Volume 28
Issue 1 *Proceedings of the 45th Annual Penn Linguistics Conference*
Article 2

11-18-2022

Glottal Stop Variation in Standard Arabic: OT-based Optionality Analysis

Mohammed J. Al-Ariqy
The University of Utah

Glottal Stop Variation in Standard Arabic: OT-based Optionality Analysis

Abstract

This paper analyzes optional glottal stop deletion in Standard Arabic. This deletion is typically accompanied by lengthening or gliding of an adjacent vowel, and deletion can be blocked when this lengthening/gliding is not possible, and also when deletion would create homophony. This paper assesses the ability of various OT-based theories of optionality to account for glottal stop deletion, arguing that the rank-ordered model of EVAL (ROE; Coetzee 2006) provides a better account than alternatives such as partially ordered grammars (PO; Anttila 1997, 2007) and serial variation (SV; Kimper 2011).

Glottal Stop Variation in Standard Arabic: OT-based Optionality Analysis

Mohammed J. Al-Ariqy*

1 Introduction

This paper is about the optional deletion of the glottal stop [ʔ] in Standard Arabic (SA). This phoneme is known as *hamzah* in Arabic grammar books. There has been much discussion among old grammarians over the phonological behavior of this phoneme in different positions of the word, when it falls in a verb or a noun, and when it is uttered in isolation or within a phrase or a sentence. This paper addresses glottal stops within the prosodic word only. Glottal stops can optionally delete in some positions of the word and this deletion, depending on whether the glottal stop is in onset or coda position, is typically accompanied by some alternations such as lengthening or shortening of a preceding vowel depending on some factors to be outlined later, spreading of the preceding vowel to create a glide that fills in the slot of the deleting glottal stop, or accompanied by gemination. When gemination is the option, the geminate is usually a glide that must agree with the features of the preceding high vowel. However, this deletion is blocked under some conditions outlined later.

This paper does not make a difference between the terms *Classical and Standard Arabic*, they are interchangeable. The phonotactics, phonological and morphological rules in the literature about SA originate from the grammar books of *Classical Arabic*. Onset and coda clusters are not allowed in this language, according to Hetzron (2019), except for coda clusters in word-final positions. The syllables attested are CV, CVC, CVV, and CVVC, whose occurrence is restricted to word-final positions. According to Hetzron (2019:375), epenthetic vowels are used to avoid initial clusters, and "unacceptable codas are avoided by shortening the vowel, dropping weak consonants, simplifying geminated consonants or adding a paragogic vowel to word-final clusters". Ryding (2014:34) also mentions that the first three syllable types mentioned above are "permissible in full-form pronunciation". The author, however, states that other restricted super-heavy syllable types such as CVVC and CVCC may also be found within SA words, mainly when there are geminates in the word. I also add that CVVCC syllable types may also be found in forms such as *raadd* 'returning', *ħaadd* 'sharp', *dʒaadd* 'serious' when they come in utterance-final positions. Onsetless syllables are not permissible in SA, and vowel and consonant length is phonemic. Standard Arabic has 28 consonants; they are all phonemic (Watson 2007).

Most of the discussions about the phonology of glottal stops in Arabic are within the traditional Arabic morphology and phonology books that discuss it descriptively. Little research has been done on the phonological behavior of this phoneme, and I am not aware of any that use a recent phonological framework such as OT and account for its optional deletion utilizing OT-based optionality models. The data in this paper is based on descriptive illustrations from one of the traditional books on the linguistics of Classical or Fus7a Arabic, namely *Al-Kitaab* by Sibawayh (760-796 AD), a linguist of the second century of the Islamic calendar, i.e., the 8th century AD. This paper was inspired by Sibawayh's discussion of the environments where glottal stops can optionally delete and the processes that accompany such deletion. This deletion is the focus of the analysis presented later. Similar behavior of the glottal stop is observed in the Standard Arabic spoken today and in other modern Arabic dialects. The data provided in this paper was presented to Arabic linguists and speakers who know Standard Arabic to get their grammaticality judgments and was also validated by the author's native intuitions. For the purpose of this paper, only data from Standard Arabic is presented and analyzed here, leaving data from other Arabic dialects for future research.

The goal of this paper is to account for these facts using existing approaches to optionality arguing that Coetzee's (2006) rank-ordering model of EVAL (ROE) provides a better account for

* My gratitude goes to the Department of Linguistics at the University of Utah, Prof. Aaron Kaplan, and audiences at PLC45, the 28th Manchester Phonology Meeting, the 96th LSA annual meeting, and WECOL21. Any mistakes found here are of my own doing.

optional glottal stop deletion than other models of optionality such as Anttila's (1997, 2007) partially ordered grammars (PO) and Kimper's (2011) serial variation (SV). I argue that glottal stops must be placeless and that moras must be present underlyingly for the analysis presented below to work.

2 Optional Glottal Stop Deletion

Glottal stops can occur both in the onset and coda positions of the syllable in SA. Deleting the glottal stop in these two positions can be optional in certain phonological conditions. When optional, this deletion is typically accompanied by lengthening of a preceding adjacent vowel when the deleting glottal stop is the coda of that syllable (1) or creating a glide, through vowel spread, that matches the features of the preceding vowel if the glottal stop is the onset of the syllable (2). Codas are assumed to be moraic in this analysis.

(1)

a.	miʔðnah	miiðanah	'minaret'
b.	miʔrah	miirah	'revenge (n)'
c.	d͡ʒuʔnah	d͡ʒuunah	'a type of container'
d.	luʔluʔa	luuluʔa	'pearl'
e.	faʔrah	faarah	'mouse (FEM)'
f.	fiʔraan	fiiraan	'mice'
g.	faʔs	faas	'ax'
h.	raʔs	raas	'head'
i.	faʔl	faal	'omen'

The glottal stops in (1a-f) are singleton codas and in (1g-h) are the first part of the complex codas. When the glottal stop deletes in (1), the preceding vowel becomes long; as shown in the middle column. The constraint HAVEPLACE, which penalizes placeless phonemes in the output, triggers deletion of the glottal stop because it lacks place features. When a coda [ʔ] is deleted, MAX-μ triggers compensatory lengthening. The mora of the deleted glottal stop is reassigned to the preceding vowel which explains the lengthening of the preceding vowel.

The glottal stop in (2) is the onset of its syllable, so when it is deleted, as seen in the second column, ONSET, which penalizes onsetless syllables, compels spread of the preceding vowel which creates a glide whose features match those of the preceding vowel, that glide then fills in the empty onset position. This vowel spread must create a glide that matches the features of that vowel, so if the vowel preceding the glottal stop is [u], the glide caused by the spread is the rounded [w], and if the vowel preceding the glottal stop is [i], the glide is [j].

(2)

a.	miʔar	mijar	'revenge'
b.	d͡ʒuʔan	d͡ʒuwan	'type of container (PL)'
c.	miʔah	mijah	'hundred'
d.	luʔluʔa	luuluwa	'pearl'
e.	maʔaal	*maɑ̯aal	'return'

When no such glide is available (i.e., when the preceding vowel is low), ONSET blocks deletion (2e). Notice that the word for 'pearl' shows a different deletion variant in (1d) from that in (2d). This word is with multiple glottal stops and thus displays four optional variants: (i) one that preserves all glottal stops [luʔluʔa], (ii) one that deletes them all [luuluwa], (iii) one that deletes the onset glottal stop only [luʔluwa], and (iv) one that deletes the coda glottal stop [luuluʔa]. This is an example of Local Optionality which is defined as "the state of affairs in which some of the observed outputs of an optional process cannot be derived by reranking (plausible) constraints that are not position-specific" (Riggle and Wilson 2005:2). This example plays a crucial role in the analysis.

Deletion of the glottal stop can also be accompanied by glide gemination if the glottal stop is in the onset position and preceded by a long vowel. Gemination happens either intervocalically (3a-

c) or in word-final position (3d-e). However, deletion in word-final positions must be accompanied by shortening the preceding long vowel if that vowel is low (3f,g). If the vowel preceding the word-final glottal stop is already short, deletion happens with no compensation (3h,i). It is worth mentioning that these alternations were attested in some other dialects of Arabic and the author's dialect, as well as other behaviors of the glottal stop, which are not attested in Standard Arabic.

(3)	a.	maliiʔah	malijjah	'full of'
	b.	χɑtˤiiʔah	χɑtˤijjah	'sin (n)'
	c.	daniiʔah	danijjah	'low'
	d.	maqruuʔ	maqruww	'read (v) (PASSIVE)'
	e.	mamluuʔ	mamluww	'filled'
	f.	masaaʔ	masa	'evening'
	g.	liqaaʔ	liqa	'meeting'
	h.	ðˤɑmaʔ	ðˤɑma	'thirst'
	i.	nabaʔ	naba	'news'

Deletion of the glottal stop in (3) gives rise to a geminate glide because CVV syllables with [ii] and [uu] are banned if the onset of the following syllable is either [j] or [w], consecutively: [xɑtˤi:ʔah] ~ [xɑtˤijjah] but not *[xɑtˤiijah], [mamluuʔah] ~ [mamluwwah] but not *[mamluuwah]. When in a word-final position (3d,e), [ʔ] deletes, and this deletion creates a glide geminate: [maq.ruuʔ] ~ [maq.ruww] if the vowel preceding the glottal stop is a high vowel. The constraint *CVV#PW penalizes heavy open syllables in the final position of the prosodic word, so it rules out forms like *[maq.ruu]. This constraint triggers gemination instead. However, if the [ʔ] is preceded by a low short vowel, *LowGlide, which penalizes low glides, compels deletion without compensation: [nabaʔ] ~ [naba] 'news'. If a long low vowel precedes the word-final glottal stop, however, *CVV#PW compels the shortening of that vowel after deletion of [ʔ]: [masaaʔ] ~ [masa] 'evening'. One can also argue that *LowGlide also penalizes low glides, so a low glide geminate is not possible.

If the glottal stop is part of the root of the word, Max-Root, which penalizes deletion of root segments, blocks its deletion (4a-e). If glottal stop deletion causes homophony, a homophony avoidance constraint (Crosswhite 1999) blocks its deletion (4f,g). In this case, the deletion of [ʔ] is blocked because *Homophony, which penalizes homophonous outputs, outranks HavePlace. Also, if deletion of the glottal stop will cause a morphologically ill-formed word (4g,h), its deletion is blocked as well by a markedness constraint, not within the scope of this article. The cases where glottal stop deletion is blocked are left for future work. They are presented here to show that glottal stops do not delete unconditionally in SA.

(4)	a.	sajjiʔah	'a bad deed'				
	b.	masʔalah	'issue (n)'				
	c.	ʔisaaʔah	'offense'				
	d.	kaʔaabah	'depression'				
	e.	mustaaʔ	'annoyed'				
	f.	fanaaʔ	'courtyard'	cf. fana	'finish (PAST)'		
	g.	mawʔɪl	'resort'	cf. mawwɪl	'fund (v)'	cf. *mawil	
	h.	tawʔam	'twin'			cf. *tawam	

Here is a summary of the facts presented in the data above. The glottal stops in (1) are in the coda positions. The lengthening of the preceding vowel compensates for their deletion. In (2), the glottal stops are in the onset positions. Their deletion is accompanied by gliding. The glide created by vowel spread must agree in place with the preceding vowel. In (3), deletion of the glottal stop triggers gemination. The geminates are always glides that match the features of the vowels preceding the deleted glottal stops. Glottal stops in word-final positions preceded by long low vowels (3f,g) can also delete, but the preceding long vowels become short because gemination is not possible for the lack of a glide that matches the features of the low vowel. Can a word-final glottal stop delete if the preceding vowel is short, however? Yes (3h,i), and nothing accompanies this deletion: [nabaʔ] ~ [naba] 'news'. Deletion of the glottal stop, when allowed by the grammar, is optional in all these cases.

Glottal stop deletion is banned in (4) for different reasons: when it creates a sequence of adjacent segments sharing identical features such as the sequence of the glides in *[sajjijah] if the glottal stop deletes in (4a), when the glottal stop is part of the consonantal root of the word (4b,e), when gliding is not possible for the lack of a low glide in SA (4c,d), when deletion causes homophony (4f,g), and when it creates morphologically ill-formed words (4h). In brief, when deletion of the glottal stop cannot be compensated by either shortening or lengthening of a preceding vowel or through gliding for the lack of a low glide in SA, it is blocked. While other situations present additional complications, these are the core facts.

These are some facts about the deletion of the glottal stop in SA. Only some of these alternations are within the scope of the presented analysis in this paper, the rest are left for future research. Section 3 provides an OT-based analysis of the optionality in the data using some approaches to optionality. Section 4 concludes the paper and shows issues left for future research.

3 OT-based Optionality Analysis of Glottal Stop Deletion

This paper assesses the ability of various OT-based approaches of optionality to account for [ʔ] deletion, arguing that the rank-ordering model of EVAL proposed by Coetzee (2006) provides a better account than alternatives such as partially ordered grammars and serial variation. Optionality within OT has received remarkable attention recently (cf. Kaplan 2016). Many approaches to optionality have been proposed, such as multiple-ranking theories (Anttila 1997, Boersma 1998, Boersma and Hayes 2001); among these is the partially ordered grammars (PO) model, which is proposed by Anttila (1997, 2007). Other approaches to optionality do not introduce new generative power to OT but rather use a different mechanism to allow existing possible outputs to become legal outputs. One such model is the rank-ordering model of EVAL (ROE) mentioned above. Kimper (2011) also introduced the Serial Variation (SV) model. Local optionality is accounted for in this model using the multiple-ranking theory within the framework of Harmonic Serialism (HS) proposed by (Prince and Smolensky 2004).

The analysis starts with the ROE model which I argue works best at accounting for this optionality. The ROE assumes a cut-off line somewhere in the constraint ranking. Constraints above the cut-off line eliminate candidates as normal, but any candidate that survives to the cut-off line is a possible output. MAX-ʔ and HAVEPLACE are then below the cut-off, which is identified here by the solid double lines, to yield variants presented above. This model can capture all these possible outputs, including those of 'pearl'.

/luʔluʔah/	ONSET	MAX-μ	MAX-ʔ	HAVEPLACE
a. ☞ luʔ.lu.ʔah				***
b. ☞ luː.lu.wah			**	*
c. ☞ luː.lu.ʔah			*	**
d. ☞ luʔ.lu.wah			*	**
e. luʔ.lu.ah	*!		*	**
f. lu.lu.ʔah		*!	*	**

Table 1. optional deletion of the [ʔ] in *luʔluʔah* using the ROE model

The optional outputs (a-d) of 'pearl' all survive the evaluation because they only violate MAX-ʔ and HAVEPLACE which are below the cut-off line. The faithful candidate (a) violates HAVEPLACE by preserving all glottal stops. I assume that the glottal fricative [h] also lacks place features in

Standard Arabic, but I assume that MAX-H is high-ranking enough to prevent its deletion, i.e., MAX -H outranks HAVEPLACE. By deleting both glottal stops candidate (b) violates MAX-ʔ twice. Candidates (c) and (d) are tied. They both preserve only one of the two glottal stops, the onset in (c) and the coda in (d), thus violating MAX-ʔ once and HAVEPLACE twice. Both candidates in (e&f) are ruled out because they violate constraints above the cut-off line. Candidate (f) violates MAX-µ because it deletes the coda [ʔ]. Codas are assumed to be moraic in SA, so deleting a coda without assigning it to the preceding vowel, i.e., lengthening it, violates MAX-µ. It should be mentioned here that moras are assumed to be present in the underlying form for this analysis to work.

This model can also capture other facts in the data. When an onset [ʔ] is deleted, ONSET compels spreading of the preceding high vowel, as seen in Table 2. The glide resulting from this spread then fills in the onset position left empty after the deletion of the glottal stop and satisfies ONSET. The [+high] feature stands for all of [i]'s features that spreads to that onset position.

/miʔar/ | [+high]	ONSET	MAX-µ	MAX-ʔ	HAVEPLACE
a. 👉 mi.ʔar				*
b. 👉 mi.jar |/ [+high]			*	
c. mi.ar			*	

Table 2: optional deletion of [ʔ] in *miʔar* 'revenge' using the ROE model

Having MAX-ʔ and HAVEPLACE below the cut-off line again produces both optional outputs. In (b) when [ʔ] is deleted, ONSET compels the spread of the preceding vowel to fill in the onset position with the glide [j] whose features match those of the preceding high vowel. This is illustrated by the two upward lines branching from the mora. Candidate (c) is ruled out because its second syllable is onsetless. However, if a coda [ʔ] deletes, see Table 3, the preceding vowel lengthens as a result of reassignment of the floating mora to that vowel so to have two moras as seen in (b) below.

/miʔrah/ | | µ µ	ONSET	MAX-µ	MAX-ʔ	HAVEPLACE
a. 👉 miʔ.rah				**
b. 👉 miː.rah |\\ µ µ			*	*
c. mi.rah		*!		*

Table 3: optional deletion of [ʔ] in *miʔrah* 'revenge' using the ROE model

The deleting [ʔ] in Table 3 is in the coda position. Its deletion leaves a floating mora that must be reassigned. This is illustrated on the input form in the tableau. So, deletion of [ʔ] in this position causes the reassignment of the floating mora to the preceding vowel, which then lengthens as shown in the tableau. Notice, unless [ʔ] has a mora, candidate (c) cannot be ruled out. Also, there is no reason for lengthening if the coda glottal stop is not moraic. Therefore, moras must be present underlyingly.

This model also accounts for other cases of glottal stop deletion, such as the deletion that is accompanied by gemination in (3). See Tables 4 and 5 below. The constraint HAVEPLACE triggers the deletion of the onset glottal stop in Table 4, but deleting that glottal stop leaves the onset empty in (c), which is penalized by ONSET. The onset requirement is then satisfied through the spread of the long vowel to fill in the empty onset slot with a glide that matches the features of that high vowel; it is [j] in this case that matches the features of the high front vowel [i]. This spread gives rise to a glide geminate in (b).

/maliiʔah/	Onset	Max-μ	Max-ʔ	HavePlace
a. 👉 ma.lii.ʔah				**
b. 👉 ma.lij.jah			*	*
c. ma.lii.ah	*!		*	*

Table 4: Optional deletion of [ʔ] accompanied by gemination in word-medial position.

There is no good answer to why this deletion gives rise to a glide geminate instead of just creating a form like [maliijah]. It may be hard to determine whether the output is [malijjah] or [maliijah]. I assume the former, and *iij rules out the latter, but more work is needed to clarify the issue. So, both optional outputs in Table 4 are attained through ranking Max-ʔ and HavePlace below the ROE cut-off line. The same thing applies to the example in Table 5 below.

/maqruuʔ/	Onset	*CVV#PW	Max-μ	Max-ʔ	HavePlace
a. 👉 maq.ruuʔ					*
b. 👉 maq.ruww				*	
c. maq.ruu		*!		*	
d. maq.ru			*!	*	

Table 5: Optional deletion of [ʔ] accompanied by gemination in word-final position.

Notice that a new constraint is introduced in this tableau. *CVV#PW penalizes heavy open syllables in the final position of the prosodic word. These are not attested in this position of the prosodic word in SA, so candidate (c) above is ruled out. I argue that this constraint triggers the gemination in the word-final position, in (b). A candidate like that in (d) satisfies *CVV#PW but at the expense of Max-μ. The same argument about [maliijah] vs. [malijjah] applies on [maqruuw] vs. [maqruww], with another markedness constraint such as *uuw that rules out [maqruuw].

Alternative theories fail to capture the variation in the data fully. In PO, the ranking can vary across tableaux—illustrated by the dotted line in the tableaux below, potentially giving multiple outputs for one input. This model fails to capture all variants of /luʔluʔah/ as seen in Table 6.

/ luʔluʔah/	Onset	Max-μ	Max-ʔ	HavePlace
a. 👉 luʔ.lu.ʔah				***(!)
b. 👉 lu:.lu.wah			**(!)	*
c. (👉) lu:.lu.ʔah			*(!)	**(!)
d. (👉)luʔ.lu.wah			*(!)	**(!)
e. luʔ.lu.ah	*!		*	**
f. lu.lu.ʔah		*!	*	**

Table 6: Optional deletion of *luʔluʔah* in using the PO model.

Under either of PO's rankings, the winner will have to maximally satisfy the higher of the two relevant constraints, but the outputs it does not produce (c&d) only partially satisfy those constraints; they neither delete all the glottal stops nor fully preserve them, and that problem remains no matter how many rankings are allowed for PO. In other words, these two candidates are collectively harmonically bound, (Samek-Lodovici and Prince 1999). However, this model predicts variation in the language where there are only two possible optional outputs, as in Table 7. Having Max-ʔ over HavePlace produces the faithful candidate in (a), and flipping the ranking produces the other optional output in (b). Candidate (c) is ruled out by the onset constraint.

/miʔar/	ONSET	MAX-μ	MAX-ʔ	HAVEPLACE
a. 👉 mi.ʔar				*(!)
b. 👉 mi.jar			*(!)	
c. mi.ar	*!			

Table 7: Optionality in *miʔar* using the PO model.

Glottal stop can also delete in word-final positions in coda clusters such as in [raʔs] 'head' and this deletion triggers lengthening of the preceding vowel [raas]. The partial order of MAX-ʔ and HAVEPLACE accounts for this deletion in Table 8. The output in (c) is ruled out because deletion of the glottal stop violates MAX-μ. That is because the first part of the coda cluster, i.e. [ʔ], contributes a mora to the syllable weight and its deletion leaves a floating mora that must be assigned to the preceding vowel to yield the optional winning output in (b). A possible candidate that is not given in the tableau is [raʔ] which has the same violations as the faithful candidate. Such an output is assumed to be ruled by a high-ranking correspondence constraint.

/raʔs/	ONSET	MAX-μ	MAX-ʔ	HAVEPLACE
a. 👉 raʔs				*(!)
b. 👉 raas			*(!)	
c. ras		*	*	

Table 8: Glottal stop deletion in word-final coda clusters.

Serial Variation, which uses PO in a serial derivation, also fails to capture variation in /luʔluʔah/ due to GEN's restriction of producing outputs different from the input by only a single change. In this model, the ranking can change between steps. See the tableaux in Table 9. Syllabification is assumed to come for free here; it does not count as a step in the derivation.

Step1: (Derivation 1)

luʔ.lu.ʔah	ONSET	MAX-μ	MAX-ʔ	HAVEPLACE
a.👉luʔ.lu.ʔah				***
b. luː.lu.ʔah			*!	**
c. luʔ.lu.ah	*!		*	**

Convergence!

Step 1: (Derivation 2)

luʔ.lu.ʔah	ONSET	MAX-μ	HAVEPLACE	MAX-ʔ
a. luʔ.lu.ʔah			***!	
b. 👉luː.lu.ʔah			**	*
c. luʔ.lu.ah	*!		**	*

Table 9: Serial variation analysis of the local optionality in *luʔluʔah.*

The ranking between MAX-ʔ and HAVEPLACE can vary from step to step; if MAX-ʔ dominates on the first step, the derivation converges with no deletion; if HAVEPLACE dominates as on the second step, one glottal stop will delete, and that glottal stop will always be the one that is a coda because it harmonically bounds the candidate that deletes the onset. Then this glottal stop is not anymore available for further steps to get the form where only the onset glottal stop deletes, i.e., *luʔluwah*. So, we see that serial variation cannot account for the local optionality in this example.

4 Conclusion

To conclude, this paper shows that the PO and SV models cannot fully capture the variation of glottal stop in SA, mainly where more than two variants are attested. It supports the ROE model of optionality and shows some shortcomings for the PO and Serial Variation models of optionality. This work is significant as it shows that the ROE model can handle some optional processes that other theories of optionality cannot. It also shows the importance of having moras in the underlying representation. It also shows that only if we treat glottal stop as placeless that we can account for what triggers its deletion in SA.

This paper presented some cases where glottal stop deletion is not possible in (4) but, for space reason, did not go beyond mentioning some constraints which block this deletion in section 2. Further OT analysis of these cases is left for future research. Other cases of optional glottal stop deletion were not discussed in this paper. Future research can explore this variation using other optionality models such as MaxEnt and Harmonic Serialism.

References

Anttila, Arto. 1997. Deriving variation from grammar. *Amsterdam Studies in the Theory and History of Linguistic Science Series 4*, 35–68.

Anttila, Arto. 2007. Variation and optionality. *The Cambridge Handbook of Phonology*, 519–536. Cambridge, Mass.: MIT Press.

Coetzee, Andries. 2006. Variation as accessing 'non-optimal' candidates. *Phonology*, 23:337–385.

Crosswhite, Katherine. 1999. Intra-paradigmatic homophony avoidance in two dialects of Slavic. *UCLA working papers in linguistics*, 1:48–67.

Greenberg, Joseph. 1950. The patterning of root morphemes in Semitic. *Word*, 6:162–181.

Hetzron, Robert. 2013. *The Semitic Languages*. Routledge.

Kaplan, Aaron. 2016. Local optionality with partial orders. *Phonology*, 33:285–324.

Kimper, Wendell. 2011. Locality and globality in phonological variation. *Natural Language & Linguistic Theory* 29:423–465.

McCarthy, John. 1979. On stress and syllabification. *Linguistic Inquiry* 10:443–465.

McCarthy, John. 1981. A prosodic theory of nonconcatenative morphology. *Linguistic Inquiry* 12:373–418.

McCarthy, John. 2000. *Harmonic Serialism and Parallelism*. Linguistics Department Faculty Publication series 40.

Prince, Alan and Paul Smolensky. 2004. *Optimality Theory: Constraint Interaction in Generative Grammar Malden*. MA: Blackwell.

Ryding, Karin. 2014. *Arabic: A Linguistic Introduction*. Cambridge University Press.

Samek-Lodovici, Vieri, and Alan Prince. (1999). *Optima*. Rutgers Optimality Archive ROA-363.

Sibawayh, Abu Bishr. 8th century. *Al-Kitaab*.

Watson, Janet. 2007. *The Phonology and Morphology of Arabic*. Oxford University Press.

Department of Linguistics
The University of Utah
Salt Lake City, UT 84112
m.alariqy@utah.edu