint space*: two constraints are neighbours in a constraint space if the structural description of one may be obtained from that of another by a single formal substitution (switch of feature value, addition or loss of a feature or association line).

c. *Less complex*: constraint C_1 is said to be less complex than constraint C_2 iff the structural description of C_1 is properly included in the structural description of C_2.

d. *Grounded*: given a phonological constraint C and a phonetic map M, C is said to be grounded with respect to M if the phonetic effectiveness of C is greater than that of all neighbours of C of equal or less complexity.

The constraint *HiRtr, for example, has one neighbour, *LowRtr. (For privative features, as assumed here, polars like [HIGH] and [LOW] are considered formal permutations of each other.) That neighbour has an effectiveness score of .667, so *HiRtr does not survive. Surviving constraints, their effectiveness, and neighbours, are:

(22) Surviving constraints (besides *LowLab, *LongRtr)

	effectiveness	*neighbours in the constraint space*
*LowRtr	.667	*hi rtr
*LabRtr	.444	--
*ShortRtr	.566	--
*LongShort	.000	--

The constraint *LongShort (‘A segment is not durationally long if it is structurally short.’) is a relatively perverse constraint because it bans e and o (assuming a vowel is durationally long if it is near or over 100 msec, based on Stevens (1998)). That constraint does not ban several of the other short vowels, which are shorter than e and o, and so perceptually more difficult than e and o. However, having no neighbours, *LongShort survives. (The constraint *ShortLong does not survive, because it does not compute: as Palestinian input contains no short long vowels, *ShortLong bans nothing and cannot be evaluated.)

If the short low vowel is to remain structurally low, but is to change so that it is more different from long low /Æː/, e would seem to be the best candidate: by (17), e is clearly the least difficult [LOW] contender. However, ɛ is the optimal candidate, which indicates the ranking and interaction in (23).

(23)

/mÆlk/	Max-F	*Long Short	*Low Rtr	*Short Rtr	Ident-F
mɪlɪk	*!			*	**
mælɪk		*			
mɛlɪk			*	*	**
melɪk		*!			*
malɪk			*	*	*

Structurally, æ and a, being specified only for [LOW], are ruled out by an undominated constraint responsible for the /Æ/-to-something-else shift in the first place, an Anti-Faith constraint (Benua 2000; Bat-El this volume) left unformulated here. Undominated *LowLab rules out o and ɔ (which candidates are excluded from the tableau). The constraint interaction in (23) shows that it is perverse *LongShort which determines the optimal replacement vowel. The losing vowel e has less perceptual difficulty for duration than ɛ, seen from (24); e is in fact long (see Table 1). The result is phonologisation of ɛ, the winner based on its short duration, and the net effect is replacement of Æ by the contender most distinct from long /Æː/.

(24) Phonetic map of perceptual difficulty: duration

	i	ɪ	e	ɛ	æ	a	ə	o	ɔ	u	ʊ
short	.7	.8	.4	.7	.6	.7	.8	.6	.8	.5	.7
long	.1		.2		.3			.2		0	

5. Account of /O/

The new colloquial /O/ is derived from /U/. This is indicated by dialectal/idiolectal variation in pairs like lubiə~lobiə (type of small pea) and bʊrdʔæːn~bɔrdkæːn 'oranges'. Innovation of /O/ is clearly an effect of the /ɛ/-innovation in the language. Maddieson (1984) provides extensive evidence for the crosslinguistic preference for balanced vowel systems. Were /O/ not innovated on the heels of /ɛ/, the result would be a front-lopsided system, as seen in (25). (See Croft 2000 and Sihler 2000 for recent discussion of gapfilling sound changes.) Given the presence of emergent /O/, it is clear that pattern symmetry is being imposed on the vowel system, illustrating the formal symmetry required of things present in phonology cognition (Hayes 1998). This is supported by learnability considerations. In constructing their segmental inventory, given the bias toward formal symmetry, learners expect symmetry and operate with a reduced hypothesis space based on that expectation. A symmetrical system is more learnable, since reality matches expectation.

(25) */I ɛ Æ U/

Consider, alternatively, that the back short mid vowel might be a phonetic variant of /U/. While no diagnostics are apparent by which the phonological visibility of its midness can be tested, I reject this alternative based on the typological argument above. The important observation is that tokens of /U/ are migrating into the mid back space, not anywhere else. This is not entirely expected of phonetic variation. It makes sense only if the /U/ → /O/ shift is phonologically driven, with the aim of balancing the vowel system, so /O/ must be a new underlying vowel.

6. Conclusion

The aims of this paper were to show the vowel innovation currently taking place in an Arabic colloquial, and to provide a theoretical account of it. New /ɛ/ and /O/, the latter with non-rtr and rtr surface variants, have lexical status and thus cannot be dismissed as phonetic variants. New front mid /ɛ/, from /Æ/, is being innovated under pressure for greater perceptual distinction between long /Æː/ and short /Æ/. The phonologisation of /ɛ/ is accounted for as the effect of constraints induced by Palestinian speakers from their perceptual input. High ranking of a constraint against long short vowels ensures that the replacement for /Æ/ is rtr mid /ɛ/, the shortest candidate and the one most perceptually distinct from long /Æː/. New /O/, from /U/, results from imposition of pattern symmetry on an otherwise lopsided, and so less learnable, new short system.

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