ON THE DIRECTIONALITY OF EMPHASIS SPREAD

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This paper discusses the asymmetric directionality of the phenomenon known as Emphasis Spread. The Optimality Theoretic (Prince and Smolensky 1993) approach proposed by McCarthy (1997) will be examined, and it will be shown that the analysis lacks a necessary explicit restriction on the ordering of the proposed constraint hierarchy. The ordering restriction will be phonetically motivated and the resulting system of constraints will be used to construct a factorial typology of the phenomenon. The paper is organized as follows: Section 1 introduces Emphasis and the phonological process of Emphasis Spread. Section 2 showcases examples of Emphasis Spread from 8 dialects of Arabic and Aramaic (2.1-2.3), concluding, that the process is blocked, if it is blocked, when spreading from left to right (2.4). Section 3 provides an outline and an evaluation of the analyses proposed in Davis (1995) and in McCarthy (1997). Section 4 briefly outlines a failed attempt of explaining the asymmetry from a perceptual perspective. Section 5 considers the asymmetry from an articulatory point of view and shows that the asymmetry can be attributed to the articulatory properties of emphatic consonants. In Section 6 the asymmetry is imposed on McCarthy's constraint hierarchy using a strict ordering statement, and a resulting factorial typology is discussed. A summary of the conclusions and a discussion of related issues is provided in Section 7.

1. Emphasis and Emphasis Spread

The term "Emphasis" has been used to refer to a phonological property that is commonly found in the Semitic Languages. The phonetic realization of Emphasis varies among these languages and their dialects, surfacing in some cases as pharyngealization, uvularization, velarization, or as glottalization (Hoberman 1995.) Only the pharyngealized realization of Emphasis will be considered in this paper.

In most Arabic dialects, emphatic segments are produced with a concomitant constriction of the pharynx, which has been represented as [+RTR] (Retracted Tongue Root) in the literature. Underlyingly, the only emphatic segments in Semitic languages are a group of alveolar obstruents, and it is these consonants that cause the spreading of the feature [+RTR] on to other segments in the phonological word.

Emphasis Spread is an assimilatory process whereby segments inherit the [+RTR] feature of the neighboring emphatic segment. The process can apply iteratively, causing the assimilation to propagate through a series of adjacent segments, sometimes spanning the entire phonological word. In other words, an underlyingly-emphatic consonant can cause the spreading of the [+RTR] feature to the next segment, which can in turn spread the feature over to the next

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segment and so on. The examples provided in the next section will demonstrate some of the attested restrictions on the process.

2. Examples of Emphasis Spread: A Cross-dialectal Survey

2.1 Two Dialects of Palestinian Arabic

In a southern dialect of Palestinian Arabic, Davis (1995) reports that Emphasis Spread is unrestricted when proceeding from right to left (see (1a).) When spreading from left to right, however, Emphasis is blocked by the high front segments /i/, /ʃ/, /j/, and /dʒ/ (see (1b).) (Emphatic segments are underlined hereafter for ease of vision.)

(1) Emphasis Spread in Southern Palestinian: (a) Leftward spreading is unblocked; (b) Rightward spreading is blocked by /i/, /ʃ/, /j/, and /dʒ/.

a.	/balːaːsˤ/	→	[bˤaˤlˤːaˤːsˤ]	"*thief*"
	/naʃaːtˤ/	→	[nˤaˤʃˤaˤːtˤ]	"*activity*"
	/χajːaːtˤ/	→	[χˤaˤjˤːaˤːtˤ]	"*tailor*"
	/ʔatˤfaːl/	→	[ʔatˤfaːl]	"*children*"
b.	/ʕatˤʃaːn/	→	[ʕatˤʃaːn]	"*thirsty*"
	/sˤajːaːd/	→	[sˤaˤjːaːd]	"*hunter*"
	/ðˤadʒːaːt/	→	[ðˤaˤdʒːaːt]	"*noises/types of noise*"
	/tˤiːnak/	→	[tˤiˤːnak]	"*your mud*"

In a northern dialect of Palestinian Arabic, according to Davis (1995), leftward Emphasis Spread is also unimpeded, but rightward Emphasis Spread is subject to further restrictions: spread is blocked by high segments, and is blocked from proceeding further than the low vowel /a/.

(2) Emphasis Spread in northern Palestinian: rightward spread is blocked by the high segments /w/, /i/, and /u/, and proceeds no further than the low vowel /a/.

/tˤwaːl/	→	[tˤwaːl]	"*long*"
/tˤaːza/	→	[tˤaˤːza]	"*fresh*"
/sˤiħːa/	→	[sˤiħːa]	"*health*"
/katːˤuːʕa/	→	[kˤaˤtˤːuːʕa]	"*piece of mat*"

In both dialects, restrictions are active only when Emphasis spreads from left to right. It will be shown in the remaining subsections that the same pattern holds for other dialects of Arabic and of Aramaic as well.

2.2 Sanaani Arabic

Watson (1999) reports that in Sanaani Arabic, a dialect spoken in Yemen, Emphasis is marked not only with pharyngeal constriction, but also with simultaneous labialization. Watson claims that, upon spread, the labial feature of emphatic consonants propagates rightward, while the [+RTR] feature spreads leftward. An example of [+RTR] spread in Sanaani Arabic is shown in (3).

(3) Emphasis Spread in Sanaani Arabic: Leftward spread is unblocked.

/mistadˤiːlih/	→ [mˤiˤsˤtˤaˤdˤiːluh]	"*long*"
/ʕardˤih/	→ [ʕaˤrˤdˤuh]	"*its length*"
/saliːtˤ/	→ [sˤaˤlˤiˤːtˤ]	"*oil*"

Though lip rounding does favor rightward spreading, the spreading of [+RTR] follows the pattern observed in the previous section: restricted from left to right, unrestricted from right to left. (The effect of spread-blocking segments, according to Watson, is still unknown and awaits further analysis.)

2.3 Unbounded Bidirectional Emphasis Spread: Four Dialects

Hoberman (1995) reports that, in some Kurdistan dialects of Arabic and Aramaic, Emphasis spreads unrestricted both from left to right and from right to left. This exemplifies the simplest form of [+RTR] spread, where no segment impedes the assimilatory process. The pattern is also attested in Cairene Arabic (Hoberman 1995, Watson 1999), Qatari Arabic (Bukshaisha 1985, referred to in Watson 1999), and in the Modern Aramaic spoken by the Jews of Azerbaijan (Hoberman 1989).[1]

2.4 Conclusion

The eight dialects surveyed in sections 2.1-2.3 clearly show that when Emphasis Spread is blocked, it is blocked when proceeding from left to right rather than from right to left. This conclusion was summarized in Watson (1999), whose typological findings predict that, of the four patterns of Emphasis Spread shown in (4), only the first three can occur.

(4) Watson's (1999) predictions on Emphasis Spread: only (a-c) are predicted
- (a) Unbounded leftward spread, unbounded rightward spread.
- (b) Unbounded leftward spread, bounded rightward spread.
- (c) Bounded leftward spread, bounded rightward spread.

[1] The Cairene Arabic data presented in Hoberman (1995) suggests that the pattern of spread varies according the morphological domain. In Cairene Arabic, rightward spread is more restricted in suffixes than it is word-internally. In the Jewish Aramaic of Azerbaijan (discussed in Hoberman 1989,) spread is restricted only in non-Semitic loanwords. Both these discrepancies were ignored for the purposes of this paper.

(d) Bounded leftward spread, unbounded rightward spread.

3. Previous Analyses: Davis (1995) and McCarthy (1997)

Using a Grounded Phonology approach (Archangeli and Pulleyblank 1993), Davis (1995) provides a solution to the asymmetry that assumes different target conditions on different directions of spread. Southern Palestinian right-to-left spreading, for example, imposes no conditions on targets, but left-to-right spreading requires the targets of spread to be non-high and non-front segments. Note that, in principle, these stipulations could just as easily be placed in reverse, yielding a grammar in which leftward spreading is blocked while rightward spreading is not. The fact that no such grammar is attested calls for an alternative approach, which was provided by McCarthy (1997).

McCarthy (1997) presents an Optimality Theoretic account of the asymmetry. He proposes a set of 8 constraints, listed in (5), and accounts for the behavior of Emphasis Spread in the Palestinian dialects discussed in 2.1 by imposing a distinct constraint hierarchy on each dialect (see (6).) (The markedness constraints *RTR/Hi, *RTR/HiFR, and RTR-Lower-VT are motivated phonetically since the retraction of the tongue root is antagonistic with the advancement/raising of the tongue blade during the production of high segments, front segments, and [-low] segments.)

(5) The constraints proposed by McCarthy (1997).

ALIGN(RTR, Left, Word, Left): Any instance of [+RTR] is aligned initially in Word.

ALIGN(RTR, Right, Word, Right): Any instance of [+RTR] is aligned finally in Word.

ALIGN(RTR, Right, *a*, Right): Any instance of [+RTR] is aligned finally with /a/.

*RTR/Hi: if [+RTR] then [-high].

*RTR/HiFr: if [+RTR] then [-high, +back]

RTR-Lower-VT: if [+RTR] then Lower Vocal Tract

IDENT(+RTR): [+RTR] segments in input must remain [+RTR] in output.

IDENT(-RTR): [-RTR] segments in input must remain [-RTR] in output.

(6) a. The constraint interaction for Southern Palestinian

	/t̪ˤaːzaˤ/	ALIGN (RTR, L)	*RTR/hi	ALIGN (RTR, R)	ALIGN (RTR, *a*)	RTR-Lower-VT
☞	[t̪ˤaˤːzˤaˤ]					**
	[t̪ˤaːzaˤ]			*!		*

b. The constraint interaction for Northern Palestinian

	/tˤaːza/	ALIGN (RTR, L)	*RTR/hi	ALIGN (RTR, *a*)	RTR-Lower-VT	ALIGN (RTR, R)
☞	[tˤaːza]				*	*
	[tˤaˤːzˤaˤ]				*!*	

While the solution successfully describes the patterns in these two dialects, it still fails to capture the generalization in (4). It is possible to arrange the constraints such that rightward Emphasis Spread proceeds unrestricted and at the same time place restrictions on leftward spread, thereby contradicting the attested pattern and negating Watson's generalization. One such hierarchy is shown in (6): aligning [+RTR] word-finally is more important to satisfy than restricting [+RTR] segments to non-high, non-front, and low segments. But since ALIGN(RTR, Left) is ranked lowest, leftward spreading of [+RTR] cannot override these markedness conditions.

(6) a. Contradictory ranking to Watson's generalization:
{ALIGN(RTR, Right)} >> {*RTR/Hi} >> {ALIGN(RTR, Left)}

b. Sample tableau for ranking in (a) (nonsensical word.)

	/bitˤi/	ALIGN (RTR, R)	*RTR/hi	RTR-Lower-VT	ALIGN (RTR, L)
☞	[bitˤiˤ]		*	*	**
	[bˤiˤtˤiˤ]		*!*	*	
	[bˤiˤtˤi]	*!	**	*	
	[bitˤi]	*!		*	**

The conclusion, then, is that McCarthy's proposal cannot account for attested asymmetry of Emphasis Spread unless it is accompanied by a strict ordering statement, one in which ALIGN(RTR, Left) necessarily dominates ALIGN(RTR, Right). Sections 4 and 5 seek to motivate this ordering relationship from a phonetic point of view.

4. A Failed Perceptual Account of the Asymmetry

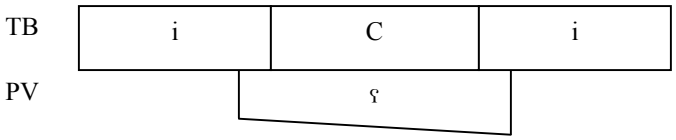
A series of sound recognition experiments were designed to test the intuition of native speakers of Arabic. In one experiment, four subjects were asked to recognize the fricative (whether emphatic or non-emphatic) in 3 audio files: the first containing repetitions of the plain fricatives, the second containing CV syllables, some of which were shuffled so that the emphatic fricative preceded a non-emphatic vowel and the non-emphatic fricative preceded an emphatic

vowel, and the third containing VC syllables, with some being shuffled in the same way as in the second file. Given that Emphasis Spread is favored regressively rather than progressively, it was predicted that the subjects have more difficulty distinguishing between the fricatives in VC syllables than in CV syllables. This would explain why the [+RTR] feature spreads farther leftward than rightward, given the perceptual confusion that would arise otherwise. (These predictions are based on Steriade (2001).) The experiment, however, provided no evidence for this: the subjects relied on the quality of the following vowel just as often as they did on the quality of the preceding vowel in order to determine the [RTR] value of the consonant. The preference for direction, therefore, could not explained on perceptual grounds, but it will be shown in the next section that the asymmetry can be explained on articulatory grounds.

5. An Articulatory Account

Emphasis is acoustically characterized by a lowering of the second formant frequency (F2) (Hoberman 1995, Yeou 1997, Shahin 2002). This was verified in the series of audio recordings used for the perceptual experiment described in Section 4: the F2 for the non-emphatic alveolar fricatives averaged at roughly 2000 Hz, and at roughly 1500 Hz for emphatic alveolar fricatives. It is furthermore claimed by Ladefoged and Maddieson (1996) that pharyngealization is most prominent articulatorily during the onset stage of the pharyngealized consonant. Considering the co-articulatory nature of emphatic consonants, then, the primary articulatory gesture (the position of the tongue in relation to the alveolar ridge) may be treated as an independent gesture from the secondary narrowing of the pharynx. This view was used by Gafos (1999) in his account of locality in assimilation. In Gafos's analysis, each active articulator is represented with a rectangle stretched temporally: the configuration of each articulator (e.g. articulator orientation, constriction area, etc.) is indicated at the proper time during the articulation. Following this format, it is possible to represent Emphasis using the tongue as one articulator and the pharynx as another, as shown in (7): Emphasis is marked by a decrease in pharyngeal volume (PV.) Note that PV increases in the later stages of the consonant, resulting in a decrease in the degree of emphasis.

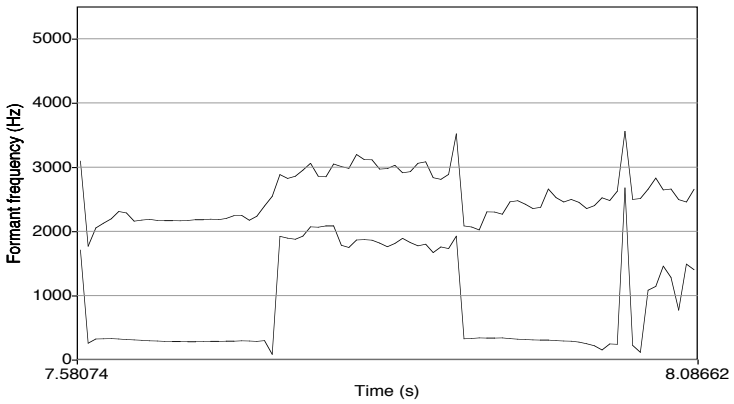
(7) An articulatory representation of Emphasis: [iC$^{\varsigma}$i]; pharynx constriction is more prominent at the onset stage of the emphatic consonant. (PV: Pharyngeal volume; TB: tongue body.)



If pharyngealization is indeed prominent at the early stages of articulation, and if F2 lowering is an acoustic characteristic of emphasis, then it is expected that, in a VC$^{\varsigma}$V cluster, the F2 of the vowel preceding the emphatic consonant be lower than that of the vowel that follows it, since the acoustic

mark of pharyngealization (the lowering of F2) will coincide with the constriction of the pharynx. Through acoustic measurements, this was found to be the case. The formant plot in (8) is one of a series of recorded [isˤi] clusters that were found to support this conclusion: within the 500 milliseconds that preceded the consonant (VC,) F2 peaked at 2272 Hz; within the 500 milliseconds that followed (CV,) F2 peaked at 2517 Hz.

(8) A formant plot of [isˤi]: the formant "plateau" in the middle corresponds to the fricative [s]. Preceding values of F2 are lower than those of the following vowel.



6. Revising McCarthy's Constraints

The constraints proposed by McCarthy were initially fed into OTSoft (Hayes et al. 2003), and the generated typology contained 123 possible outputs. As discussed above, the asymmetry was not predicted and several unattested grammars that favor rightward spreading (including the one outlined in Section 3) were produced in the typology, contrary to the predictions of Watson (1999). However, with the phonetic findings of Section 5, there is strong motivation for imposing an a priori ordering relation (which may now be considered an a posteriori relation) of the form ALIGN(RTR, Left) >> ALIGN(RTR, Right). This restriction reduces the number of outputs to 76.

Of the 76 outputs, none exhibited unbounded rightward spread and bounded leftward spread. Indeed, in every output in which leftward spread was restricted, the same restrictions (at least) applied to rightward spread as well. The typology was sufficiently descriptive, in that it predicted each of the types of Emphasis Spread attested in the languages that were surveyed in Section 2. Unbounded bidirectional spread, attested in Cairene, the Arabic and Aramaic of Kurdistan, and the Aramaic of Azerbaijani Jews, corresponded to an output in which the ranking is {IDENT(+RTR), ALIGN(RTR, Left)} >> {ALIGN(RTR, Right)} >> {*RTR/Hi, *RTR/HiFr, ALIGN(RTR, *a*), RTR-Lower-VT, IDENT(-RTR)}. Northern Palestinian Arabic corresponded to {IDENT(+RTR), ALIGN(RTR, L)} >> {*RTR/Hi, *RTR/HiFr, RTR-Lower-VT } >> {

ALIGN(RTR, *a*), ALIGN(RTR, R)} >> IDENT(-RTR), and Southern Palestinian Arabic to the ranking {IDENT(+RTR), ALIGN(RTR, L)} >> *RTR/HiFr >> ALIGN(RTR, R) >> {*RTR/Hi, RTR-Lower-VT, ALIGN(RTR *a*), IDENT(-RTR)}. Sanaani Arabic, based on the limited data from Watson, corresponded to {IDENT(+RTR), ALIGN(RTR, L)} >> {*RTR/Hi, *RTR/HiFr, RTR-Lower-VT, IDENT(-RTR)} >> {ALIGN(RTR *a*), IDENT(-RTR)}.

This leaves 72 unattested outputs. It may seem that the system of constraints (with the imposed ordering statement) overgenerates, but note that the set of surveyed languages and dialects is by no means exhaustive of the various dialects of Arabic, Aramaic, and other Semitic languages (either living or extinct.) Arabic is spoken by nearly 270 million people, in a region that contains 22 countries. Much work is needed to document the different patterns of Emphasis Spread before the predictive power of the constructed typology can be evaluated. The system predicts, for example, the existence of 23 dialects (outputs 1-23) in which de-pharyngealization is an active process. While no documented dialects exhibit this process, one dialect of Jordanian, spoken by the upper class of Amman and familiar to the author from personal experience, does employ de-pharyngealization. In this dialect, faith to [+RTR] is ranked relatively low, resulting in forms in which underlying emphatic consonants lose their [+RTR] feature in the surface output. Only time and volumes of fieldwork will tell if 23 different ways of attaining this output really do exist.

7. Conclusion and Further Research

It was shown that Emphasis spreads more freely from right to left than from left to right. The asymmetry was attributed to the articulatory nature of emphatic consonants, and a factorial typology was built on a necessary ranking in which leftward spread dominated rightward spread. At this point it is noteworthy that, with these conclusions, an Optimality Theoretic approach does not seem advantageous when compared to the Grounded Phonology approach proposed by Davis (1995). The restriction on constraint ranking was added to the hierarchy only because of the phonetic information available on the phenomenon. It was not *in consequence* of Optimality Theory (as McCarthy claims) that the asymmetry arose; rather, the asymmetry resulted from a stipulation that was added because of the phonetic findings and because of the attested patterns. A Grounded Phonology approach could impose the same restrictions and arrive at the same predictions if these phonetic results are invoked.

It does seem, however, that Emphasis Spread cannot be explained or accounted for using Locality conditions in Feature Geometry. This comes as no surprise, since one cannot posit certain locality conditions on the feature [+RTR] in one direction and posit different locality conditions on it in the other direction, let alone provide a consistent framework in which [+RTR] (if on a separate tier) falls in a larger domain of locality leftward than it does rightward. Nor does a suprasegmental/autosegmental account, as proposed by Harrell (1957), Lehn (1963), Sasse (1971), and Card (1983) (referred to in Hoberman 1989), seem advantageous, for two reasons. First, in each of the presented examples, emphasis spreads contiguously without skipping over opaque

segments; when a segment is opaque to [+RTR], it stands as a barrier to further spreading. Second, an autosegmental account assumes the existence of a [+RTR] feature that may or may not be underlyingly associated with segments in the phonological word. It is true that some Arabic words, though very few, are emphatic despite containing no emphatic consonants in their underlying representation, but if a [+RTR] autosegment is posited, what explanation could there be for associating it underlyingly with the appropriate alveolar segment? If further research does show that modern Arabic did historically lose the underlying [+RTR] contrast, then an autosegmental analysis may be applicable.

Finally, it may be interesting to further pursue the motivation for Emphasis Spread (and its asymmetry) from a perceptual perspective. The experiments conducted for this paper were brief and the subjects that participated in them were few. With more sophisticated, larger-scale recognition and discrimination tests, however, a pattern of preference may emerge and explain the development of this directional asymmetry. Results could further be contrasted with the patterns of spread in other Semitic languages, in which emphatics are velarized, uvularized, or glottalized. The articulatory difference between these segments and their pharyngealized correspondents may shed light on the history of the process: if the patterns contradict the articulatory expectations, then it may be the case that spread was active in the proto-language, and was inherited into the grammars of the descendant languages. If spread behaves differently depending on the articulatory/perceptual properties of pharyngeals, velars, etc. then it may be more plausible to assume that the process grew somewhat more independently of the grammar of the proto-language. This, unfortunately, is well beyond the scope of this paper.

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