On the logic of conditional grounding

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1 Opacity

A language is said to exhibit vowel harmony if there is a tendency for all vowels in some domain (typically, the word) to agree with each other in terms of some feature(s). For instance, Tangale (Afro-Asiatic, W. Chadic; Kidda 1985) has stem-controlled [±atr] harmony, as shown in (1). (In all examples, the radical symbol '√' indicates the root morpheme; capital letters represent vowels whose underlying specification for the harmonic feature cannot be determined. Under-lining in underlying forms indicates the vowel instigating harmony, and in surface forms it indicates the propagation of the harmonic feature throughout the word.)

(1) Tangale [±atr] harmony

a. /√pɛ̲d + nO/	→	[pɛ̲dnɔ̲]	*[–atr] stem*
untie + 1SG		'farming'	
b. /√pe̲e̲r + nO/	→	[pe̲e̲rno̲]	*[+atr] stem*
compel + 1SG		'pounding'	

The tendency toward complete harmony within a word is often observed to be systematically counteracted by a natural class of vowels. In Tangale, for example, [+low] vowels are **harmonically unpaired**: they can only be [–atr] and thus fail to harmonize with [+atr] stem vowels, resulting in some disharmonic forms. (The harmonically unpaired [+low] vowel is *italicized*.)

(2) Tangale low vowel opacity

a. /√pɛ̲d + n*a*/	→	[pɛ̲dn*a*]	*[–atr] stem*
untie + ¬PRX.LOC		'untie (loc. diff. from spkr.)'	
b. /√pe̲e̲r + n*a*/	→	[pe̲e̲rn*a*]	*[+atr] stem*
compel + ¬PRX.LOC		'compel (loc. diff. from spkr.)'	

Such systematic disharmony often results in what is called **opacity**. In Tangale, the [+low] vowel is opaque in that it blocks the propagation of [+atr] from the stem. Vowels further from the stem than the [+low, –atr] opaque vowel surface as [–atr] in agreement with the opaque vowel.[1]

(3) Tangale low vowel opacity

a. /√pɛ̲d + n*a* + n + gO/	→	[pɛ̲dn*a*ngɔ̲]	*[–atr] stem*
untie + ¬PRX. LOC + 1SG + PERF		'untied me (loc. diff. from spkr.)'	
b. /√pe̲e̲r + n*a* + n + gO/	→	[pe̲e̲rn*a*ngɔ̲]	*[+atr] stem*
compel + ¬PRX.LOC + 1SG + PERF		'compelled me (loc. diff. from spkr.)'	

Another type of systematic disharmony (which I do not discuss here) is **transparency**, in which the propagation of the harmonic feature seems to pass through a harmonically unpaired vowel. I assume (uncontroversially following

Kiparsky 1981) that transparency and opacity have the same fundamental basis, namely the fact that they both crucially involve harmonically unpaired vowels.

Opacity could in principle be accounted for by modification of the harmony rule, from the general form in (4)a to the more specific form in (4)b.

(4) Opacity as a modification of the harmony rule
a. Original harmony rule: V → [αatr] / [αatr] __
b. Modified harmony rule: **[–low]** → [αatr] / [αatr] __

However, this would not explain the systematic absence of the relevant vowels from the inventory of the language, not just from the output of harmony — that is, the fact that harmony is *structure preserving* (Kiparsky 1981). Any account of opacity (and of systematically disharmonic vowels more generally) must involve a condition on the association of [+low] and [+atr] to which the vowel inventory of the language *and* the harmony rule are both subject. An example of such a condition, stated in a familiar negative form, is given in (5).

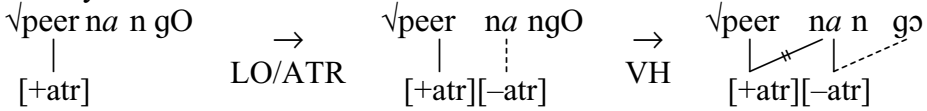
(5) Negative association condition
*[+low]
|
[+atr]

Archangeli & Pulleyblank (1994) foreground the phonetic naturalness (or, in their terms, "grounding") of such association (or "path") conditions and propose to state them in *implicational* (*if-then*) terms: "*if* [+low], *then* [–atr]."[2]

(6) Grounded path condition
LO/ATR: [+low] → [–atr]

This grounded path condition supplies [+low] vowels with a [–atr] specification and thus prevents [+low] vowels from being associated with [+atr], roughly in the manner shown in the derivation in (7).

(7) Activity of LO/ATR



In sum, systematic disharmony (e.g., opacity) is best analyzed as the result of (phonetically-motivated) negative or implicational conditions on the association of some value of the harmonic feature with some value of another feature.

2 Re-pairing

The behavior of unpaired [+low] vowels with respect to [±atr] harmony in some other languages cannot be accounted for with implicational LO/ATR. In Diola Fogny (Sapir 1965), which has dominant-recessive [+atr] harmony, [+low, –atr]

vowels simply alternate with [**–low**, +atr] vowels. I call this **re-pairing**. The relevant vowels are again *italicized*; the [–low, +atr] vowel is transcribed as [ɔ].

(8) Diola Fogny harmony & re-pairing (Niger-Congo, N. Atlantic)

a. /nɪ + √b*a*j + ɛn + ʊ/ → [nɪb*a*jɛnʊ] *recessive*
1SG + have + CAUS + 2PL 'I have caused you (pl.) to have'

b. /nɪ + √b*a*j + u̲l + ʊ/ → [ni<u>b*ɔ*julu</u>] *dominant*
1SG + have + FROM + 2PL 'I have from you (pl.)'

Re-pairing due to vowel harmony is far more common than is often explicitly acknowledged in the literature. Other examples include Yokuts (Newman 1944), in which the [–back] vowel [i] and the [+back] vowel [u] alternate under [±round] harmony, and Turkish (Underhill 1976), in which the [+low] vowel [a] and the [–low] vowel [e] alternate under [±back] harmony.

Since it is the feature [±low] rather than [±atr] that must be altered, a grounded path condition distinct from LO/ATR must be invoked to account for re-pairing: "*if* [+atr], *then* [–low]." This condition must operate as shown in (9)b. (The transcribed [ɒ] represents an intermediate-stage [+low, +atr] vowel.)

(9) Definition and activity of ATR/LO

a. ATR/LO: [+atr] → [–low]

b. nɪ √b*a*j ul ʊ → (VH) ni √bɒj ulu → (ATR/LO) ni√bɔj ulu
[+atr] [+atr] [+atr]

But a generalization is being missed here: [+low, +atr] vowels do not exist in Tangale nor in Diola Fogny due to the same phonetically grounded fact that [+low] and [+atr] are antagonistic articulatory gestures. Why, then, should the relevant facts in these two languages be accounted for by *separate* grounded path conditions? Clearly, an analysis that avoids this redundancy is to be preferred.

3 Optimality Theory

Such an analysis is not far to seek. Abstracting away from the procedural metaphor of the implicational conditions — that the antecedent (*if*) feature is held constant while the consequent (*then*) feature varies — the two implicational conditions LO/ATR and ATR/LO, as well as the negative condition *[+low, +atr], are revealed to be logically equivalent. This is shown by the truth table in (10).[3]

(10) Logical Equivalence of LO/ATR, ATR/LO, and *[+low, +atr]

	LO/ATR ([+low] → [–atr])	ATR/LO ([+atr] → [–low])	*[+low, +atr]
[+low, +atr]	F	F	F
[+low, –atr]	T	T	T
[–low, +atr]	T	T	T
[–low, –atr]	T	T	T

In Optimality Theory (OT), the procedural metaphor is an impossible construal of implicational conditions. LO/ATR, ATR/LO, and *[+low, +atr] are thus all (correctly) equivalent. The difference between opacity (in Tangale) and re-pairing (in Diola Fogny) must then be due to the same mechanism that accounts for differences among all languages in OT: re-ranking of the same constraints.

The constraints I presume to be germane to the task are given in (11). (I arbitrarily refer to the grounded path condition in (11)c as *[+low, +atr], having already determined that the negative and implicational conditions are equivalent.)

(11) Constraints
- a. AGREE(atr) : Adjacent segments have the same value of [±atr].
- b. IO-IDENT(low): Correspondents have the same value of [±low].
- c. *[+low, +atr] : [+low, +atr] segments are disallowed.

The harmony constraint AGREE(atr) is satisfied if all vowels agree in terms of [±atr]; it is thus violated by opacity. The faithfulness constraint IO-IDENT(low) is satisfied if all surface vowels retain their underlying values of [±low]; it is thus violated by re-pairing. The grounded path condition *[+low, +atr] is, of course, violated by "plain harmony" — a candidate with no opacity and no re-pairing.

To obtain opacity as in Tangale, *[+low, +atr] and IO-IDENT(low) must dominate AGREE(atr). This is a **blocking ranking**: the process of harmony is blocked by the combination of both faithfulness and grounding.

(12) Opacity as blocking (Tangale)

Candidates	*[+low, +atr]	IO-IDENT(low)	AGREE(atr)
a. peern*ʊ*ngo	* !		
b. peern*ə*ngo		* !	
c. ☞ peern*a*ngɔ			*

To obtain re-pairing (in Diola Fogny), *[+low, +atr] and AGREE(atr) must dominate IO-IDENT(atr). This is a **triggering ranking**: the process of re-pairing is triggered by the combination of both harmony and grounding.

(13) Re-pairing as triggering (Diola Fogny)

Candidates	*[+low, +atr]	AGREE(atr)	IO-IDENT(low)
a. nib*ɲ*julu	* !		
b. ☞ nib*ə*julu			*
c. nɪb*a*julu		* !	

4 A Conspiracy

In Maasai and Turkana (Eastern Nilotic; Tucker & Mpaayei 1955, Dimmendaal 1983), there is both opacity **and** re-pairing. The examples in (14)a show that a [+low, –atr] vowel surfaces faithfully when it is not in the vicinity of a [+atr] vowel. The examples in (14)b show that the same underlying [+low, –atr] vowel surfaces re-paired as [–low, +atr] when **preceded** by a [+atr] vowel.[4] Finally, the

examples in (14)c show that when a [+low, –atr] vowel is **followed** (and not preceded) by a [+atr] vowel, it surfaces faithfully — that is, there is opacity.

(14) Maasai & Turkana: harmony, re-pairing, and opacity

a.	**M**	/ɪn + √lɪpɔŋ + *a*/ FEM.PL + noun + PL	→	[ɪlɪpɔŋ*a*] 'full-grown female'	/*a*/ → [*a*]
	T	/ɛ + √pɛg + *aa* + n + *a*/ 3 + argue + HAB + SG + VOI	→	[ɛpɛg*aa*n*a*] 's/he is argumentative'	/*a*/ → [*a*]
b.	**M**	/ɪn + √mudoŋ + *a*/ FEM.PL + noun + PL	→	[imudoŋ*o*] 'kinship'	/*a*/ → [*o*] *(re-pairing)*
	T	/ɛ + √pup + *aa* + n + *a*/ 3 + obey + HAB + SG + VOI	→	[ɛpup*oo*n*o*] 's/he is obedient'	/*a*/ → [*o*] *(re-pairing)*
c.	**M**	/ɛ + √ɪpʊt + *a* + rɪ + ie/ 3SG + fill + MA + N + APPL	→	[ɛɪpʊt*a*riyie] 'it will get filled up'	/*a*/ → [*a*] *(opacity)*
	T	/*a* + √pɛg + *aa* + n + u/ GN + deny + HAB + SG + NOM	→	[*a*pɛg*aa*nu] 'denial'	/*a*/ → [*a*] *(opacity)*

Following Archangeli & Pulleyblank (1994) and Albert (1995), one could analyze these facts as the result of two different harmony processes, each enforced by a different harmony constraint. One process, operating directionally from left-to-right, is in a triggering configuration, as shown in (15). The other process, operating from right-to-left, is in a blocking configuration, as shown in (16). In both cases, the same *[+low, +atr] condition plays the starring role.[5,6]

(15) Re-pairing as left-to-right triggering (Maasai & Turkana)

Candidates	*[+low, +atr]	AGR(atr)-LR	IO-IDENT(low)
a. [+atr] … *ɒ*	* !		
b. ☞ [+atr] … *o*			*
c. [+atr] … *a*		* !	

(16) Opacity as right-to-left blocking (Maasai & Turkana)

Candidates	*[+low, +atr]	IO-IDENT(low)	AGR(atr)-RL
a. *ɒ* … [+atr]	* !		
b. *o* … [+atr]		* !	
c. ☞ *a* … [+atr]			*

This is in fact the essence of Albert's (1995) analysis of Turkana (see also McCarthy 1997), but not of Archangeli & Pulleyblank's (1994) analysis of Maasai. Archangeli & Pulleyblank assume two different harmony processes, and that one of them (the right-to-left one) is subject to the grounded path condition LO/ATR, resulting in opacity. But the left-to-right process is not subject to any condition; the fact that there is re-pairing in this direction is essentially left unaddressed by these authors. (See Bakovic 2000, 2001 for additional discussion.)

Alternatively, one could analyze the distinction between opacity and re-pairing as being determined by the cycle (Baković 2000, 2001; following Benua

1997), distinguishing between input-output and stem-affixed form faithfulness to the feature [±low]. Again, blocking and triggering by *[+low, +atr] are key. IO-IDENT(low), which regulates faithfulness in the cyclic direction, is in a triggering configuration, which results in re-pairing as shown in (17). SA-IDENT(low), which regulates faithfulness in the anti-cyclic direction (by demanding that affixed forms be identical to their stems of affixation in terms of [±low]), is in a blocking configuration, which results in opacity as shown in (18).

(17) Re-pairing as cyclic triggering (Maasai & Turkana)

Candidates	*[+low, +atr]	AGREE(atr)	IO-IDENT(low)
a. [+atr] … *ɒ*	* !		
b. ☞ [+atr] … *o*			*
c. [+atr] … *a*		* !	

(18) Opacity as anti-cyclic blocking (Maasai & Turkana)

Candidates	*[+low, +atr]	SA-IDENT(low)	AGREE(atr)
a. *ɒ* … [+atr]	* !		
b. *o* … [+atr]		* !	
c. ☞ *a* … [+atr]			*

However the asymmetrical pattern of behavior of underlying [+low] vowels in Maasai and Turkana is ultimately analyzed, it is clear that the **conspiracy** (Kisseberth 1970) of [+low, +atr] avoidance is best analyzed as being due to one and the same grounded path condition against such vowels.

5 Conclusion

Kiparsky (1981) conclusively argued that association conditions are necessary in order to explain the connection between systematic disharmony with gaps in vowel inventories. I hope to have shown in this paper that a proper understanding of association conditions leads to an explanation of the connection between systematic disharmony and re-pairing processes, both across and within languages.

Notes

[1] See Baković & Wilson 2000 for a recent account of transparency vs. opacity.

[2] Assuming binarity of the relevant features, the condition could equivalently be written "*if* [+low] *then not* [+atr]."

[3] The import of the logical equivalence of negative and implicational conditions was first discussed explicitly by Stanley (1967). In Stanley's terms, the negative and implicational conditions at issue here all *reject* [+low, +atr] and they all *accept* other combinations of [±low] and [±atr].

[4] Unlike Diola Fogny, re-pairing in Maasai and Turkana involves an additional change in [±round] which is put aside here.

[5] I do not address here the proper formalization of directional harmony constraints, referred to in these tableaux as AGREE(atr)-LR and AGREE(atr)-RL. There are a number of formalizations of such constraints in the literature, most notably in terms of featural alignment (Akinlabi 1994).

[6] Note that *[+low, +atr] dominates IO-IDENT(low) in tableau (16), as indicated by the solid line between them; this is not a necessary fact about the blocking ranking, but rather follows from the triggering ranking independently established in tableau (15).

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