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An Optimality Theoretic account for pharyngealization spread in Rural Jordanian Arabic

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Previous research has provided evidence for an asymmetrical directionality in the spread of emphasis as well as blocking effects that are process-specific in some dialects of Arabic. However, the interaction between morphology and phonology in terms of the spread of emphasis has been somewhat neglected in the literature. Instead, previous studies have claimed that [RTR] harmony spreads to the whole phonological word. Besides, the phonological repercussion of pharyngealization has not been well investigated. More importantly, the phonological learnability and awareness of pharyngealization have not been touched upon. In this study, we show – with data from Northern Rural Jordanian Arabic – that the spread of emphasis is sensitive to morphemic boundaries, and that the spread of emphasis to affixal segments poses problems for previous analyses. To this end, further treatment is proposed within a theory of constraint ranking. Adopting OT, we try to unravel what is going on in native speakers' minds pertaining to choosing the optimal candidate. This adds to the general goal of linguistics in figuring out the kind of tacit knowledge speakers have that would enable them to speak the way they do.

KEYWORDS: emphasis spread, Jordanian Arabic, Optimality Theory, phonology, morphology.

1. Introduction

Pharyngealization is a distinctive phonemic feature of Semitic languages such as Arabic and Classical Hebrew. Even though pharyngealization is preserved in most modern dialects of Arabic, it does not necessarily have the same articulatory, acoustic, and perceptual correlates in these dialects. Therefore, there has been much debate in the literature on the articulatory nature of pharyngealized sounds resulting in a multiplicity of terms standing for different configurations of the vocal tract during the production of pharyngealized sounds.

Jordanian Arabic (henceforth **JA**) consists of three major subdialects: Urban, Rural, and Bedouin. All of them are characterized by a group of pharyngealized coronal consonants. Rural Jordanian Arabic[1] (henceforth **RJA**) retains four phonemic pharyngealized consonants:

(/tˤ, sˤ, ðˤ, dˤ/); the emphatic alveolar plosive /dˤ/ is very often substituted with /ðˤ/.

Several studies have examined the acoustic and sociophonetic properties of pharyngealization in JA (e.g. Zawaydeh 1997; Abudalbuh 2010, Jongman *et al.* 2011; Jaber *et al.* 2019; Omari & Jaber 2019, 2020), which have contributed to the understanding of the articulatory and acoustic properties of this phenomenon. However, the phonological repercussion of pharyngealization has not been well investigated in this dialect. Pharyngealization is represented by the distinctive phonological feature Retracted Tongue Root (henceforth **RTR**), which is a harmonic feature that extends beyond the underlying pharyngealized segment to neighboring segments as in the following two tokens, in which the affected segments are underlined: [mat$^{\text{ˤ}}$ar] 'rain (n)' and [s$^{\text{ˤ}}$aad] 'he hunted'.

More importantly, the phonological learnability and awareness of pharyngealization have not been touched upon. This acoustic phenomenon has strong bearing on the phonological knowledge of speakers, so we adopt OT to unravel what is going on in native speakers' minds pertaining to choosing the optimal candidate. This adds to the general goal of linguistics in figuring out and unraveling the kind of tacit knowledge speakers have that would enable them to speak the way they do. Acoustic studies play a major role in laying out the facts about this phenomenon but cannot explain the learnability of these facts. Therefore, this study is complementary to the acoustic studies done on the dialect and other Arabic dialects.

The organization of this paper is as follows. Section 2 discusses the background of the study where some major phonological studies on pharyngealization are reviewed. Due to the phonological nature of the current study, acoustic and sociophonetic studies of pharyngealization will not be outlined here. In sections 3 and 4, we provide an OT analysis of pharyngealization in RJA, and the conclusions will be laid out in section 5.

2. Background

The phonological treatment of pharyngealization spread has been problematic and controversial. Wahba (1993) discussed the controversy between the proponents of the segmental approach and the proponents of the suprasegmental approach to the description of pharyngealization spread. While the proponents of the segmental approach argued for pharyngealization as an inherent feature of the consonant or the vowel, advocates of the suprasegmental approach called for the utterance as the minimum domain of pharyngealization. On the other hand, Lehn

(1963) argued that pharyngealization never occurs as a feature of only one segment but rather spreads minimally into CV syllables. Therefore, he proposed a prosodic approach to the phenomenon where he called for the syllable as the minimum scope of pharyngealization and the utterance as the maximum scope. Regardless of the debate between the proponents of the suprasegmental and the prosodic approaches, the segmental approach, which restricts the domain of pharyngealization to the pharyngealized segments themselves, underestimates the vitality of this feature.

Davis (1995) approached the issue of pharyngealization spread with data from two modern rural dialects of Palestinian Arabic (a southern dialect and a northern dialect). For the latter dialect, he relied on data from Herzallah (1990) and Younes (1993). He observed that the leftward spread of pharyngealization was unbounded in the phonological word in both dialects. He observed that pharyngealization spreads rightward also in both dialects. However, he argued that the rightward spread of pharyngealization was always blocked by intervening opaque segments. According to Davis, the high front segments /i, j, ʃ, ʤ/ block the spread in both Palestinian dialects, but the high segments /u, w/ as well as the low vowel /a/ operate only in the northern Palestinian dialect. The vowel /a/ itself undergoes pharyngealization in the northern dialect but blocks the spread of pharyngealization beyond it.

Taking a Grounded Phonology position (Archangeli & Pulleyblank 1994), Davis (1995) attributed the directional asymmetry in the pharyngealization spread in these two dialects to 'process-specific grounded path conditions' that are imposed on the rightward spread but not on the leftward spread. These conditions ban the co-occurrence of the features [RTR] and [high] as well as the co-occurrence of [RTR] and [front]. Davis (1995) claimed that Optimality Theory (henceforth **OT**; Prince & Smolensky 1993) cannot account for this asymmetry since OT treats such conditions as language-general constraints rather than process-specific conditions. He proposed that the high tongue body configuration and the front tongue body configuration are articulatory (physiologically) antagonist with [RTR], which is required for pharyngealization.[2] To this end, Davis (1995: 475) proposed the following two grounded path conditions:

(1) a. *RTR/Hi Condition*
If [RTR] then not [+high]
b. *RTR/Fr Condition*
If [RTR] then not [-back]

In response to Davis (1995), McCarthy (1997) argues that the asymmetrical directionality observed in the spread of pharyngealization in the two Palestinian dialects can be accounted for in Optimality Theory since process-specific constraints are, according to him, natural and expected outcomes of constraint ranking. In order to motivate pharyngealization spread in both directions, McCarthy (1997: 235) proposed the following alignment constraints:

(2) *Constraints on [RTR] alignment*
a. RTR-LEFT
Align ([RTR], Left, Word, Left)
"Any instance of [RTR] is aligned initially in Word."
b. RTR-RIGHT
Align ([RTR], Right, Word, Right)
"Any instance of [RTR] is aligned finally in Word."

According to McCarthy (1997), both above alignment constraints need to be ranked higher than the faithfulness constraint IDENT-ATR, which requires that every instance of [ATR] feature, the opposite feature of pharyngealization, is preserved in the output.

(3) RTR-LEFT, RTR-RIGHT > > IDENT-ATR

In order to account for the fact that rightward, but not leftward, spread of pharyngealization in the southern Palestinian Arabic is blocked by segments that carry the features [high] and [front], McCarthy (1997) proposed one more markedness constraint that prohibits [RTR] segments from being high and front as in the following:

(4) RTR/HI&FR
*[high, front, RTR]

By ranking the new constraint in (4) below RTR-LEFT (2a) and above RTR-RIGHT (2b), the latter being responsible for the rightward spread of pharyngealization, McCarthy's (1997) analysis ensures that rightward, but not leftward, spread of pharyngealization is blocked by intervening high and front segments in the southern dialect of Palestinian Arabic. According to McCarthy (1997), the following constraint ranking accounts for the patterns observed for both the leftward and rightward spread of pharyngealization in the southern Palestinian Arabic:

(5) RTR-LEFT > > RTR/HI & FR > > RTR-RIGHT > > IDENT-ATR

Although the leftward spread of pharyngealization in the northern Palestinian Arabic fits the analysis in (5), the rightward spread required

further manipulation. The rightward spread in the northern Palestinian Arabic is blocked by high (not necessarily front) segments. Moreover, [RTR] harmony does not spread further than /a/ in this dialect. To this end, McCarthy (1997) proposed the following constraints:

(6) RTR/HI
*[high, RTR]
(7) RTR-TO-*a*
(Align [RTR], Right, *a*, Right)
(8) RTR/LOWER-VT
If [RTR], then lower vocal tract.

The constraint in (7) requires that the right edge of [RTR] span be the low vowel /a/. This constraint is responsible for the local [RTR] harmony, to use Davis (1995) and McCarthy's (1997) term, where [RTR] spreads to /a/ in the absence of intervening high segments. The constraint in (8) requires that the segment targeted by the spreading of [RTR] has a specification for a lower vocal tract node. According to McCarthy (1994, 1997) and Davis (1995), the segments with a lower vocal tract node in Palestinian Arabic are the low vowel /a/ and the gutturals. Thus, the constraint in (8) accounts for the long-distance [RTR] harmony where [RTR] spreads from pharyngealized /a/ to other low segments. The final ranking for the northern Palestinian Arabic is one in which RTR-LEFT is undominated, RTR/HI outranks RTR-TO-*a* to prevent rightward spread of pharyngealization into /a/ in the presence of an intervening high segment. RTR-TO-*a* outranks RTR/LOWER-VT in order to allow for local [RTR] spread into /a/ across consonants that do not carry Lower VT node. Also, this order prohibits long-distance rightward [RTR] spread from pharyngealized /a/ into contiguous segments that carry Lower VT node when the right edge of these segments is not the low vowel. RTR/LOWER-VT outranks RTR-RIGHT to account for cases where [RTR] does not spread rightward further than pharyngealized /a/ into a sequence of segments that are not gutturals. However, this last ranking ignores the possibility of rightward [RTR] spread into an adjacent non-opaque consonant (e.g. [ga**s**$^{\text{ʕ}}$diir] 'foil'). This possibility was not considered by Davis (1995). Anyway, only rightward [RTR] spread is sensitive to the new constraints as the constraint responsible for the leftward [RTR] spread is ranked too high to be affected by these constraints.

(9) IDENT RTR, RTR-LEFT > > RTR/HI > > RTR-TO-*a* > > RTR/LOWER-VT > > RTR-RIGHT > > IDENT-ATR

After this review of the major phonological attempts to account for the spread and directionality of pharyngealization in some Arabic dialects, we now turn to present an Optimality Theoretic account of this phenomenon in RJA, one of the under-investigated dialects in this regard. In the next two sections, we will show that RJA exhibits patterns that cannot be explained by the existing accounts. We will also highlight a gap in the previously proposed accounts in terms of the role of morphology (the interaction between morphology and phonology) in the spread of pharyngealization.

3. The spread of pharyngealization in Rural Jordanian Arabic

The initial list of data was prepared and compiled by the authors, who are all native speakers of the target dialect (i.e. Rural Jordanian Arabic). The authors' intuition about the pharyngealization patterns was checked (hence confirmed or disconfirmed) with the help of five other consultants who were as well native speakers of the same dialect. With this regard, the methodology was for the authors to trigger the utterance of the target words by the consultants by asking them as many questions as possible. The goal was to make sure that each consultant produces as many natural instances of the target word as possible. Any item that was not confirmed by at least 4 consultants was excluded.

In this section, we present sets of data that display patterns of pharyngealization spread within "basic stems" (Watson 2002) in RJA.[3] Watson (2002) defines a basic stem as "the bare word prior to the affixation of any suffixes or prefixes, but after any stem-internal changes" (p. 130). In other words, one can assume that basic stems often have root segments at both edges. The underlying pharyngealized consonants targeted in this study are /tˤ, sˤ, ðˤ/. These will be examined at the leftmost, middle, and rightmost of the word in order to evaluate both leftward and rightward spread of pharyngealization. Following Herzallah (1990) and Davis (1995), and contrary to Younes (1993) and Zawaydeh (1997), we will consider non-low vowels immediately following an underlying pharyngealized consonant as phonologically nonpharyngealized on perceptual grounds (see Zaba 2007). On the other hand, we follow the consensus that low vowels are pharyngealized following an underlying pharyngealized consonant (e.g. Jongman *et al.* 2011; Omari & Jaber 2019).

Upon the examination of our first four sets of RJA data[4] (10-13), we argue that RJA patterns more similar to Davis's (1995) northern Palestinian Arabic in terms of the spread of pharyngealization. We first

show that the leftward spread of pharyngealization is unbounded in RJA even by high and/or front segments, a pattern that was true for both of the Palestinian dialects in Davis (1995). As the data in (10) show, neither the intervening high and/or front segments /i, j, ʃ, ʤ, w, u/ nor the intervening low vowel /a/ block the leftward spread of pharyngealization. Instances of rightward spread of pharyngealization in (10), where applicable, are not indicated for the sake of clarity.[5]

(10)	sat^{ʕ}ir	'a line'	mat^{ʕ}ar	'rain (n)'
	sarat^{ʕ}aan	'cancer'	baat^{ʕ}il	'void'
	bað^{ʕ}aajiʕ	'goods'	baað^{ʕ}	'laid eggs'
	mað^{ʕ}ii	'past'	ʃaat^{ʕ}ir	'smart'
	ras^{ʕ}iif	'pavement'	ras^{ʕ}iid	'credit (n)'
	sat^{ʕ}uur	'butcher's knife'	wasat^{ʕ}	'middle'
	siraat^{ʕ}	'path'	basiit^{ʕ}	'simple'
	xajjaat^{ʕ}	'tailor'	balluut^{ʕ}	'oak'
	sult^{ʕ}aan	'sultan'	maʤluut^{ʕ}	'heart attacked'
	ʕarmuut^{ʕ}	'type of fish'	maʃʃat^{ʕ}	'he combed'
	xaʃt^{ʕ}	'a scratch'	naʃaat^{ʕ}	'energy'

On the other hand, the data in (11) show that pharyngealization may spread in a rightward fashion to the other consonants and vowels in the word. However, the harmonic spread of [RTR] is blocked by the intervening high segments /i, j, ʃ, u, w/. This pattern is the same pattern attested for the northern Palestinian dialect, where the high feature sufficed for blocking the rightward spread of pharyngealization. The leftward spread of pharyngealization in (11) is not indicated for clarity purposes.

(11)	tas^{ʕ}diig	'authenticating'	gas^{ʕ}diir	'foil'
	gas^{ʕ}iid	'poetry'	ras^{ʕ}iid	'account balance'
	ħas^{ʕ}iid	'harvesting'	s^{ʕ}iit	'fame'
	s^{ʕ}idig	'honesty'	manat^{ʕ}iid	'balloons'
	s^{ʕ}jaam	'fasting'	at^{ʕ}jaab	'kind (pl.)'
	mas^{ʕ}jaf	'summer resort'	ð^{ʕ}jaafa	'hosting'
	ʕat^{ʕ}ʃaan	'thirsty'	lat^{ʕ}ʃaat	'good deals'
	mas^{ʕ}duum	'shocked'	s^{ʕ}unduug	'box'
	s^{ʕ}udfa	'coincidence'	s^{ʕ}udaaʕ	'headache'
	mat^{ʕ}ruud	'dismissed'	ð^{ʕ}rus	'teeth'
	mags^{ʕ}uud	'intended (adj)'	t^{ʕ}waal	'tall (pl.)'
	s^{ʕ}waat	'voices'	ð^{ʕ}waw	'lights'

Moreover, RJA data reveal another phonological similarity with northern Palestinian Arabic. As presented in (12) below, the rightward spread of pharyngealization is blocked by the low vowel /a/ from proceeding to the remaining segments on the right side of the word. The low vowel /a/ itself is affected by [RTR] and is realized as the allophone

[a] rather than [æ]. The leftward spread of pharyngealization in (12) is not indicated for the sake of clarity.[6]

(12)	sˤad	'he pushed back'	sˤaad	'he hunted'
	rtˤaal	'pounds'	masˤdar	'source'
	misˤbaaħ	'lamp'	misˤdaar	'name of a place'
	tˤams	'eliminating'	tˤags	'weather'
	tˤard	'firing'	tˤawuus	'peacock'
	saratˤaan	'cancer'	ɣatˤtˤaas	'diver'
	mintˤaad	'balloon'	ðˤaal	'astray'
	ħasˤaad	'harvest'	sˤajda	'name of city'
	sˤajjaad	'hunter'	batˤtˤaal	'unemployed'
	matˤar	'rain'	amtˤaar	'rains (pl.)'
	masˤʕad	'elevator'	matˤʕam	'restaurant'

However, RJA exhibits an important difference with northern Palestinian Arabic; rightward spread of pharyngealization may extend even further than pharyngealized /a/ into a sequence of segments that end with another /a/. The condition that these segments hold lower vocal tract node is not necessary in RJA as the following examples show:

(13)	sˤanaadil	'sandals'	tˤanaaʤir	'cooking pots'
	sˤanaabiir	'taps'	sˤanaadiig	'boxes'
	tˤalaasim	'ambiguous things'	sˤalaaba	'toughness'
	tˤalaag	'divorce'	sˤalaa	'prayer'
	sˤalaaħ	'rightness, proper name'	tˤammaaʕ	'greedy'
	tˤabbaal	'drum player'	ðˤaraajib	'taxes (pl.)'
	tˤaħaalib	'mosses'	sˤaddaam	'car bumper'

Having said that about the phonological similarity between RJA and northern Palestinian Arabic in Davis (1995), we will now attempt to account for the [RTR] harmony patterns in RJA using McCarthy's (1997) schema in (9), which he proposed for the northern Palestinian Arabic. However, since the constraint RTR/LOWER-VT is not crucial in RJA (as shown in 13), it will be lowly ranked in the hierarchy, producing the following scheme:

(14) IDENT RTR, RTR-LEFT > > RTR/HI > > RTR-TO-*a* > > RTR-RIGHT > > RTR/LOWER-VT > > IDENT-ATR

The full hierarchy for RJA is applied to selected examples in Tableaux 1 through 6. And Tableau 4 shows that the schema in (14) correctly predicts the optimal candidate. The candidate [siraatˤ] wins as it does not incur any violations of the top-ranked constraints, including the one that requires unbounded leftward spread of [RTR]. Any candidate that does not involve [RTR] spread to ALL segments to the

left of the underlying [RTR] segment will lose to the optimal candidate, which does not incur any violations of this type as the following analysis shows:

Tableau 1.
/siraat$^{\varsigma}$/ → siraat$^{\varsigma}$ (see (12))

/siraat$^{\varsigma}$/	IDENT-RTR	RTR-LEFT	RTR-HI	RTR-TO-*A*	RTR-RIGHT	RTR/ LOWER-VT	IDENT-ATR
a. ☞siraat$^{\varsigma}$			*	*		****	****
b. siraat$^{\varsigma}$		*!***		*		*	
c. siraat$^{\varsigma}$		*!	*	*		***	***
d. siraat	*!						

Tableau 2 illustrates how the schema in (14) accounts for the blocking of the rightward spread of pharyngealization into high segments in RJA. Although the candidates [gas$^{\varsigma}$iid] and [gas$^{\varsigma}$iid] tie with the candidate [gas$^{\varsigma}$iid] on the two top-ranked constraints, the latter wins as it does not incur any violations of the constraint RTR-HI, which bans the spread of pharyngealization into high segments such as /i/. The candidate [gas$^{\varsigma}$iid] was not considered as it violates the undominated NO-GAP principle, which prohibits feature harmony from skipping intervening segments. Therefore, candidates of this type will not be considered in the analyses.

Tableau 2.
/gas$^{\varsigma}$iid/ → gas$^{\varsigma}$iid (see 13)

/gas$^{\varsigma}$iid/	IDENT-RTR	RTR-LEFT	RTR-HI	RTR-TO-*A*	RTR-RIGHT	RTR/ LOWER-VT	IDENT-ATR
a. ☞gas$^{\varsigma}$iid				*	**	**	**
b. gas$^{\varsigma}$iid			*!	*	*	***	***
c. gas$^{\varsigma}$iid			*!	*		****	****
d. gas$^{\varsigma}$iid		*!*		*	**	*	
e. gasiid	*!						

The original schema (9) which McCarthy (1997) proposed for northern Palestinian Arabic fails to account for the local rightward [RTR] harmony to an adjacent non-opaque consonant. This harmonic spread should be possible in both northern Palestinian Arabic and RJA given the absence of an intervening high segment or an intervening /a/.

This possibility was ignored in Davis (1995), thus, it was not accounted for in McCarthy (1997). For example, our analysis should allow local rightward harmony into /d/ in [gas$^{\varsigma}$diir]. However, with RTR/LOWER-VT being ranked higher than RTR-RIGHT, [RTR] harmony is banned from proceeding into a non-low segment such as /d/. Therefore, the ranking in (9) fails to favor [gas$^{\varsigma}$diir] over [gas$^{\varsigma}$diir] as Tableau 3 shows.

Tableau 3.
/gas$^{\varsigma}$diir/ → *gas$^{\varsigma}$diir (see 13)

/gas$^{\varsigma}$diir/	IDENT-RTR	RTR-LEFT	RTR-HI	RTR-TO-*A*	RTR/ LOWER-VT	RTR-RIGHT	IDENT-ATR
a. ☹gas$^{\varsigma}$diir				*	***!	**	***
b. ☞gas$^{\varsigma}$diir				*	**	***	**
c. gas$^{\varsigma}$diir			*!	*	*****		*****
d. gas$^{\varsigma}$diir		*!*		*	**	**	*
e. gasdiir	*!						

However, the schema in (14), which this study proposes for RJA, allows for local rightward [RTR] spread into an adjacent non-opaque consonant. Therefore, it successfully predicts the right output of /gas$^{\varsigma}$diir/ in Tableau 4. The candidate [gas$^{\varsigma}$diir], which wins in Tableau 3, ties with the desirable output [gas$^{\varsigma}$diir] on the top-ranked constraints in Tableau 4. However, [gas$^{\varsigma}$diir] loses to the optimal candidate [gas$^{\varsigma}$diir] because of more critical violations of RTR-RIGHT.

Tableau 4.
/gas$^{\varsigma}$diir/ → gas$^{\varsigma}$diir (see 13)

/gas$^{\varsigma}$diir/	IDENT-RTR	RTR-LEFT	RTR-HI	RTR-TO-*A*	RTR-RIGHT	RTR/ LOWER-VT	IDENT-ATR
a. ☞gas$^{\varsigma}$diir				*	**	***	***
b. gas$^{\varsigma}$diir				*	***!	**	**
c. gas$^{\varsigma}$diir			*!	*		*****	*****
d. gas$^{\varsigma}$diir		*!*		*	**	**	*
e. gasdiir	*!						

Tableau 5 considers another case of local harmony, in which [RTR] spreads rightward to /a/ but no further as in [mint$^{\varsigma}$aad]. The candidate [mint$^{\varsigma}$aad] wins as it does not incur violations of the critical constraint RTR-TO-*a*, a constraint that requires that the right edge of [RTR] span

is the low vowel /a/. Any other candidate that does not involve [RTR] spread to the vowel /a/ (e.g. [mint^{ʕ}aad]) or involves [RTR] spread beyond /a/ (e.g. [mint^{ʕ}aad]) fails on RTR-TO-*a* although they tie with the optimal candidate [mint^{ʕ}aad] on the top three constraints.

Tableau 5.
/mint^{ʕ}aad/ → mint^{ʕ}aad (see 13)

/mint^{ʕ}aad/	IDENT-RTR	RTR-LEFT	RTR-HI	RTR-TO-*A*	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞mint^{ʕ}aad			*		*	****	****
b. mint^{ʕ}aad			*	*!	**	****	***
c. mint^{ʕ}aad			*	*!		*****	*****
d. mint^{ʕ}aad		*!	*		*	***	***
e. mint^{ʕ}aad		*!**		*		**	**
f. mintaad	*!						

As shown in (13), [RTR] harmony proceeds from the first pharyngealized low vowel into the low vowel of the following syllable across non-opaque segments. Tableau 6 considers the form [ð^{ʕ}abaab], where [RTR] rightward harmony spreads ultimately into the vowel /a/ in the following syllable. The analysis shows that the constraint RTR-RIGHT is crucial here; [ð^{ʕ}abaab] wins over its rival candidate [ð^{ʕ}abaab] because the latter incurs more crucial violations of RTR-RIGHT. This output cannot be attained following McCarthy's (1997) scheme in (9).

Tableau 6.
/ð^{ʕ}abaab/ → ð^{ʕ}abaab (see 13)

/ð^{ʕ}abaab/	IDENT-RTR	RTR-LEFT	RTR-HI	RTR-TO-*A*	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞ð^{ʕ}abaab					*	**	***
b. ð^{ʕ}abaab					**!*	*	*

4. Affixal spread of pharyngealization in RJA

Unlike Lahrouchi & Ridouane (2016) and Jaber *et al.* (2019) which established morpheme boundaries opaque to pharyngealization spread, previous phonological treatments of the spread of pharyngealization proposed by Davis (1995), McCarthy (1997), Watson (1999), and Al

Khatib (2008) have neglected the role of morphology in the spread of pharyngealization. In all of these accounts, reference was made to the phonological word as the domain/span of [RTR] harmony. Although Davis (1995) reported that pharyngealization may fail to spread (leftward) to inflectional prefixes, he only provided two examples of these instances and did not provide any account for this 'optional blocking'. In her acoustic study of Ammani JA, Zawaydeh (1997) found that [RTR] did spread obligatory into the suffixes, including the verbal feminine singular suffix *-at* and the second-person masculine singular suffix *-ak*. She observed that [RTR] spreads obligatory into the plural suffix *-aat* if the stem ends with a pharyngealized consonant but optionally if the pharyngealized consonant is farther away from the end of the stem. However, Zawaydeh (1997) did not provide any phonological account for her acoustic findings with this regard.

Lahrouchi & Ridouane (2016) provide an account for the morphosyntactic derivation of plural nouns in Moroccan Arabic. They argue that the derivation of the broken (i.e. irregular) plural applies lower in the structure within the domain of the nP projection, where the root merges with **n** that is endowed with a plural feature (+pl). In the case of sound (i.e. regular) plurals, however, the head n is not endowed with a (+pl). The feature resides higher in the structure at the NumP projection, so the root raises to join Num. Interestingly, Lahrouchi and Ridouane find that pharyngealization spread is sensitive to the domain of plural derivations. In particular, they show that pharyngealization spread to the regular plural suffix *-at* in Moroccan is weaker than the spread found in broken plurals since sound plural is derived outside the nP phrasal domain. This analysis implies that the domain of emphasis spread in this dialect of Arabic could be morphosyntactic.

Given that the domain of emphasis spread may vary from one dialect to another (e.g. Davis 1995), a recent analysis of Jordanian Arabic shows that the domain of emphasis spread is morphophonological (Jaber *et al.* 2019). We posit the same domain for emphasis spread in RJA (see tableau (10) and the discussion there)).

Kenstowicz & Louriz (2009) present an OT analysis pertaining the adaptation of French and Spanish loanwords into Moroccan Arabic. The paper examines the vowel correspondences in loanwords, arguing that redundant vocalic features trigger the insertion of pharyngealization on the adjacent consonant. In French, mid and back low vowels are regularly adapted into Moroccan Arabic by adding pharyngealization on the neighboring consonant; whereas front vowels resist this correspondence. For example, French *moquette* [mɔkɛt] 'carpet' surfaces as [MokeT], instead of /MukiT/ with the underlying high vowel phonemes

entertained in the vowel inventory in Moroccan Arabic. The insertion of pharyngealization on the neighboring consonant creates a suitable phonological environment that would allow the change of the underlying high vowels phonemes /i/ and /u/ into allophones approximate to the French mid vowels. Kenstowicz and Louriz concluded "that auditory similarity and salience are critical alternative dimensions of faithfulness that may override correspondences based on phonologically contrastive features" (p. 2). In other words, the adaptation strategy of French mid and back low vowels into Moroccan Arabic is guided by the enhancing relations between the lexically distinctive feature of pharyngealization and the salient, redundant vocalic features of vowels.

The interaction between phonology and morphology is very important. For example, Watson (2002) explains that the anticipatory assimilation of /l/ to a contiguous coronal obstruent in Arabic (stands true for RJA also) takes place only where /l/ belongs to the definite article prefix *il-*. However, assimilation does not take place when a root-initial /l/ immediately precedes an affixal coronal obstruent. See the following two examples in (15):

(15)	a.	/il-tiin/	→	[it-tiin]	'figs'
	b.	/iltimaas/	→	[iltimaas]	'petition'

In this section, we will examine the spread of pharyngealization into the affixal segments in RJA. The following discussion is based on a survey of the affixes in Jordanian Arabic as well as a review of the work of McCarthy (1990) and Watson (2002) on the morphology of Arabic. Arabic has a root-and-pattern morphology. Watson (2002) draws a difference between level-one morphology and level-two morphology. According to Watson (2002), level-one morphemes are those discontinuous morphemes (i.e. infixes) that are affixed to a stem or word. On the other hand, level-two morphemes are the continuous morphemes (i.e. prefixes and suffixes) which are affixed in a linear order to the outcome of level-one morphology. Watson's (2002) distinction between level-one and level-two morphemes can be motivated in terms of the syntactic positioning of these morphemes (see Lahrouchi & Ridouane 2016) and in terms of their phonological patterning in the context of harmonic [RTR] spread as we will see below.

Level-one morphemes in RJA do not exhibit different [RTR] harmony patterns from those observed in (10-13). An example of level-one morphology is the formation of broken plurals in RJA. The broken plural in RJA is formed by mapping the root consonants in the singular form onto one of several templates such as aCCaaC (16a-d), CaCaaCiC (17e),

aCCuC (18f), CuCuuC (19g-h), or CuC:aaC (20i). The data in (23) show that level-one morphemes behave just like the root segments in terms of [RTR] harmony. Pharyngealization spreads into the segments of level-one morphemes if they occur to the left of the underlying [RTR] consonant (such as in 16a-e). Similar to the pattern of a root low back vowel, the vowel /a/ of a level-one morpheme does not allow rightward [RTR] harmony to proceed further than it (such as in 16c-d). Moreover, high segments of level-one morphemes block the rightward [RTR] harmony (such as in 16f-i).

(16)	a.	**tˤ**abʔ	'nature'	→	atˤbaaʔ	'natures'
	b.	maraðˤ	'a disease'	→	amraaðˤ	'diseases'
	c.	**tˤ**ifl	'a child'	→	atˤfaal	'children'
	d.	**sˤ**inf	'type'	→	asˤnaaf	'types'
	e.	mintˤaga	'area'	→	manaatˤig	'areas'
	f.	satˤir	'a line'	→	astˤur	'lines'
	g.	**tˤ**aqs	'weather'	→	**tˤ**uquus	'rituals'
	h.	**ðˤ**irs	'a tooth'	→	**ðˤ**uruus	'teeth'
	i.	**tˤ**aalib	'a student'	→	**tˤ**ullaab	'students'

Level-two morphemes in Arabic fall into one of two types: nominal morphemes and verbal morphemes. The basic nominal level-two suffixes and prefixes in northern RJA are presented in Table 1 (adapted from Watson 2002: 187) in terms of the order by which they attach to the stem.[7]

ORDER	MORPHEME	
1	Nominalizer prefixes	*it-, ma-*
1	Comparative adjective prefix	*a-*
1	Adverbial prefix	*(i)b-*
2	Definite article prefix	*il-*
1	Adjectival suffixes	*-ii, -aan*
2	Feminine singular suffix	*-a*
2	Masculine plural suffix	*-iin*
2	Feminine plural suffix	*-aat*
3	Dual suffix	*-en*
4	Possessive pronoun suffixes	*-ii, -ak, -ik, -kum, -kin, u, -ha, -hum, -hin*

Table 1. Nominal level-two morphemes in RJA.

Verbal level-two morphemes are the subject agreement affixes, object suffixes, future and habitual prefixes, and the negators. These morphemes can be organized in terms of the order by which they attach to the stem in RJA. For more details about level-two morphemes, see Watson (2002).

We start by examining the long-distance spread of [RTR] harmony to the segments of the suffix. Generally speaking, the long-distance spread of pharyngealization to the segments of the suffix (at the rightmost edge of the phonological word) is not likely to take place because of opaque segments in the stem as the following examples show:

(17)	a.	sˤiit-ak	'your fame'	b.	sˤalj-aat	'bursts'
	c.	sˤaaʤ-ak	'your baking plate'	d.	matˤaʤʤ-aat	'weak'
	e.	latˤʃ-aat	'good deals'	f.	batˤʃ-ak	'your force'
	g.	ʕatˤw-aat	'reconcilements'	h.	ħasˤw-aat	'stones'
	i.	xutˤw-aat	'steps'	j.	ʕuðˤw-aat	'members'

Moreover, local [RTR] harmony to suffix segments is blocked when the suffix starts with an opaque (high) segment as the following examples show:

(18)	a. ragasˤ-it	'I/you danced'	b. samatˤ-uu-na	'they hit us'
	c. salatˤ-iin-ak	'your rulers'	d. xajjaatˤ-iin-ha	'her tailors'

In sum, the spread of [RTR] harmony to suffix segments is often blocked by either opaque segments in the stem (for long-distance harmony) or by opaque segments in the suffix itself (for local harmony). When there are no stem or suffix opaque segments intervening between the underlying pharyngealized consonant and suffix segments, [RTR] harmony may spread rightward. The data in (19) show that [RTR] harmony spreads locally into the suffix *-a*.

(19)	a.	ħatˤ	'he put (past)'	ħatˤtˤ-a	'a head cover for men'
	b.	batˤ	'ducks'	batˤtˤ-a	'a female duck'
	c.	gasˤ	'he cut (past)'	gasˤsˤ-a	'a haircut'
	d.	garsˤ	'biting'	garsˤ-a	'a bite'
	e.	wartˤ	(a non-word)	wartˤ-a	'a dilemma'

The observation in (19) is further confirmed by the data in (20), where [RTR] harmony spreads locally into the vowel /aa/ at the beginning of the suffix *-aat*. However, [RTR] does not spread beyond /aa/ into /t/, a segment of the same suffix, hence confirming the observation in (12).

(20)	a.	baasˤ-aat	'buses'	b.	rabtˤ-aat	'ties'
	c.	bastˤ-aat	'open markets'	d.	raðˤðˤ-aat	'bruises'

Furthermore, the data in (21) show that [RTR] harmony spreads from the underlying pharyngealized consonant to the nonadjacent low vowel in the suffix across no intervening opaque segments. Notice that in all of these cases the right edge of stem [RTR] span is not /a/.

(21)	a.	lat^{ʕ}ʕ-aat	'burns'	b.	lat^{ʕ}m-aat	'hits'
	c.	xus^{ʕ}l-aat	'hair strands'	d.	ʕat^{ʕ}s-aat	'sneezes'
	e.	ʕas^{ʕ}b-aat	'head bands'	f.	rat^{ʕ}b-aat	'wet'
	g.	ʕað^{ʕ}m-aat	'bones'	h.	bas^{ʕ}m-aat	'fingerprints'

Contrary to the data in (19-21), the data in (22) show that [RTR] harmony does not proceed into the vowel /a/ in the suffix *-aat* when the right edge of the stem [RTR] span is already the low vowel even though no opaque segments intervenes between the underlying pharyngealized consonant and the second low vowel.

(22)	a.	t^{ʕ}aʕ-aat	'submissions'	b.	t^{ʕ}abl-aat	'drums'
	c.	s^{ʕ}aʕ-aat	'units of measurement'	d.	t^{ʕ}alg-aat	'bullets'
	e.	t^{ʕ}ag-aat	'openings, energies'	f.	mað^{ʕ}all-aat	'umbrellas'
	g.	t^{ʕ}alab-aat	'demands (n)'	h.	t^{ʕ}aab-aat	'balls'

Recall that in (13) [RTR] harmony spread from the first pharyngealized /a/ into the following /a/ across non-opaque segments within the stem. It seems that this long-distance [RTR] harmony does not take place when the second low vowel is part of the suffix even when there are no intervening opaque segments. Therefore, this blocking effect suggests that long-distance [RTR] harmony does not cross a morphemic boundary when the right edge of the stem [RTR] span is already the vowel /a/.

Another piece of evidence that [RTR] harmony spread is sensitive to morphemic boundaries comes from the data in (23), where local [RTR] harmony fails to spread into the first suffix *-t*. (Stems ending with an alveolar pharyngealized stop /t^{ʕ}/ were excluded from the data here in order to avoid geminate consonants).[8]

(23)	a.	garas^{ʕ}-t-ak	'I bit you (m)'
	b.	raggas^{ʕ}-t-ak	'I made you (m) dance'
	c.	rabas^{ʕ}-t-ha	'I leveled it/her'
	d.	marrað^{ʕ}-t-ak	'I nursed you (m), I made you sick'

The blocking effect in (23) was not predicted given the patterns observed earlier for [RTR] harmony spread in RJA. Clearly, this blocking pattern contradicts two observations about RJA. First, [RTR] harmony does not spread rightward from the underlying pharyngealized consonant to the adjacent /t/ of the first suffix (e.g. *[garas^{ʕ}-t-ak]). Second, contrary to the observation in (19-21), [RTR] harmony does not spread rightward

into the low vowel /a/ of the second suffix (e.g. *[garas^{ʕ}-t-ak]) even though the right edge of the stem [RTR] span is not /a/, suggesting that [RTR] harmony may not spread across two morpheme boundaries.

Overall, the data in (19-23) show that [RTR] harmony does not spread into the segments of the first suffix except into /a/ (in the absence of opaque segments) only when the right edge of stem [RTR] span is not already /a/. Even when [RTR] spreads into a suffix-initial /a/, it neither spreads to the other segments of the same suffix nor the segments of the second suffix. In no circumstance does [RTR] harmony spread across two morphemic boundaries to /a/ even when the right edge of the stem [RTR] span is not /a/. This was true for both nominal and verbal suffixes.

We will now evaluate the spread of [RTR] harmony into the segments of the prefixes. The following morphemes were identified as the target prefixes of the current study: the nominalizer *ta-*, the present tense second-person masculine *tu-* (both with order-one prefixes), the definite article prefix *il-*, the future prefix *ta-*, and the instrumental *is-* (both are order-two prefixes). These prefixes were selected since they involve consonants that are good candidates for pharyngealization. The data in Table 2 show that pharyngealization does spread (leftward) locally to the segments of the first prefix. However, when a second prefix is attached to the leftmost edge of the phonological word, pharyngealization fails to spread to the segments of that second prefix as the following examples show:

VERB	DEFINITE NOUN	NOUN	DEFINITE NOUN	GLOSS
s^{ʕ}ana^{ʕ}	is-**s^{ʕ}**un^{ʕ}	ta-**s^{ʕ}**nii^{ʕ}	it-ta-**s^{ʕ}**nii^{ʕ}	manufacturing
s^{ʕ}addar	(a non-word)	ta-**s^{ʕ}**diir	it-ti-**s^{ʕ}**diir	importing
t^{ʕ}abbal	it-**t^{ʕ}**abbal	ta-**t^{ʕ}**biil	it-ta-**t^{ʕ}**biil	playing drums
t^{ʕ}amman	it-**t^{ʕ}**uma^{ʔ}niina	ta-**t^{ʕ}**miin	it-ta-**t^{ʕ}**miin	asking for assuring
ð^{ʕ}arab	ið-**ð^{ʕ}**arb	ta-**ð^{ʕ}**riib	it-ta-**ð^{ʕ}**riib	kicking, hitting
ð^{ʕ}aman	ið-**ð^{ʕ}**aman	ta-**ð^{ʕ}**miin	it-ta-**ð^{ʕ}**miin	guaranteeing

Table 2. Nominal order (two prefixes).

As the data in Table 2 show, the nominalizer prefix *ta-* is attached first to the stem, which has an initial underlying pharyngealized consonant. Pharyngealization spreads from the initial consonant in the stem to the affixal segments, the consonant /t/ and the vowel /a/. However, when the definite article prefix *il-* is attached to the already affixed form, pharyngealization does not spread to the new segments, those of

the definite prefix. While the leftmost prefix, the definite article prefix, assimilates to the place of articulation of the consonant in the nominalizer prefix, hence *it-*, it does not copy the [RTR] feature.

The data in Tables 3 and 4 confirm the pattern in Table 2. Table 3 shows that [RTR] harmony spreads from the underlying [RTR] consonant to the segments of the first adjacent prefix *tu-* but does not spread further leftward to the segments of the second prefix *ta-*. Similarly, Table 4 shows that while [RTR] harmony spreads to the first prefix *ta-*, it does not spread as much leftward as the second prefix *is-*. The data in Table 3 reveals an interesting observation; [RTR] harmony spreads to the first prefix in cases such as [ta-tu-nt^{ʕ}ur] ('until you wait') and [ta-tu-ns^{ʕ}ur] ('until you support') even though the underlying pharyngealized consonant is not root-initial in which case the pharyngealized first prefix does not belong to the same syllable as that of the underlying pharyngealized consonant ([ta-.tu-n.t^{ʕ}ur] and [ta-tu-n.s^{ʕ}ur]), thus ruling out the potential effect of same syllable affiliation in the observed [RTR] harmony.

Root	Pres. 2nd person masc.	Future aspect 2nd person masc.	Gloss
t^{ʕ}-l-b	tu-t^{ʕ}lub	ta-tu-t^{ʕ}lub	until you request
n-t^{ʕ}-r	tu-nt^{ʕ}ur	ta-tu-nt^{ʕ}ur	until you wait
s^{ʕ}-r-f	tu-s^{ʕ}ruf	ta-tu-s^{ʕ}ruf	until you spend
n-s^{ʕ}-r	tu-ns^{ʕ}ur	ta-tu-ns^{ʕ}ur	until you support
d^{ʕ}-r-b	tu-ð^{ʕ}rub	ta-tu-ð^{ʕ}rub	until you hit
m-r-ð^{ʕ}	ti-mrað^{ʕ}	ta-ti-mrað^{ʕ}	until you get sick

Table 3. Imperfect verbal prefixes.

Root	Pres. 2nd person masc.	Past 3rd person masc.	Gloss
t^{ʕ}-ʕ-m	ti-t^{ʕ}ʕam	is-ta-t^{ʕ}ʕam	He tasted.
t^{ʕ}-r-d	tu-t^{ʕ}rud	is-ta-t^{ʕ}rad	He continued.
s^{ʕ}-l-ħ	ti-s^{ʕ}laħ	is-ta-s^{ʕ}laħ	He fixed.
s^{ʕ}-d-r	ti-s^{ʕ}dir	is-ta-s^{ʕ}dar	He issued.
z-b-t^{ʕ}	tu-zbut^{ʕ}	is-ta-zbat^{ʕ}	He felt something or somebody is OK.

Table 4. Perfect verbal prefixes.

Overall, the data in this section show that affixal segments behave differently from the stem segments in terms of the spread of pharyngealization. First, [RTR] harmony does not spread to the segments of the suffix except locally to an adjacent suffix-initial /a/. Second, [RTR] harmony does not spread further than the first prefix; it never spreads to the second prefix. These observations suggest that [RTR] rightward harmony fails to cross a morpheme boundary to the first suffix unless the stem ends with an underlying [RTR] consonant and the suffix starts with /a/. On the contrary, [RTR] harmony crosses a morpheme boundary to the first prefix (even if it belongs to a different syllable as we saw in Table 3 above) but fails to spread across another morpheme boundary to the second prefix. This claim would be better attested if there was a prefix with an underlying [RTR] specification that spreads leftward to another prefix because in that case, we would be able to rule out an account where [RTR] does not spread from an affix even if it carries primary pharyngealization.

The phonological patterns observed in Tables 2-4 above are phonetically, acoustically, and phonologically motivated. The farther a segment is from the segment with the underlying specification for a feature, [RTR] here, the weaker the spread of that feature, if any, to that segment. Acoustically, the previous studies have attested that pharyngealization spread is gradient whether within the same syllable or to the adjacent syllables (e.g. Zawaydeh 1997; Al-Masri & Jongman 2004; Jongman *et al*. 2011). However, the lack of [RTR] spread to the segments of the second prefix cannot be attributed to process-specific conditions on grounded phonology, such as those proposed by Davis (1995), nor can they be explained in terms of our proposed analysis in (14) because, as we have shown, leftward spread of [RTR] is unimpeded and is unblocked by any opaque segments.

Likewise, we cannot replicate Lahrouchi & Ridouane's (2016) account for [RTR] spread across morphemic boundaries, and we do not believe that the maximal harmonic domain of [RTR] spread in RJA is morpho-syntactically determined. Rather, we posit that the domain of [RTR] spread is morpho-phonological. The maximal [RTR] harmonic domain consists of the stem (which may include internal/level-one morphemes), the leftmost (inner) suffix, and the rightmost (inner) prefix. Our argument is motivated by the patterns of [RTR] spread in our data. For example, the definite article is emphaticized in RJA when it appears as the first (inner) prefix but resists [RTR] harmony when it is the second (outer) prefix (see Table 2). If the morpho-syntactic specification of the definite article has anything to do with [RTR] spread, we should not expect to see this patterning. Finally, the observed patterns cannot be

accounted for on pure phonological ground such as same syllable affiliation because our data (see Table 3) reveal that [RTR] spreads from the underlying [RTR] consonant to the first prefix that belongs to a different syllable (i.e. across a syllable boundary).

The fact that we observe [RTR] spread to the definite article when it occurs as the inner prefix to a stem that has an underlying [RTR] consonant as its onset can be seen as cross-linguistically relevant and may be empirically supported and theoretically motivated by feature propagation, adjacency conditions, and the notion of 'sequential prohibition' (Pulleyblank 2002). Pulleyblank (2002) argues that feature agreement approaches require that "adjacent segments within some domain have the same value for the harmonic feature" (p. 250), and that "the sequential prohibition would disallow any immediately adjacent sequence of differing tongue root specifications" (p. 256); thus he proposed the following constraint:

* ATR RTR: "An ATR segment may not be immediately followed by RTR". (p. 256)

Giving the fact that no Arabic affixes contain underlying [RTR] segments, we can understand why [RTR] does not proceed further to other prefixes and suffixes. Since such underlying [RTR] prefix does not exist, we will proceed with the current claim and propose the following two markedness constraints:[9]

(24) *[RTR] +
"no morphemic boundary in an [RTR] domain"
(25) *[RTR] + +
"no two morpheme boundaries in an [RTR] domain"

While the constraint in (24) prohibits the spread of [RTR] harmony across a morpheme boundary, the constraint in (25) is more tolerant as it bans the spread of [RTR] harmony only across two (or more) morphemic boundaries. The proposed constraint in (24) needs to dominate RTR-RIGHT to ban rightward [RTR] spread into the segments of the suffix. This ranking will not affect the spread of [RTR] into a suffix-initial /a/ since RTR-TO-*a* dominates *[RTR] +. The proposed constraint in (25) needs to be ranked in the top stratum along with IDENT-RTR so that both dominate RTR-LEFT to impose restrictions on the leftward spread of pharyngealization into the leftmost prefix when another prefix intervenes. Ranking (*RTR-+ +) higher than (*RTR-+) satisfies the subset criterion as the conditions imposed by the former constraint are a subset of the conditions imposed by the latter. The final constraint hierarchy for RJA is as follows:

(26) IDENT RTR, *RTR-+ + > > RTR-LEFT > > RTR/HI > > RTR-TO-*a* > > *RTR-+ > > RTR-RIGHT > > RTR/LOWER-VT > > IDENT-ATR

The following Tableaux 7 to 11 show sample analyses with the new constraint ranking. Tableau 7 shows how /it-ta-**sˤ**niiʕ/ surfaces as [it-ta-**sˤ**niiʕ], which wins over the rival candidate [it-ta-**sˤ**niiʕ] (where the left-most prefix copies [RTR]) by virtue of no violation of top-ranked *RTR-+ +. On the other hand, RTR-LEFT takes care of the other candidates in which [RTR] does not spread to all segments of the first prefix. Although the optimal candidate violates *RTR-+, this constraint is ranked too low to be crucial to the candidate evaluation here.

Tableau 7.
/it-ta-**sˤ**niiʕ/ → it-ta-**sˤ**niiʕ (see Table 2)

/it-ta-**sˤ**niiʕ/	IDENT-RTR	*RTR-+ +	RTR-LEFT	RTR-HI	RTR-TO-*A*	*RTR-+	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞it-ta-**sˤ**niiʕ			**		*	*	**	***	****
b. it-ta-**sˤ**niiʕ		*!		*	*	**	**	*****	*****
c. it-ta-**sˤ**niiʕ			***!		*	*	**	**	***
d. it-ta-**sˤ**niiʕ			*!***		*		***	*	
e. it-ta-sniiʕ	*!								

Tableau 8 shows again how *RTR-+ + is crucial for [ta-tu-n**sˤ**ur] to win over [ta-tu-n**sˤ**ur]. Again, RTR-LEFT rules out the candidates in which [RTR] harmony does not spread or spreads partially to the segments of the first prefix.

Tableau 8.
/ta-tu-n**sˤ**ur/ → ta-tu-n**sˤ**ur (see Table 3)

/ta-tu-n**sˤ**ur/	IDENT-RTR	*RTR-+ +	RTR-LEFT	RTR-HI	RTR-TO-*A*	*RTR-+	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞ta-tu-n**sˤ**ur			**	*	*	*	**	****	***
b. ta-tu-n**sˤ**ur			**	**!	*	*		******	*****
c. ta-tu-n**sˤ**ur			*** !*		*		**	**	*
d. ta-tu-n**sˤ**ur			***!**		*		**	*	
e. ta-tu-n**sˤ**ur		*!		*	*	**	**	*****	*****

The analysis in Tableau 9 shows that [is-ta-**tˤ**rad] incurs no violations of *RTR-+ + contrary to [is-ta-**tˤ**rad] which incurs a fatal violation of this constraint. The candidate [is-ta-**tˤ**rad], which ties with the optimal candidate on the first four top-ranked constraints, loses because of a fatal violation of RTR-TO-*a*.

Tableau 9.
/is-ta-**tˤ**rad/ → is-ta-**tˤ**rad (see Table 4)

/is-ta-**tˤ**rad/	IDENT-RTR	*RTR-+ +	RTR-LEFT	RTR-HI	RTR-TO-*A*	*RTR-+	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞is-ta-**tˤ**rad			**			*	*	***	****
b. is-ta-**tˤ**rad		*!		*		**	*	*****	******
c. is-ta-**tˤ**rad			***!*				*	**	**
d. is-ta-**tˤ**rad			**		*!	*		****	*****

Tableau 10 shows that (*RTR-+ +) rules out candidates in which [RTR] spreads across two morpheme boundaries towards the segments of the second (rightmost) suffix (in [garas**ˤ**-t-ak] and [garas**ˤ**-t-ak]). The constraint (*RTR-+) is crucial here because it helps ruling out [garas**ˤ**-t-ak], which ties with the optimal candidate [garas**ˤ**-t-ak] on the five top-ranked constraints.

Tableau 10.
/garas**ˤ**-t-ak/ → garas**ˤ**-t-ak (see (23a))

/garas**ˤ**-t-ak/	IDENT-RTR	*RTR-+ +	RTR-LEFT	RTR-HI	RTR-TO-*A*	*RTR-+	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞garas**ˤ**-t-ak					*		***		****
b. garas**ˤ**-t-ak					*	*!	**		*****
c. garas**ˤ**-t-ak		*!				**	*		******
d. garas**ˤ**-t-ak		*!			*	**			*******
e. garas**ˤ**-t-ak			*!***				***		

Finally, Tableau 11 shows that [rab**tˤ**-aat] surfaces as the optimal output although it involves [RTR] spread into the /a/ segment of the adjacent suffix, thus, incurs a violation of (*RTR-+). However, [rab**tˤ**-aat] wins over [rab**tˤ**-aat], which does not violate (*RTR-+), by virtue of avoiding violations of the higher constraint (RTR-TO-*a*), a constraint that [rab**tˤ**-aat] violates.

Tableau 11.
/rabtˤ-aat/ → rabtˤ-aat (see (20b))

/rabtˤ-aat/	IDENT-RTR	*RTR-+ +	RTR-LEFT	RTR-HI	RTR-TO-*A*	*RTR-+	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞rabtˤ-aat						*	*	***	****
b. rabtˤ-aat					*!		**	***	***
c. rabtˤ-aat					*!	*		****	*****
d. rabtˤ-aat			*!**			*	*	*	*

As a final remark, our current analysis can account for the [RTR] spread patterns in the Palestinian dialects examined in Davis (1995). However, as mentioned earlier, Davis (1995) and McCarthy (1997) focused on [RTR] spread within stems and did not examine the spread of the feature across morphemic boundaries to prefixes and suffixes. Therefore, the proposed constraints (*RTR-+ and *RTR-+ +) are not relevant to their data. The following analysis illustrates our point.

Tableau 12.
/wasˤlaat/ → wasˤlaat

/wasˤlaat/	IDENT-RTR	*RTR-+ +	RTR-LEFT	RTR-HI	RTR-TO-*A*	*RTR-+	RTR-RIGHT	RTR/LOWER-VT	IDENT-ATR
a. ☞wasˤlaat				*			*	**	****
b. wasˤlaat				*	*!		***	*	**
c. wasˤlaat				*	*!			***	*****
d. wasˤlaat			*!*				*	*	**

The validity of our proposal (i.e. our ranking argument) in which we posit two distinct markedness constraints is theoretically and cross-linguistically motivated by the difference between gradient constraints and categorical constraints. While the constraint (*[RTR] +) is gradient (can assign multiple violation marks) and violable (but rather not necessarily fatal), the constraint (*[RTR] + +) is both categorical (i.e. assigns/tolerates no more than one violation mark) and always fatal if violated (i.e. inviolable in the optimal candidate).

On the one hand, ranking such categorical constraint immediately above the constraint (RTR-Left), which is responsible for the unbounded leftward spread of [RTR], helps avoid passing undesirable outputs in which [RTR] spreads leftward (or rightward of course) in an unbounded

manner to the left edge of the phonological word across more than one morphemic boundary. On the other hand, ranking the gradient (and relatively less crucial) constraint below (RTR-Left) but immediately above (RTR-Right) allows for leftward spread of [RTR] across one morphemic boundary (when conditions are met) while prohibiting rightward spread of [RTR] across any morphemic boundary unless sanctioned by the higher-ranked constraint [RTR-to-a] as attested in our data.

As such, the two constraints are different in terms of force and are both needed in order to mirror the process-specific grounded path conditions which are observed for stems and thus replicate the directional asymmetry in [RTR] spread in RJA, making leftward [RTR] spread across one morphemic boundary more likely relevant to the rightward spread across one morphemic boundary.

5. Conclusion

The results of the present study show that RJA patterns very similarly to northern Palestinian Arabic in Davis (1995) in terms of both the directionality of [RTR] spread and the nature of opaque segments. In RJA, leftward [RTR] harmony is unbounded within the stem word. Although [RTR] spreads rightward, it is often blocked by intervening opaque segments; these are the high segments. Also, [RTR] does not spread rightward further than the syllable nucleus /a/, except into a following /a/ across non-opaque segments. However, RJA is different from northern Palestinian Arabic as it does not restrict such long distance spread of [RTR] onto lower vocal tract segments. Yet, this study shows that McCarthy's (1997) analysis is inadequate in accounting for some of the possible patterns in RJA and probably even in the northern Palestinian Arabic.

Moreover, this study shows that the spread of [RTR] harmony is sensitive to morphemic boundaries in RJA. On the one hand, [RTR] harmony does not spread rightward across a morphemic boundary except into a suffix-initial /a/ only when the right edge of the stem [RTR] span is not already /a/. On the other hand, [RTR] harmony does not spread leftward across more than one morphemic boundary. Therefore, the directional asymmetry of [RTR] harmony spread (observed for stem and morpheme-one segments) is extended to the prefixes and suffixes though in a morphological sense rather than segmental one this time; [RTR] spread onto prefixes is less bounded than [RTR] spread onto suffixes in RJA.

These results suggest that the domain of [RTR] spread in RJA is defined in morpho-phonological terms. In other words, the maximum domain of [RTR] spread is the following morphologically-defined phonological word: Rightmost Prefix + Stem + Leftmost Suffix – whereby the leftmost suffix is limited to a suffix-initial /a/ if, and only if, the right edge of the stem [RTR] span is not already /a/.

This paper reflects indirectly on learnability. A major goal of linguistics is to unravel natural language learnability. The goal is to construct a psychological model of language acquisition that would reveal how an infant learns, in roughly four years, an extremely intricate system, Language, and arrives at the target adult grammar. OT is a theory that proved effective in accounting for learnability, hence being adopted in the current paper. In OT the grammar of the language consists of a set of universal constraints and a ranking of these constraints (Prince & Smolensky 1993). Constraint ranking plays a significant role in learning different domains in language. Phonology is one of these domains in which constraint ranking is crucial in learning the different phonological patterns like phonotactics, allophonic variation, and pharyngealization. Learning such patterns is the result of a certain constraint ranking. Since typological patterns represent all possible constraint rankings, learning a language depends on learning its constraint ranking (Smith 2000). Thus, the learnability of pharyngealization in RJA requires a restricted learning process of the ranking of the relevant universal constraints in (26). Going into detail in discussing how a learner of pharyngealization in RJA gradually approaches the adult target outputs is interesting but falls outside the scope of this paper.[10]

Notes

[1] Rural Jordanian Arabic is a Jordanian dialect spoken by village dwellers in the northern part of Jordan.

[2] The [RTR]-[High] and [RTR]-[Front] antagonistic configurations are not a restriction on the occurrence of such conflicting features in adjacent segments but rather a restriction on feature spread (i.e. a restriction on the co-occurrence of such physiologically conflicting features in the same segment: if [+RTR] then not [+High]).

[3] The data presentation and discussion in this study are limited to RJA, which is our native dialect. However, we believe that the observations in this study are generalizable to some other dialects of JA, especially Bedouin JA.

[4] In the transcription system of the current study, the underlying emphatic consonant is printed in bold, underlined letters indicate the [RTR] span/domain (= the surface pharyngealized sounds + the underlying emphatic consonant), and lowercase non-underlined letters indicate surface nonpharyngealized sounds. The symbol /j/ represents a voiced palatal approximant.

[5] When an example includes more than one coronal consonant that can potentially be underlyingly emphatic (such as /satˤir/), our approach for determining the true underlying pharyngealized consonant is motivated by the overall pattern of the data. For example, if /sˤatir/ was the underlying representation, the observed phonetic representation in which the segment /t/ is realized as pharyngealized should not be expected as the rightward spread of pharyngealization does not proceed beyond the low vowel /a/. The sanity of this approach is supported not only by the lexical entries in the Arabic dictionaries which list the root structure of these Arabic words, but is also supported by our observation that those pseudo-emphatic consonants surface as plain (i.e. non-emphatics) in the elevated speech (MSA) and in the urban dialects of JA, which is the same approach adopted by Davis (1995).
The underlying representation /sˤatˤir/ is not possible. Following the Obligatory Contour Principle (OCP), which bans the occurrence of certain consecutive identical features in underlying representations, we posit that the same principle applies to this Jordanian dialect and disallows the co-occurrence of two instances of the feature [RTR] within the same Arabic root. In fact, this pattern was observed and argued for in Davis (1995) with regard to the Palestinian dialects. Similarly, Frisch *et al.* (2004) observed that emphatic coronals do not co-occur with each other in adjacent position in Arabic. This observation was elaborated by McCarthy (1988) and formulated in the constraint OCP-PHAR, which states that "Adjacent pharyngeals are prohibited" (Coetzee & Pater, 2008: 3).

[6] Geminate emphatics do not seem to trigger different [RTR] harmony patterns from those triggered by emphatic singletons in RJA. Therefore, we believe that our proposed analysis is still adequate in this regard.

[7] Order refers to the furthest order of an affix. '1' means that an affix has to be immediately adjacent to the stem and cannot be added after another affix. '3' entails that '1' and '2' are also possible in the absence of closer morphemes.

[8] Geminate consonants occur in Arabic when two identical consonants are contiguous, and the first consonant is syllabic. Thus, the word rabatˤ-t 'I tied' becomes rabatˤtˤ. For some speakers, an epenthetic /i/ is inserted between the two consonants to avoid the geminate: rabatˤ-it.

[9] We would like to thank an anonymous reviewer of IJL for raising interesting questions that helped motivate this proposal.

[10] Within OT a learning algorithm known as Error-Driven Constraint Demotion (EDCD) has been proposed to account for how a constraint ranking can be learned successfully (see Tesar & Smolensky 1996, 1998; Smolensky 1996; and Prince & Tesar 1999).

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