LONG-DISTANCE VOICING ASSIMILATION IN BERBER: SPREADING AND/OR AGREEMENT?*

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1. Locality, "visibility", and the spreading *vs.* agreement distinction

The question of *locality* has long been a topic of interest and controversy in phonology (see, e.g. Steriade 1986, 1987, Odden 1994, Gafos 1999, Vaux 1999, Hansson 2001, Ní Chiosáin & Padgett 2001, Rose & Walker 2004, Nevins 2005). Simplistic locality principles are challenged by the seemingly non-local interactions evidenced by many harmony systems. The trigger and target may be separated by a number of intervening segments, and are often located several syllables apart, as in Finnish vowel harmony (Kiparsky & Pajusalu 2003) or Ineseño Chumash consonant harmony (Applegate 1972), illustrated in (1) and (2), respectively; trigger and target segments are shown in boldface.

(1) a. /**u**i-ske-nte-le-mi-se-ni-k**O**/ → [**u**iskentelemisenik**o**]
'my swimming around?'
b. /s**yø**-ske-nte-le-mi-se-ni-k**O**/ → [s**yø**skentelemisenik**ø**]
'my constant eating?'

(2) a. /ha-**s**-xintila/ → [ha**s**xintila] 'his Indian name'
b. /ha-**s**-xintila-wa**ʃ**/ → [ha**ʃ**xintilawa**ʃ**] 'his former Indian name'

A common assumption, motivated in part on formal, theory-internal grounds and partly based on a restrictive view of the phonology-phonetics interface, is that all feature spreading is *strictly local* (Ní Chiosáin & Padgett 2001). According to the Strict Locality hypothesis, given three segments α, β and γ, where $\alpha \prec \beta \prec \gamma$ in the output string, α and γ can share a featural element [F] if and only if [F] is also shared with β. In other words, [F] can never spread from α to γ (nor from γ to α) without also becoming associated with β. In short: feature spreading—manifested phonetically as the temporal extension of an articulatory gesture (Gafos 1999)—never "skips" segments.

In recent work, long-distance consonant assimilations like that in (2) have been argued to involve not spreading but a different mechanism: *agreement* in feature values between potentially non-adjacent segments (Walker 2000, Hansson 2001, 2010, Rose & Walker 2004, McCarthy 2007; cf. also Mailhot & Reiss 2007). Such long-distance interactions do not violate Strict Locality, as the two interacting (and non-adjacent) segments do not share a single token of a feature/gesture. The spreading (feature-sharing) *vs.* agreement (value-matching) distinction is illustrated schematically in (3), where the [F] value of S_2 is "transmitted" to the preceding S_1, across one or more intervening segments $S_i \ldots S_n$; cf. /s…ʃ/ → [ʃ… ʃ] in (2) above.

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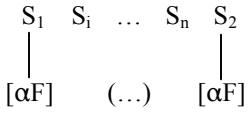
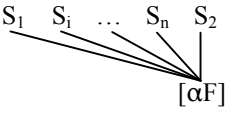
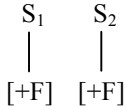
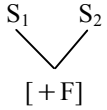
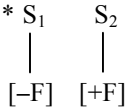
(3) a. 

b. 

Segmental opacity effects, whereby a certain type of intervening segment has the effect of blocking an otherwise regular long-distance assimilation process, have generally been taken to be a diagnostic of spreading as opposed to agreement. However, the relationship between agreement and spreading is not so straightforward, as the two are not incompatible in principle. A spreading ([F]-sharing) output configuration can serve as the *means* to satisfy a demand for agreement, in the form of a constraint like AGREE[F] or *[–F][+F] (Pulleyblank 2003, Hansson 2007b). Thus the two alternative configurations in (4a) and (4b) equally satisfy such an agreement constraint, whereas (4c) violates it.

(4) a. 

b. 

c. 

The tenet of Strict Locality is not universally accepted, and advocates of a *relativized* notion of locality have instead continued to seek principled ways of constraining the transparency or invisibility (in effect, "skipping") of intervening segments, based on factors such as contrastivity and/or markedness relations. For example, Vaux (1999) and Nevins (2005) propose (following Calabrese 1995), that individual phonological rules are parametrized in this respect, with (5a–c) being the three possible parameter settings:

(5) a. Contrastive values visible
Spreading of [αF] can pass through any and all segments that are *redundantly* (predictably) specified as [+F] or [–F].

b. Marked values visible
Spreading of [αF] can pass through any and all segments that carry the *unmarked* value for [±F] (e.g. [–voice] in obstruents, [+high] in vowels).

c. All values visible
Spreading of [αF] *cannot* pass through any segment that is [+F] or [–F]. (This presumably still allows for "inherent underspecification", e.g. lack of supralaryngeal features in /ʔ, h/)

While the framework in (5) is quite flexible in comparison to most underspecification-based approaches, and is therefore, as a hypothesis, rather more difficult to falsify, it does make one concrete and testable prediction. Any intervening segment that *contrastively* carries the *marked* value for [±F] can never be transparent/invisible to any process that spreads [+F] (and/or [–F]).

In what follows, I will illustrate a pattern of long-distance sibilant voicing assimilation that is attested in various Berber languages and which exhibits

variation with respect to which intervening segments are opaque and which transparent. We will see how the Berber facts are deeply problematic for the notion that "visibility" of intervening segments depends on contrastivity and/or universal markedness relations, as well as for the assumption that long-distance consonant agreement always involves value-matching (3a) rather than feature spreading (3b). I outline a formal, constraint-based analysis in which the observed patterns and typological variation derive from differences in constraint ranking. The core idea is that the long-distance sibilant voicing assimilation in Berber is a hybrid system, in which a demand for featural agreement is being met by means of feature spreading. Finally, I briefly explore the implications and predictions of such an "agreement-by-spreading" analysis, and point out another plausible case (Kinyarwanda sibilant harmony; Walker et al. 2008)

2. Long-distance sibilant voicing assimilation in Berber languages

The Berber languages, spoken throughout much of NW Africa (Morocco, Niger, Mali, Algeria, Tunisia, etc.), constitute one of the branches of the Afro-Asiatic language family. Many Berber languages display a voicing alternation in sibilants, most typically manifested in the causative /s-/ prefix, conditioned by the presence *vs.* absence of a voiced sibilant (/z, zˤ, ʒ, ʒˤ/) in the following verb root.[1] Thus, for example, the causative counterpart of Tamajaq Tuareg [əbzəg] 'be mad, panic' is [z-əbzəg] 'drive mad' (with /s…z/ → [z…z]). Similarly, voiced and voiceless sibilants do not co-occur within root morphemes.

This voicing assimilation coexists with another long-distance process involving sibilants, [±anterior] harmony: /s…ʃ/ → [ʃ…ʃ], /s…ʒ/ → [ʒ…ʒ]. As a result, the outcome is typically (though not always; see §2.2) complete identity in the output form between the target /s-/ and the triggering root sibilant.

2.1 Tuareg (Southern Berber) branch: all non-sibilants transparent

In the Tuareg or Southern Berber branch, the long-distance voicing assimilation described above is relatively unrestricted, in that it is enforced across any and all non-sibilant segments. The examples in (6) are drawn from the Tamajaq (Tayert and Tawellemmett) dialects of Niger that are covered in Alojaly (1980). The underlying form of the prefix /s-/ is evident from those cases in (6a) where no sibilant follows, while (6b–d) show [±voice] and [±anterior] assimilation.

(6) Tamajaq Tuareg of Niger: harmony without blocking (Alojaly 1980)

a.	əlməd	'learn, study'	s-əlməd	'teach, inform'
	əʁdər	'betray'	s-əʁdər	'cause to betray'
	əχrək	'err, be lost'	s-əχrək	'mislead'
	busu	'be injured'	s-əbːusu	'injure'
	əwəsˤ	'boil (intr.)'	s-əwəsˤ	'boil (tr.)'
	qusət	'inherit'	s-əqːusət	'cause to inherit'

[1] Much is unclear regarding the historical origins and time depth of this phenomenon within the Berber subgroup. It seems unproductive or variable in some varieties, though this may well be due to (later) levelling and lexicalization.

b.	əkləzˤ	‘invent’	z-əkləzˤ	‘cause to invent’
	əntəz	‘pull out, extract’	z-əntəz	‘cause to extract’
	əlfəzˤ	‘squash, flatten’	z-əlfəzˤ	‘cause to squash’
	əbzəg	‘be mad, panic’	z-əbzəg	‘drive mad’
	guləz	‘be left, remain’	z-əgːuləz	‘cause to remain’
c.	măʃăn	‘be overwhelmed’	ʃ-əmːəʃən	‘overwhelm’
	ătʃu	‘eat’	ʃ-ătʃu	‘feed’
	fərəʃːət	‘be ugly, humiliated’	ʃ-əfːərəʃːət	‘make ugly, humiliate’
	əʁʃəd	‘destroy, spoil’	ʃ-əʁʃəd	‘cause to spoil’
d.	kuʒət	‘saw (v.)’	ʒ-əkːuʒət	‘cause to saw’
	fănʒăr	‘have a torn nose/ear’	ʒ-əfːənʒər	‘tear one’s nose/ear’
	əgʒəʒ	‘crave, insist’	ʒ-əgʒəʒ	‘cause to crave’
	ăʁʒu	‘be amazed’	ʒ-ăʁʒu	‘amaze’

The same is true for the Tamajaq (Tudalt, or Western Tawellemmett) and Tamashek (Tadraq) dialects that are spoken in the northeastern part of Burkina Faso (Sudlow 2001), and for the Tamashek (Taneslemt) dialects of Mali (Heath 2005), as illustrated in (7)–(8). (In the examples in (8), “V” = full vowel, “Ŭ” = short vowel; see Heath 2005 for details on surface vowel qualities in Tamashek.)

(7) Tamajaq/Tamashek Tuareg of NE Burkina Faso (Sudlow 2001)

a.	s-əlməd	‘teach’	c.	z-uzăr	‘winnow’
	s-əbdəd	‘make stand up’		z-əgzəl	‘shorten’
	s-əkwəl	‘make black’		z-əkməz	‘scratch (itch)’
b.	ʃ-ăʁʃəd	‘spoil, discourage’	d.	ʒ-əʒwəl	‘brand, mark’
	ʃ-əʃləj	‘miss (target)’		ʒ-əkːəmbəʒ	‘put on headscarf’
	ʃ-ugəʃ	‘put inside’		ʒ-iʒəl	‘draw (water)’

(8) Tamashek Tuareg of Mali (Heath 2005)

a.	-s-VdufŬ-	‘make plump’	c.	-z-VgzVl-	‘shorten’
	-s-VskVr-	‘hold upright’		-z-VjVzːŬ-	‘scrutinize’
b.	-ʃ-VluʃŬ-	‘clean sand from’	d.	-ʒ-VʒVlwVʁ-	‘glare at’
	-ʃ-VlVjtVʃ-	‘shake off’			

It is important to note that the distinction between [+voice] and [–voice] obstruents is phonemic in these languages, such that /k/ contrasts with /g/, /t/ with /d/, /χ/ with /ʁ/, and so forth. Despite this, voiced and voiceless obstruents alike are fully transparent to the long-distance [+voice] assimilation between sibilants, as seen in the examples in (9)–(10), culled from (6) above. In each case, the relevant intervening segment is shown in boldface.

(9) Tamajaq Tuareg: interaction across (contrastively) [+voice] obstruent

/s-əbzəg/	z-ə**b**zəg	‘drive mad, cause to panic’
/s-əgːuləz/	z-ə**g**ːuləz	‘cause to remain’
/s-əgʒəʒ/	ʒ-ə**g**ʒəʒ	‘cause to crave’
/s-ăʁʒu/	ʒ-ă**ʁ**ʒu	‘amaze’

(10) Tamajaq Tuareg: interaction across (contrastively) [–voice] obstruent

/s-əkləzˤ/	z-ə**k**ləzˤ	‘cause to invent’
/s-əntəz/	z-ən**t**əz	‘cause to extract’
/s-əlfəzˤ/	z-əl**f**əzˤ	‘cause to squash’
/s-əkːuʒət/	ʒ-ə**k**ːuʒət	‘cause to saw’
/s-əfːənʒər/	ʒ-ə**f**ːənʒər	‘tear one’s nose/ear’

2.2. Imdlawn Tashlhiyt: voiceless obstruents opaque, voiced transparent

As described by Elmedlaoui (1995), the Imdlawn dialect of Tashlhiyt (spoken in Morocco) shows the same long-distance sibilant assimilation in [±voice] (and in [±anterior]), but here the process is blocked by certain intervening consonants. As illustrated in (11a–b), voiceless (non-sibilant) obstruents are *opaque*, preventing [+voice] from being propagated across them, from a root sibilant to the prefix /s(ː)-/. Note that when [±voice] assimilation is blocked, [±anterior] assimilation is still enforced as usual; see (11b). By contrast, all voiced consonants, even obstruents, are *transparent* to the transmission of [+voice] (11c).

(11) Imdlawn Tashlhiyt: voicing harmony with blocking (Elmedlaoui 1995)

a.	ħuz	s-**ħ**uz	‘annex’
	ukz	sː-u**k**z	‘recognize’
	rˤuˤfˤːzˤ	sˤ-rˤuˤ**f**ˤzˤ	‘appear resistant, recalcitrant’
	rkz	sː-r**k**z	‘dance’
	m-χazaj	s-m-**χ**azaj	‘loathe each other’
b.	fʒːiʒ	ʃ-**f**ʒːiʒ	‘go for a walk (for pleasure)’
	qːuʒːi	ʃ-**q**uʒːi	‘be dislocated, broken’
	nːuqːʒ	ʃ-nu**q**ːʒ	[no gloss]
	mˤ-ħˤaˤrˤaˤʒˤ	ʃˤ-mˤ-**ħ**ˤaˤrˤaˤʒˤ	‘get angry with each other’
c.	bruzːa	z-**b**ruzːa	‘crumble’
	gʷˤrˤaˤzˤ	zˤː-**g**ʷˤrˤaˤz	‘regret’
	gˤrˤuˤʒˤːmˤ	ʒˤ-**g**ˤrˤuˤʒˤːmˤ	‘be extinguished (in cooking)’

A similar pattern (though not in all respects) is observed in the Agadir dialect (Lahrouchi 2003), where blocking by an intervening [–voice] obstruent is seen in examples like [ʃ-**f**ərːəʒ] or [ʃ-**f**əʒːiʒ], causatives of [fərːəʒ] ‘amuse, entertain’ and [fəʒːiʒ] ‘be good’, respectively (cf. [ʒː-ənʒəm] from [nʒəm] ‘save’).

At this point, a word of caution is in order. At first glance, it would seem possible that cases like Agadir [ʃ-fərːəʒ] or Imdlawn [s-ħuz] are not due to

voiceless obstruents being opaque, strictly speaking, but rather by the sibilant voicing harmony being overridden, or masked, by a local (regressive) [–voice] assimilation in obstruent clusters. Stated in traditional rule-ordering terms, the derivation would be /s-fərːəʒ/ → [ʒ-fərːəʒ] → [ʃ-fərːəʒ], with local assimilation to [f] undoing the effects of the long-distance voicing assimilation to [ʒ].[2] Put differently, the constraint demanding sibilant voicing agreement would be outranked by a constraint that penalizes mixed-voicing obstruent clusters, as well as by a positional faithfulness constraint preventing the voicing of [f] (*[ʒ-vərːəʒ]).

What lends some *prima facie* support to this alternative interpretation is the fact that such regressive [–voice] assimilation in obstruent clusters is independently attested for some Tashlhiyt dialects, including Imdlawn, as can be seen from examples like /t-alqːaʁ-t/ → [talqːaχt] 'lamb (fem.)', /t-amdːuz-t/ → [tamdːust] 'garbage bin (fem.)'. Moreover, such local assimilation is indeed known to give rise to exceptions to the long-distance sibilant voicing harmony, rendering it non-surface-apparent. This is evident from examples like Imdlawn Tashlhiyt /t-a-s-ag^{w}z-t/ → [tazak^{w}st] 'place of descent (fem.)' or /sː-uzf/ → [zːusf] (caus. of [azuf] 'be uncovered'); in both cases an underlyingly voiced root sibilant (/z/) triggers voicing in a prefixal /s/, despite itself surfacing as voiceless due to local assimilation to a following voiceless obstruent.

Though there is quite possibly some *historical* connection between this local devoicing and the blocking effects observed in (11a–b), it does not suffice as a synchronic explanation. This is because the opaque (blocking) obstruent need not be adjacent to the target (prefix) sibilant. Some relevant examples from (11a–b) are repeated in (12) to emphasize this point. In (12a) a voiced sonorant intervenes between the opaque [–voice] consonant and the target sibilant of the prefix, whereas in (12b) the two are separated by a vowel.

(12) Imdlawn Tashlhiyt: opaque obstruent not adjacent to target sibilant

a.	rkz	sː-rkz	'dance'
	m-χazaj	s-m-χazaj	'loathe each other'
	mˤ-ħˤaˤrˤaˤʒˤ	ʃˤ-mˤ-ħˤaˤrˤaˤʒˤ	'get angry with each other'
b.	ukz	sː-ukz	'recognize'
	rˤuˤfˤːzˤ	sˤ-rˤuˤfˤzˤ	'appear resistant, recalcitrant'
	nːuqːʒ	ʃ-nuqːʒ	[no gloss]

In sum, the failure of the /s-/ prefix to undergo long-distance voicing harmony in cases like (12) cannot be due to some (independent) local assimilation in [–voice] to the intervening obstruent (/k/, /χ/, /f/, …) that is overriding the long-distance sibilant-to-sibilant interaction.

2.3 Interim summary: implications of the Berber evidence

The patterns of long-distance sibilant voicing assimilation in Berber have significant theoretical implications in two respects.

[2] For simplicity, I display the effects of voicing and anteriority harmony in one and the same derivational step. This hould not be taken too literally.

Firstly, they pose a serious problem for the parametrized ("visibility"-based) Calabrese/Vaux/Nevins construal of locality relations, as summarized in (5) above. For obstruents, [+voice] is uncontroversially the inherently marked feature value. Since voicing is phonemic in Berber obstruents, it follows that segments like [b] or [ʁ] are contrastively specified as [+voice]. In both the Tuareg and Tashlhiyt varieties discussed above (in §2.1 and §2.2, respectively), long-distance assimilation between sibilants thus takes place across segments that are *contrastively* specified for the *marked* value of the feature in question, precisely the one state of affairs that is predicted to be impossible. Furthermore, in Imdlawn Tashlhiyt, only one of the contrastive feature values is opaque, while the other is transparent. However, it is the unmarked value ([–voice]) that is "visible" (= opaque), opposite to what is predicted.

We may ask ourselves whether it is a mere accident that (in Tashlhiyt) the transparent segments are precisely those which happen to carry the *same* feature value as that which is being transmitted from one sibilant to another (namely [+voice]), while the opaque segments are those which carry a *conflicting* feature value. Perhaps this situation could be thought of as, in a sense, "sympathetic" transparency, entirely unrelated to the factors of contrastivity or markedness. In order to reach from one sibilant to another, the [+voice] property can be transmitted through any and all [+voice] segments, but not ones that are [–voice].

The second challenge posed by the Berber facts pertains to (Imdlawn) Tashlhiyt in particular (§2.2). Berber sibilant voicing harmony in general, and the Tuareg patterns in (6)–(10) in particular, can be analyzed as featural *agreement* in pairs of highly-similar consonants (Walker 2000, Hansson 2001, 2010, Rose & Walker 2004, McCarthy 2007). Pairs of co-occurring sibilant fricatives are singled out due to their high degree of similarity. These enter into a privileged (formal) relation of correspondence, and agreement (identity) in [±voice] specifications is enforced over that relation. However, segments that intervene between the two sibilants are not participants in the correspondence relation, and should therefore not be able to interfere with it. For this reason, the Imdlawn Tashlhiyt pattern in (11)–(12) is highly problematic. As noted in §1 above, segmental opacity (blocking) effects are generally taken to be a clear diagnostic of *spreading*, not of featural *agreement* between non-adjacent segments (Walker & Mpiranya 2005; cf. Hansson 2001, Rose & Walker 2004).[3]

However, as was pointed out earlier, the relationship between "spreading" and "agreement" is not one of mutual exclusivity. A spreading (feature-sharing) configuration in the output can serve perfectly well as the *means* for achieving the *goal* of ensuring agreement (identical feature values) between two segments. The next section outlines a formal analysis of long-distance sibilant voicing assimilation in Berber that exploits this means *vs.* end distinction. In the analysis, the impetus for long-distance assimilation is due to constraints that require agreement in [±F] values between co-occurring consonants that are highly similar. As a side effect of the language-specific ranking of constraints, (strictly-

[3] As a caveat, it has been shown that this need not always hold true, in that intervening segments are potentially able to participate "covertly" in the correspondence relation (Hansson 2007a, Rhodes 2008, Walker 2009), in which case they may cause blocking effects. However, the specific circumstances that are required in order for such effects to arise do not hold in the Berber case.

local) feature spreading can emerge as the sole available means of implementing such long-distance agreement. In other words, [αF] can only be transmitted from the agreement trigger to the agreement target by spreading through all intervening segments as well. Consequently, if one of these intervening segments happens to be incompatible with the spreading [αF] property (e.g., due to being [–αF]), the long-distance agreement will fail to be achieved, resulting in a segmental opacity effect.

3. Non-local agreement through local spreading: a formal analysis

The analysis of long-distance consonant agreement as correspondence (Walker 2000, Hansson 2001, 2010, Rose & Walker 2004, McCarthy 2007) has two main ingredients: constraints that impose a correspondence relation between certain pairs of (output) segments, such as (13); and constraints that enforce featural identity over such pairwise relations, such as (14)–(15).[4]

(13) CORR-S↔S
For any pair of co-occurring consonants $C_1 \ldots C_2$ in the output, if C_1 and C_2 are both [+consonantal, –sonorant, +continuant, coronal, +strident], then a correspondence relation must be present between C_1 and C_2; that is, $C_1 \Re C_2$. *(This is indicated in output candidates as coindexing: $C_i \ldots C_i$.)*

(14) IDENT[voice]-CC
For any pair of output consonants C_1 and C_2 that are linked by a correspondence relation, if C_1 is [αvoice] then C_2 must also be [αvoice].

(15) IDENT[anterior]-CC
For any pair of output consonants C_1 and C_2 that are linked by a correspondence relation, if C_1 is [αanterior] then C_2 must also be [αanterior].

The output well-formedness constraints in (13)–(15) are of course in potential conflict with input-output faithfulness constraints on featural specifications. The ones that are most relevant for our purposes are defined in (16)–(18). The definition for IDENT[anterior]-IO is identical to (16), *mutatis mutandis*.

(16) IDENT[voice]-IO
For any pair of an input consonant C_1 and output consonant C_2, such that C_2 is a correspondent of C_1, if C_1 is [αvoice] then C_2 must be [αvoice].

(17) $\text{IDENT[voice]}_{\text{ROOT}}$-IO
For any pair of an input consonant C_1 and output consonant C_2, such that C_1 belongs to the (morphological) root and C_2 is a correspondent of C_1, if C_1 is [αvoice] then C_2 must also be [αvoice].

[4] For expository purposes, the correspondence-based analysis of consonant agreement is presented here in somewhat simplified form; in particular, it glosses over the important role of relative similarity in conditioning C-to-C correspondence. More thorough expositions can be found in Rose & Walker (2004) or Hansson (2007a).

(18) DEP[voice]-IO
Any [+voice] element (autosegment) in the output representation must have a corresponding [+voice] element in the input representation.

Note that, other things being equal—that is, as long as no violation of a higher-ranked constraint is at stake—agreement will be satisfied by means of *spreading* of the [αF] element that the trigger is carrying. This avoids violating the DEP[voice]-IO constraint in (18).

The violation profiles of each of the constraints are illustrated in (19). The IDENT[F]-IO constraints for [±anterior] and [±voice] specifications are included as well for reference. (The constraints in (17)–(18) are left out, as the candidates shown do not encode information about morphological affiliation or autosegmental association patterns.)

(19)

	/s … ʒ/	CORR -S↔S	ID[voi] -CC	ID[ant] -CC	ID[voi] -IO	ID[ant] -IO
	a. s … ʒ	*				
	b. s_i … $ʒ_i$		*	*		
	c. $ʃ_i$ … $ʒ_i$		*			*
	d. z_i … $ʒ_i$			*	*	
☞	e. $ʒ_i$ … $ʒ_i$				*	*

3.1 No blocking effects: Tuareg

In the Tuareg varieties, DEP[voice]-IO is ranked below the constraints that enforce correspondence and voicing agreement. The result can be seen in (20), where a (transparent) [+voice] obstruent intervenes between the two sibilants.

(20)

	/s-əgːuləz/	CORR -S↔S	ID[voi] -CC	DEP[voi] -IO	ID[voi] -IO
	a. s ə gː u l ə z [–v][+v] [+v]	*!			
	b. s_i ə gː u l ə z_i [–v][+v] [+v]		*!		
	c. z_i ə gː u l ə z_i [+v][+v] [+v]			*!	*
☞	d. z_i ə gː u l ə z_i [+v]				*

Note that for convenience and simplicity, [+voice] specifications are only shown on obstruents in output candidates in tableaux. This is true even when [+voice] spreads through vowels and sonorants as well, as in (20d) above.

When the root contains no voiced sibilant, as in (21), assimilation does not take place. Only voiced sibilants are triggers; non-sibilants like [d] are not.[5]

(21)

/s-əlməd/	CORR -S↔S	ID[voi] -CC	DEP[voi] -IO	ID[voi] -IO
☞ a. s ə l m ə d | | [–v] [+v]				
b. z ə l m ə d | | [+v] [+v]			*!	*
c. z ə l m ə d \ | [+v]				*!

When a [–voice] obstruent intervenes between trigger and target, the spreading option (22d; cf. 20d) would violate IDENT[voice]$_{ROOT}$-IO, as it would cause the obstruent in question to become voiced. Agreement can be achieved instead by feature insertion (22c), violating lower-ranked DEP[voice]-IO.

(22)

/s-əntəz/	CORR -S↔S	ID[voi] -CC	ID[voi]$_{RT}$ -IO	DEP[voi] -IO	ID[voi] -IO
a. s ə n t ə z | | | [–v] [–v][+v]	*!				
b. s_i ə n t ə z_i | | | [–v] [–v][+v]		*!			
☞ c. z_i ə n t ə z_i | | | [+v] [–v][+v]				*	*
d. z_i ə n d ə z_i \ / | [+v]			*!		**

3.2 Blocking by intervening [–voice] segments: (Imdlawn) Tashlhiyt

The blocking effects that are seen in Imdlawn Tashlhiyt can be understood if we take both IDENT[voice]$_{ROOT}$-IO and DEP[voice]-IO as outranking (and hence overriding) the constraint that is responsible for enforcing [voice] agreement, namely IDENT[voice]-CC. The crucial ranking difference between the Tuareg and Imdlawn Tashlhiyt systems is shown in (23) *vs.* (24).

[5] The tableau inputs shown for Berber forms are rather unrealistic as underlying representations, since they incorporate predictable aspects of the templatic (root-and-pattern) morphology, as well as patterns of [ə] epenthesis. These are irrelevant to the issues under consideration.

(23) Ranking for Tuareg (no blocking effects):

IDENT[voi]-CC >> IDENT[voi]$_{ROOT}$-IO >> DEP[voi]-IO, IDENT[voi]-IO

(24) Ranking for Imdlawn Tashlhiyt (blocking by [–voice] obstruent in root):

IDENT[voi]$_{ROOT}$-IO, DEP[voi]-IO >> **IDENT[voi]-CC** >> IDENT[voi]-IO

Tableaux (25) and (26) demonstrate how the ranking in (24) results in sibilant voicing agreement being blocked by intervening [–voice] obstruents but not by [+voice] obstruents. Spreading through a compatible (voiced) intervener is shown in (25). In (26), by contrast, an incompatible (voiceless) intervener prevents [+voice] spreading as an option, and high-ranked DEP[voice]-IO rules out the feature-insertion alternative (unlike in Tuareg; cf. (22c) above).

(25)

/s-bruːa/	CORR -S↔S	ID[voi]$_{RT}$ -IO	DEP[voi] -IO	ID[voi] -CC	ID[voi] -IO
a. s b r u zː a | \ | [–v][+v] [+v]	*!				
b. s$_i$ b r u zː$_i$ a | \ | [–v][+v] [+v]				*!	
c. z$_i$ b r u zː$_i$ a | \ | [+v][+v] [+v]			*!		*
☞ d. z$_i$ b r u zː$_i$ a \ | [+v]					*

(26)

/s-m-χazaj/	CORR -S↔S	ID[voi]$_{RT}$ -IO	DEP[voi] -IO	ID[voi] -CC	ID[voi] -IO
a. s m χ a z a j | | | [–v][–v][+v]	*!				
☞ b. s$_i$ m χ a z$_i$ a j | | | [–v] [–v][+v]				*	
c. z$_i$ m χ a z$_i$ a j | | | [+v] [–v][+v]			*!		*
d. z$_i$ m ʁ a z$_i$ a j \ | [+v]		*!			**

In theory, it could just as well be the case that it is CORR-S↔S that is ranked below DEP[voi]-IO in Imdlawn Tashlhiyt, rather than IDENT[voi]-CC.

However, forms with partial assimilation ([±anterior], but not [±voice]), such as /s-nuqːʒ/ → [ʃ-nuqːʒ] (no gloss), indicate that the output in situations like (26) is indeed (26b), with correspondence but no agreement, rather than (26a), with no correspondence (and therefore no motivation for agreement). The structure of the output must be [ʃ$_i$-nuqːʒ$_i$], with a correspondence relation between the two sibilants, since that relation is the vehicle by which the [–anterior] specification of the root sibilant gets transmitted to the prefix sibilant (by IDENT[ant]-CC). In other words, forms of this kind provide indirect evidence that CORR-S↔S >> IDENT[voi]-CC in the language. (In the interest of space, a full tableau for the derivation /s-nuqːʒ/ → [ʃ-nuqːʒ] is not provided here.)

4. Formal consequences

4.1 Distinct profiles of feature spreading

In the analysis above, spreading—that is, a feature-sharing configuration in the output representation—comes about as the means of achieving featural agreement between a designated trigger-target pair. Spreading of this type, which I will refer to as *agreement-driven spreading*, is predicted to pattern differently from the kind of (usually) unbounded spreading that occurs as a goal in itself (e.g. as encoded in constraint types like SPREAD[F]-L/R or ALIGN[F]-L/R).

First of all, agreement-driven spreading is expected to be *opportunistic*, in the sense that the feature [αF] will spread to neighbouring segments that do not qualify as agreement targets (e.g. vowels and non-sibilant consonants in the case of sibilant harmony) if and only if there is an agreement target (here: a sibilant) located on the other side of those segments. There will be no gratuitous spreading, directed blindly at some domain edge.

A second, related point is that agreement-driven spreading is predicted to be *economical*: the feature [αF] will only spread up to the agreement target, but no further. Since [αF] spreading is merely a method of achieving agreement in [±F] specifications between segments of the designated class, there is no independent motivation for continuing to spread [αF] further, say, all the way to the edge of the word.

Finally, a highly characteristic feature of normal, unbounded spreading processes is that they display *myopia* (Wilson 2003, 2006; see McCarthy 2004 for discussion). That is, when an opaque/blocking segment lies in the path of a spreading feature [αF], spreading will nevertheless proceed up to that segment—even though it is destined to fail in its goal of eliminating all [αF][– αF] (or [–αF][αF]) sequences from the output. For example, in Johore Malay /pəŋawasan/ → [pə**ŋãwã**san] ‘supervision’ the fricative /s/, being unnasalizable, stands in the way of the otherwise general rightward spreading of the [+nasal] feature originating in /ŋ/, but the intervening segments /…awa…/ nevertheless do undergo nasalization. The third prediction about agreement-driven spreading is exactly the opposite: it should be *non-myopic*. If an incompatible (opaque) segment intervenes between the agreement source and the agreement target, [αF] spreading will not take place at all—not even up to the blocking segment.[6]

[6] In other words, agreement-driven spreading is predicted to exhibit so-called “sour grapes” properties (McCarthy 2004).

For example, in a segment sequence /…s_1…x_2…x_3…s_4…/ (where "s" indicates the segment type that is subject to agreement and "x" indicates other segment types) if /x_2/ blocks (regressive) spreading of [αF] from /s_4/ to /s_1/, then [αF] will not spread to /x_3/ either. In other words, spreading either reaches all the way to its designated goal (the agreement target) or does not take place at all.

Unfortunately, these three predictions are untestable in the Berber case. This is because any and all segments that are compatible with the spreading feature [+voice]—that is, all non-opaque segments—are themselves inherently voiced, either contrastively (voiced obstruents) or redundantly (vowels, sonorants). It is thus impossible in practice to verify whether a given segment of this type is affected by spreading or not. It would be more informative to look at cases where certain types of non-participating segments are (articulatorily) compatible with the spreading feature/gesture, but do not otherwise inherently carry that property. An example of this might be retroflexion—or indeed any other coronal-specific gesture—in labial or dorsal consonants. The next section briefly considers a possible case in point.

4.2 A parallel: Kinyarwanda sibilant harmony

In Kinyarwanda sibilant harmony (Walker & Mpiranya 2005, Walker et al. 2008), retroflexion spreads regressively from one sibilant fricative to another, as shown in (27). Spreading to a sibilant in the immediately preceding syllable (27a) is obligatory, whereas spreading over greater distances is optional (27b, d). Intervening non-retroflex coronals are *opaque*, blocking the (optional) harmony (27c), whereas the retroflex [ʈ] is *transparent* (27d).

(27) Kinyarwanda sibilant retroflexion harmony (Walker & Mpiranya 2005)

a.	/-sá:z-i-e/	[-ʂá:ʐe]	'get old (perf.)'
b.	/-sákuz-i-e/	[-ʂákuʐe] ~ [-sákuʐe]	'shout (perf.)'
c.	/-sí:ta:z-i-e/	[-sí:ta:ʐe]	'make stub (perf.)'
d.	/-togoseʈez-i-e/	[-togoʂeʈeʐe] ~ [-togoseʈeʐe]	'make boil for (pf.)'

Kinematic articulatory data from Walker et al. (2008) confirm that the assimilatory interaction takes place by means of spreading (gestural extension), such that the tongue-tip retroflexion gesture permeates intervening non-coronals like the [k] in (27b).

I have argued elsewhere (Hansson 2007b), this is another strong candidate for an agreement-by-spreading analysis. In particular, some of Walker et al.'s reported findings would seem to fit the "opportunism" prediction in §4.1 above. Recall that retroflexion spreading into the immediately preceding syllable is obligatory. If leftward spreading of the [retroflex] feature/gesture were a goal in itself, then we would expect to find (acoustically covert) retroflexion on an intervening non-coronal in the immediately preceding syllable, such as [k] in (27b), regardless whether spreading continues onward (optionally) to the [s]/[ʂ] in the initial syllable. That is, retroflexion on the intervening segment should *not*

be contingent on whether harmony is enforced on the preceding target sibilant or not. What Walker et al. (2008) report is that, in doublet forms like [βaʂamaːzẓe] ~ [βasamaːzẓe] 'who are attractive, the intervening [m] shows retroflexion only in the former variant, where harmony is enforced on the preceding sibilant, but not in the latter variant. This is exactly as predicted, if spreading occurs solely as a means of achieving retroflexion agreement between sibilants.

5. Conclusions

As we have seen, the long-distance sibilant voicing assimilation that occurs in various Berber languages is highly problematic for parametrized theories of locality that are based on markedness and contrastivity, whereas it is straightforwardly handled as an instance of similarity-based featural agreement. This is equally true of the Tuareg (Southern Berber) pattern, in which there are no blocking effects, and the Imdlawn Tashlhiyt pattern, where the long-distance assimilation is selectively blocked by intervening [–voice] obstruents.[7]

A formal, constraint-based analysis of these sound patterns was outlined. A crucial element of the analysis, which is key to understanding the blocking effects in Imdlawn Tashlhiyt, is the recognition that feature *spreading* can emerge, given the right circumstances, as the optimal strategy for achieving featural *agreement* between a pair of non-adjacent segments of some designated class—in this case, sibilant fricatives. When the language-specific grammar (constraint ranking) defines spreading as the *only* available means to achieve such agreement, segmental opacity—blocking effects—can emerge.

Finally, feature spreading of this type (agreement-driven spreading) is predicted to have a diagnostic profile distinct from that of unbounded spreading systems in the traditional sense (e.g. nasal harmony, emphasis spreading). While these predictions cannot easily be tested in Berber, sibilant retroflexion harmony in Kinyarwanda may be another case of agreement-driven spreading. Recent articulatory data from Kinyarwanda (Walker et al. 2008) can be taken as suggestive that an analysis along these lines is on the right track.

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[7] Imdlawn Tashlhiyt (though not Tuareg) is presumably also problematic for Mailhot & Reiss' (2007) "search-and-copy" model of computing long-distance dependencies.

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