Menomini Vowel Harmony: O(pacity) &T(ransparency) in OT

Diana Archangeli and Keiichiro Suzuki*
The University of Arizona®

1.0 Introduction

The phenomenon referred to as "vowel harmony" is illustrated in (1). The canonical pattern is that a feature which clearly belongs to one segments (or morpheme) is realized predictably on all vowels in the word.

(1) Basic Vowel Harmony

The harmonic feature F spreads to beginning and/or end of word

There are currently two basic approaches to vowel harmony under Optimality Theory, the ALIGNment approach (Kirchner 1993, Pulleyblank 1994, to appear, Archangeli & Pulleyblank (A&P) 1994b) and the Domains approach (Smolensky 1995, Cole & Kisseberth 1994a, 1994b, 1995).

Under ALIGNment, harmony is achieved via ALIGN constraints that prefer a feature to be ALIGNed to the left and/or right edge of the form. How well-ALIGNed a feature is is determined by where -- or whether -- it is associated. Thus, the ALIGNment approach simply extends the concept of Generalized ALIGNment (McCarthy & Prince (M&P) 1993) from prosodic categories to features, making use of standard autosegmental representations of features.

Under Domains, harmony is also achieve via ALIGN constraints. However, instead of simply ALIGNing a feature to an edge, the Domains approach posits a "feature domain" whose ALIGNment to the left and/or right edge of the form is evaluated. A feature domain is a bracketed substring which contains an associated token of a given feature. A further constraint, EXPRESS, ensures that the feature is realized on all vowels in the domain. (As with other models, there is also some constraint that restricts the realization of the harmonic feature to vowels only.)

These two approaches have quite different analyses of transparency and opacity, the two major perturbations in vowel harmony systems, illustrated in (2).

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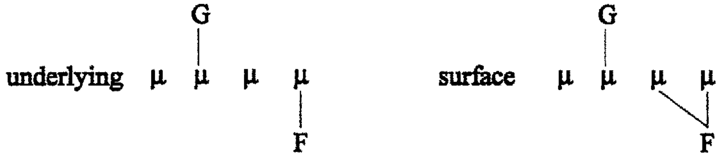
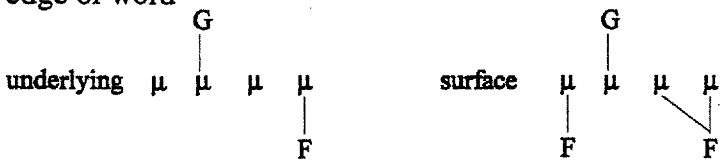
(2) Opacity & Transparency

a. Opacity: an illicit target stops the spread of F (here, the illicit target is specified "G")



b. Transparency: an illicit target is ignored and spread of F continues to(wards) edge of word



Under ALIGNment, as shown in Pulleyblank (1994), transparency and opacity are achieved by the relative ranking of ALIGN constraints with respect to faithfulness constraints (FAITH), provided that ALIGN itself is subordinate to a grounded condition (A&P 1994a) prohibiting or requiring some feature combination. In this example, the grounded condition prevents the feature combination [F,G]. If FAITH also outranks ALIGN, then no features can be inserted and opacity obtains, illustrated in (3) with opacity in Maasai (cf. Tucker & Mpaayei 1955, Levergood 1984, A&P 1994a). In (3a), the optimal candidate reveals opacity: harmony has been blocked by the low vowel -- ALIGN is maximally violated, but ALIGN is subordinate to other the constraints. In (3b), the representation is consistent with transparency: there is a fatal FAITH violation due to the inserted feature; ALIGN is minimally violated. Finally, (3c) shows complete harmony, fully satisfying both FAITH and ALIGN, but fatally violating the undominated grounded condition prohibiting [+ATR, +low] vowels.[1]

(3) Opacity: GROUNDING >> FAITH >> ALIGNMENT, e.g. Maasai

ATR/LO: [+ATR] and [+low] do not combine

lE - m - AA - niŋ	lɛmaaniŋ
ms-neg-1sg-hear	'who does not hear me'

		/lE - m - AA - niŋ/	ATR/LO	FAITH	ALIGN
a.	☞	lɛmaaniŋ +ATR			***
b.		lemaaniŋ +ATR +ATR		*!	**
c.		leməəniŋ +ATR	*!*		

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[1] In tableaux, fatal violations for nonoptimal candidates are doubly marked, in the standard way with an exclamation point, but also with shading of darker grey.

If FAITH is subordinate to ALIGN, transparency obtains: ALIGN is better satisfied if some features are inserted. This is illustrated in (4) with transparency in Wolof (Ka 1988, A&P 1994a, Pulleyblank 1994). Opacity, fatally violating ALIGN, is shown in (4a) while (4c) shows full harmony, fatally violating the grounded condition requiring [-ATR] vowels to also bear the specification [-high]. The optimal candidate is (4b), where ALIGN is minimally violated to satisfy grounding, and FAITH is minimally violated to satisfy ALIGN.[2]

(4) Transparency: GROUNDING >> ALIGNMENT >> FAITH, e.g. Wolof
/tɛkkIlEEn/ 'untie' [tɛkkilɛɛn], *[tɛkkileen]

	/tɛkkIlEEn/	RTR/HI	ALIGN	FAITH
a.	tɛkkileen | -ATR		**!	
b. ☞	tɛkkilɛɛn | | -ATR -ATR		*	*
c.	tɛkkɪlɛɛn -ATR	*!		**

Significantly, the ALIGNment approach predicts that no language has both Opacity and Transparency: Opacity requires the ranking FAITH >> ALIGN while Transparency requires the ranking ALIGN >> FAITH. Menomini (Bloomfield 1962) is an apparent counterexample to this prediction, for it has both opacity and transparency (Cole & Trigo 1988, Cole 1987, Steriade 1987, A&P 1994a).

(5) **The Counterexample: Menomini**

a. [+low, +ATR] vowels are **opaque**:
/pIːhtəhkiːʔtAw/ [pɪːhtəhkiːʔtaw] *[piːhtəhkiːʔtaw]

b. otherwise, short vowels are **transparent**:
/nIwIːnIpim/ [nɪwiːnɪpim] *[niwiːnipim] *[nɪwɪːnɪpim]

Three questions arise given this prediction and counterexample: (i) is Menomini truly a counterexample or is there a reasonable analysis possible under ALIGNment, consistent with the general approach to opacity and transparency effects? (ii) if not, is there a reasonable analysis possible under ALIGNment, consistent with an alternative yet reasonable approach to opacity and transparency effects? (iii) if not, does the Domains model make no such incorrect predictions, and therefore is to be preferred despite the introduction of purely abstract domains and the constraints that they entail?

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[2] An alternative would be complete harmony as in (4c), but with loss of the feature [+high] in order to satisfy RTR/HI. Presumably in Wolof, FAITH(HI) outranks ALIGN. This is not merely a mental exercise: in Maasai, the rightward harmony of ATR does affect low vowels, but they, in tern, are realized as nonlow. See A&P (1994a).

In this paper, we explore opacity and transparency in Menomini and argue that the ALIGNment approach is adequate. In addition to the constraint types noted above, namely Align, Grounding, and Faith, we also appeal to a constraint operation, Local Conjunction (Smolensky 1993, 1995): a violation is assessed for a pair of constraints which are locally conjoined only when *both* constraints are violated locally. (We explain the operation more completely in section 3.) Since the constraint types and the operation are all motivated independently of Menomini or Menomini-like facts, we conclude that, under Optimality Theory, a grammar is capable of accounting for the general opacity and transparency phenomena as well as accounting for the special case of Menomini, all without appealing to the additional structure assumed in the Domains approach.

2.0 Menomini Vowel Harmony

In this section, we discuss basic properties of the Menomini vowel harmony system and the constraints and constraint hierarchy motivated by these properties. By way of background, we accept the arguments in A&P (1994a) that Menomini has six vowels, pairing [+ATR] [i ə u] with [-ATR] [ɪ a ʊ]. Vowels may be long or short; there are length alternations but harmony respects the surface length. Again following A&P (1994a), we assume vowel representations are composed of the features [+low], [+round], and [+ATR]: these three features allow eight combinations, two of which are ruled out by the undominated grounded constraints prohibiting vowels that are [+low, +round].[3]

(6) Menomini F-element Combinations & symbols used to refer to them (after A&P 1994a)

*	*	ə	a	u	ʊ	i	ɪ
+LO	+LO	+LO	+LO				
+RD	+RD			+RD	+RD		
+ATR		+ATR		+ATR		+ATR	

Point 1: [+ATR] is in the output only if [+ATR] is present in the input. Regardless of the feature composition of the vowels of a form, [+ATR] can only surface if it is present in the underlying representation. This is illustrated by the forms in (7), which show both long and short versions of underlying /ɪ a ʊ/.[4]

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[3] Under OT, there can be no constraints on input representations other than those that follow from the constraint hierarchy itself. Therefore, in fact, we cannot require that input representations be underspecified (Ito, Mester, and Padgett 1995). The analysis offered here does not hinge on underspecification. However, if representations are specified more fully than as given in (6), then we assume that ATR and RTR are on separate tiers, in order for ALIGNment to work as indicated in this article. The analysis offered here is not contingent on underspecification.

[4] In our figures we show both the transcription used in Bloomfield (1962, 1975) (in the leftmost column) and the transcription corresponding to (6) and following A&P (1994a) (in the center column).

(7)		*Bloomfield*	*A&P*	*gloss*
	a.	pe:hcekona:h	[pɪ:hcɪkʊna:h]	'sacred bundle'
	b.	we:to:hkatowak	[wɪ:tʊ:hkatʊwak]	'they work together'
	c.	se:kahe:qkow	[sɪ:kahɪ:ʔkʊw]	'he puts drops in his eyes'
	d.	we:nepow	[wɪ:nɪpʊw]	'he dirties his mouth'

Correspondence Theory as outlined in M&P (1995) and McCarthy (1995) includes the IDENT family of constraints that prohibits the gratuitous deletion or changing of features. IDENT, as construed in M&P (1995), examines corresponding segments for featural identity, thereby prohibiting both the insertion and the deletion of a feature. As we show in this analysis of Menomini harmony, it is crucial that insertion and deletion of [+ATR] be evaluated independently. This is expressed by two IDENT constraints, IDENT$_{IO}$ and IDENT$_{OI}$, following Pater (1995).[5]

(8) Let α be a segment in the input and β be a correspondent of α in the output

a. IDENT$_{IO}$[γF] If α is [γF], then β is [γF].

b. IDENT$_{OI}$[γF] If β is [γF], then α is [γF].

In (8), S_1 is the input and S_2 is the output. IDENT$_{IO}$ prevents deletion of some f-element and IDENT$_{OI}$ prevents the insertion of some f-element.[6]

(9) **IDENT$_{OI}$** prevents gratuitous insertion/spread of [+ATR]

	UR:	**pI:hcIkUnA:h**	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	**IDENT$_{OI}$**
a.	☞	**pɪ:hcɪkʊna:h**						
b.		**pi:hcIkUnA:h** | **+ATR**						▨

The nonoptimal candidate in (9b) is constructed so as to violate only IDENT$_{OI}$: [+ATR] has been inserted on a long, nonlow vowel at the left edge. The optimal candidate in (9a) has no inserted [+ATR] and so has no IDENT$_{OI}$ violation.

Point 2: [+ATR], if present in UR, harmonizes to the left. This fact is illustrated by the forms in (10), which contain nonlow vowels to the right of a [+ATR] vowel, for instance

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[5] Pater (1995) argues in favor of IDENT constraints relativized to specific feature specifications, i.e. f-elements as well as proposing both IDENT$_{IO}$ and IDENT$_{OI}$. We might view this as the MAX-DEP IDENT model (M&P 1995), for the two versions of IDENT mirror MAX and DEP. See also Cole and Kisseberth (1995).

[6] Contrary of M&P (1995), this approach need not assume full specification. We see this as an advantage. First, under richness of the base, full specification cannot be guaranteed of inputs (see footnote 3). Second, the predictions about monovalent f-elements, such as Labial and Coronal, are distinct. The M&P (1995) IDENT model allows free insertion of monovalent features, a type of non-correspondence that would incur an IDENT$_{OI}$ violation.

in (10a) the [ɪ:] in [nu:kɪ:sɪk] is to the right of the [+ATR] /u:/. As these examples illustrate, there is no rightward [+ATR] effect.

(10)	*Bloomfield*	*A&P*	*gloss*
a.	nu:ke:sek	nu:kɪ:sɪk	man's name "Big Sky"
b.	miani:hse:sak	miani:hsɪ:hsak	'tiny owls'
c.	si:piahse:hseh	si:piahsɪ:hsəh	'creek'

A particularly telling example is that in (10c), where harmony affects the long high vowel to the *left* of the [+ATR] source but does not affect the long high vowel to the *right*.

(11)

Following Kirchner (1993) and Pulleyblank (to appear), directional effects of this sort are explained in OT by generalizing ALIGNment constraints (M&P 1993) to features. For Menomini, [+ATR] ALIGNs to the left, but not to the right. The default edge is either a linked token of the same feature or, in the absence of such a linked feature, a morphological edge. (See Pulleyblank (to appear) for more on "default" edges.)

(12) ALIGN(+ATR,L) (**ALIGN**): the left edge of [+ATR] is ALIGNed with a (default) left edge

In order for harmony to obtain at all, it is crucial that ALIGN dominate IDENT$_{OI}$. This point is illustrated in (13): the optimal (13a) minimally violates IDENT$_{OI}$, doing so only to satisfy ALIGN; (13b), with no harmony, satisfies IDENT$_{OI}$ but violates ALIGN; (13c) with bidirectional harmony, satisfies ALIGN but fatally violates IDENT.[7]

(13) ALIGNment dominates FAITHfulness in order for harmony to obtain:

ALIGN >> IDENT$_{OI}$

	UR:	sI:piAhsI:hsəh +ATR	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	**ALIGN**	**IDENT$_{OI}$**
a.	☞	si:piahsɪ:hsəh +ATR		*				*
b.		sɪ:piahsɪ:hsəh +ATR		*				
c.		si:piahsi:hsəh +ATR +ATR		*				

Point 3: Short vowels are transparent to harmony. Long vowels undergo harmony while short vowels do not -- nor do the short vowels prevent the propogation of harmony to a long vowel. The forms in (14) each have a short vowel intervening between the

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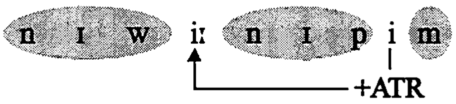
[7] ALIGN violations in the tableaux are calculated at the root node level, not at the moraic level. Thus, a long vowel incurs only a single ALIGN violation, as in (13b), not two. Nothing hinges on this decision.

source of harmony (the final vowel in (14a) and the penult in (14b)) and the long vowels which undergo harmony. The sketch in (14c) highlights the transparency of the short vowel in (14a): the transparent short vowels and consonants are greyed over.[8]

(14)	*Bloomfield*	*A&P*	*gloss*
b.	wayi:tu:hkatitwaʔ	[wayi:tu:hkatitwaʔ]	'??they work together??'
a.	newi:nepim	[nɪwi:nɪpim]	'I dirty his (my?) mouth'

c.



Restricting harmony to affect only long vowels is expressed by a constraint preferring [+ATR] on bimoraic syllables, ATR/μμ (abbreviated in tableaux as μμ).

(15) ATR/μμ (μμ): if [+ATR] then bimoraic (i.e. [+ATR] is linked only to bimoraic root nodes)

The tableau in (16) demonstrates that ATR/μμ must outrank ALIGN. The nonoptimal partially harmonic candidates in (16a,b) fatally violate ATR/μμ since a short vowel has harmonized. The nonharmonic (16c) and the optimal (16d) tie for ATR/μμ. The single violation is due to the input containing a short advanced vowel. The optimal (16d) minimally violates ALIGN and so is selected. (All candidates violate ATR/μμ once due to the input containing a short [+ATR] vowel.)[9]

(16) If ATR/μμ outranks ALIGN, only long vowels undergo harmony -- short vowels are transparent

ATR/μμ >> ALIGN (>> IDENT$_{OI}$)

	UR:	nIwI:nIpim +ATR	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	IDENT$_{OI}$
a.		nɪwɪ:nipim +ATR		[illegible]			**	*
b.		nɪwi:nipim +ATR		[illegible]			*	**
c.		nɪwɪ:nɪpim +ATR		*			[illegible]	
d.	☞	nɪwi:nɪpim +ATR +ATR		*			**	* *

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[8] Questions marks in glosses indicate reconstructions.

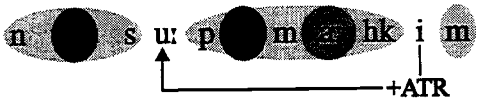
[9] Note that were ALIGN and ATR/μμ reversed in the ranking, the optimal form would be the fully harmonic **niwi:nipim*. This form is not included in the tableau in (16) since it incurs an additional (and so fatal) violation of ATR/μμ.

Point 4: Low vowels are transparent to harmony, whether long or short. Like the short nonlow vowels, low vowels are also transparent to harmony even when long, illustrated in (17). In (17a,b), long low vowels intervene between the source and the target of harmony; in (17c,d), short low vowels intervene.

(17)	*Bloomfield*	*A&P*	*gloss*
a.	nesu:poma:hkim	[nɪsu:pʊma:hkim]	'sugar-maker'
b.	neci:pa:hkim	[nɪci:pa:hkim]	'cook-nominative'
c.	wayi:tu:hkatitwaq	[wayi:tu:hkatitwaʔ]	'??they work together??'
d.	nesi:kahi:qkim	[nɪsi:kahi:qkim]	'??I put drops in my eyes??'

Figure (18) illustrates the fun of (17a), a form which simultaneously illustrates the transparency of a long low vowel (dark grey) and of a short nonlow vowel (light grey) and consonants (lightest grey).

(18)



The inability of low vowels to participate in [+ATR] harmony is well-documented in A&P (1994a); Pulleyblank (1994) and A&P (1994b) demonstrate that grounded constraints ranked in a constraint hierarchy have the appropriate limiting effect on harmony patterns. For Menomini, we appeal to ATR/LO to prevent [+ATR] from appearing on [+low]] vowels.

(19) **ATR/LO**: if [+ATR] then not [+low] (i.e. [+ATR] is not in a path with [+low])

ATR/LO must outrank ALIGN in Menomini, as demonstrated by the tableau in (20), which considers only the candidates which minimally violate ATR/μμ. The nonharmonic (20a) fatally violates ALIGN. Candidates (20b,c), while partially harmonic, include fatal violations of ATR/LO, due to harmony of the long low vowel /A:/. Candidate (20c) satisfies ALIGN better than the optimal (20d); (20d), however, satisfies the dominant ATR/LO.

(20) If ATR/LO outranks ALIGNMENT, low vowels are transparent
ATR/LO >> ALIGN(>> IDENT$_{OI}$)

	UR:	nIsU:pUmA:hkim +ATR	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	IDENT$_{OI}$
a.		nɪsʊ:pʊmɑ:hkim +ATR		*			****!	
b.		nɪsʊ:pʊmə:hkim +ATR		*		*!	***	*
c.		nɪsu:pʊmə:hkim +ATR +ATR		*		*!	**	* **
d.	☞	nɪsu:pʊma:hkim +ATR +ATR		*			***	* *

Point 5: [+ATR] surfaces where it is present in UR, despite ATR/μμ and ATR/LO. We have just argued for constraints restricting [+ATR] to long, nonlow vowels. However, [+low, +ATR] vowels are present in Menomini, as are short [+ATR] vowels. The forms in (21) include violations of ATR/LO (21a,b) and of ATR/μμ (21b,c,d).

(21)	*Bloomfield*	*A&P*	*gloss*
a.	kɛ:hkɛh	kə:hkəh	'hawk'
b.	nɛqninoh	nəʔninʊh	'three times'
c.	espa:hkihsen	ɪspa:hkihsɪn	'he/it lies high as'
d.	a:qtihsen	a:ʔtihsɪn	'he/it leans'

The constraint used to prevent gratuitous deletion of features under Correspondence Theory is IDENT$_{IO}$[γF].

(22) IDENT$_{IO}$[+ATR] (**IDENT$_{IO}$**): If a segment is [+ATR] in the input, then its output correspondent is [+ATR].

IDENT$_{IO}$ must dominate both ATR/LO and ATR/μμ because underlying low advanced vowel and underlying long retracted vowels do surface. ATR/LO is satisfied if [+ATR] is deleted from input low advanced vowels, but this fatally violates IDENT$_{IO}$.

(23) Underlying [+ATR, +low] vowels surface as such: IDENT$_{IO}$ >> ATR/LO

UR:	kə:hkəh +ATR	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	IDENT$_{OI}$
a. ☞	kə:hkəh +ATR				*		
b.	ka:hkah <+ATR>						

ATR/μμ is satisfied if [+ATR] is deleted from input short advanced vowels, but this fatally violates IDENT$_{IO}$.

(24) Underlying monomoraic [+ATR] vowels surface as such: IDENT$_{IO}$ >> ATR/μμ

UR:	A:ʔtihsIn +ATR	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	IDENT$_{OI}$
a. ☞	a:ʔtihsɪn +ATR		*				
b.	a:ʔtihsɪn <+ATR>						

At this point, we have motivated the core constraints responsible for Menomini harmony. The constraints and their ranking are summarized in (25). The dominance of IDENT$_{IO}$ ensures that underlying tokens of [+ATR] surface in situ; the two grounded constraints restricting the distribution of [+ATR] limit the vowels affected by harmony, itself forced by ALIGN. Subordinating IDENT$_{OI}$ allows for the insertion and/or spread of [+ATR] in order to satisfy the higher ranked constraints.

(25) Summary to date: **IDENT$_{IO}$ >> μμ, ATR/LO >> ALIGN >> IDENT$_{OI}$**

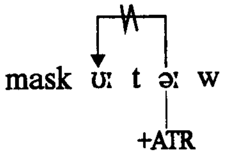
As seen above, the Menomini data argue that the original single IDENT must be two constraints, one which prohibits feature deletion, IDENT$_{IO}$, and one which prevents feature insertion, IDENT$_{OI}$. In Menomini, IDENT$_{IO}$[+ATR] ("no deletion of [+ATR]") is highest ranked while IDENT$_{OI}$[+ATR] ("no insertion of [+ATR]") is at the bottom of the relevant portion of the constraint hierarchy.

3.0 Remaining Problems

The remaining three points revolve around the behavior of low advanced vowels.

Point 6: /ə(:)/ is not a trigger. The constraint hierarchy developed in the previous section predicts that [+ATR] low vowels trigger harmony, just like any other [+ATR] vowel. However, this is not the case in Menomini: [+ATR] of /ə(:)/ does not trigger harmony, as seen in (26).

(26)



	Bloomfield	*A&P*	*gloss*	
a.	masko:tɛ:w	maskʊːtəːw	'prairie'	*maskuːtəːw
b.	ahpe:htohnɛw	ahpɪːtʊhnəw	'he walks so far/so fast'	*ahpiːtʊhnəw
c.	ape:saqnɛm	apɪːsaʔnəm	'black dog'	*apiːsaʔnəm

These examples show that /ə(:)/ is not a trigger of harmony. The question, then, is why does [+ATR] spread from a high advanced vowel but not from a low one?

To answer this question, we propose that the antagonistic relation between [+ATR] and [+low], already defined by ATR/LO, holds cross-positionally, that is, *ATR...+low. Formally, we appeal to sequential grounding (SG) (Smolensky 1993, Suzuki 1995; see also McCarthy (to appear) on sequential constraints): a SG constraint is a cross-positional (syntagmatic) counterpart of the traditional within-positional (paradigmatic) grounding constraints. In Menomini, we propose that the SG constraint *ATR...LO (27) is responsible for the lack of harmony observed in (26).[10]

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[10] A grounding constraint allows zero potential F-bearers to intervene between the two features in question; we state sequential constraints in terms of one or more intervening potential F-bearers in order to distinguish between grounding (paradigmatic) and sequential (syntagmatic) constraints.

(27) *ATR...LO: [+ATR] does not precede [+low]
(where "..." is one or more ATR-bearers and/or low-bearers).

Since any instance of [+ATR] to the left of [+low] incurs a violation mark, the SG constraint blocks leftward spreading of [+ATR] from low vowels. Ranking *ATR...LO above ALIGN accounts for low advanced vowels not triggering harmony in (26), as shown in the tableau in (28).

Both candidates in (28) satisfy IDENT$_{IO}$ and μμ; the nonharmonic winner (28a) satisfies *ATR...LO since there are no advanced vowels preceding the low final vowel. The harmonic (28b) fatally violates *ATR/LO by having an advanced vowel ([u:]) preceding the low final vowel.

(28) *ATR...LO >> ALIGN

UR:	mAskU:t ə:w +ATR	IDENT$_{IO}$	μμ	ATR...LO	ATR/LO	ALIGN	IDENT$_{OI}$
a. ☞	maskʊ:tə:w +ATR				*	**	
b.	masku:tə:w +ATR				*	*	*

Point 7 = Point 4: /a(:)/ is transparent. The introduction of *ATR...LO to our hierarchy creates another problem: *ATR...LO wrongly predicts that retracted low vowels are opaque, not transparent. This is demonstrated by the tableau in (29). The input in (29), /nIsU:pUmA:hkim/, contains the relevant sequence, a long high vowel followed by an advanced high vowel, with only transparent vowels in between, here /U/ and /A/. The form in (29a) is expected by the constraint hierarchy thus far, for it violates neither the sequential grounding constraint *ATR...LO nor ATR/LO. The attested form in (29b) is deemed nonoptimal for it fatally violates *ATR...LO.

(29) <u>**A wrong prediction**</u>: Opacity is predicted where transparency obtains

UR:	nIsU:pUmA:hkim +ATR	IDENT$_{IO}$	μμ	ATR...LO	ATR/LO	ALIGN	IDENT$_{OI}$
a. ✌	nɪsʊ:pʊmɑ:hkim +ATR		*			****	
b. (☞)	nɪsu:pʊma:hkim +ATR +ATR		*			***	* *

The problem is that *ATR...LO applies to [+ATR] preceding *any* [+low]. *ATR...LO does not distinguish between the two low vowels, the transparent /A(:)/ and the nontriggering /ə(:)/. Crucially, *ATR...LO is relevant only when the low vowel is also

[+ATR]. This is precisely the type of constraint interaction which is explained by Local Conjunction (Smolensky 1993, 1995).

Local Conjunction (LC) is a constraint operation which combines two independent constraints so that a violation is assessed only when *both* constraints are violated. The idea is that it is worse to violate two constraints locally than it is to violate either constraint independently. Thus, violations are accrued when both constraints are violated. If only one of the two locally conjoined constraints fails, there is no constraint violation. Smolensky (1993, 1995) defines LC as follows:

(30) Local Conjunction (LC) (Smolensky 1995)

Local Conjunction of C_1 and C_2 ($C_1 \&_{LC} C_2$) in some domain D:

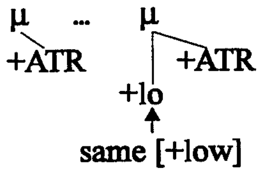
a. $C_1 \&_{LC} C_2$ is violated when there is some domain of type D in which both C_1 and C_2 are violated.
b. Universally, $C_1 \&_{LC} C_2 >> C_1, C_2$

It is now possible to relativize the significance of *ATR...LO to ATR/LO by locally conjoining the two (31).

(31) ATR/LO^2: ATR/LO $\&_{LC}$ *ATR...LO

The constraint ATR/LO^2 is violated only when both *ATR...LO and ATR/LO are violated locally. There is one representation of interest for the Menomini harmony case, shown in (32). In this configuration, we see the local violation of both conjuncts of ATR/LO^2. The second mora violates ATR/LO, and the two moras together form an ATR...LO sequence. The same token of [+low] is involved in both violations, so this configuration is assessed a violation of the locally conjoined ATR/LO^2.

(32)



By ranking ATR/LO^2 above ALIGN, the configuration in (32) does not survive.[11]

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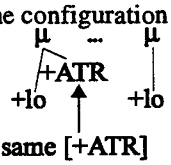
[11] There is another configuration, given in (i) below, that also violates ATR/LO^2. Violations of this sort must survive if the configuration is present in the input, since they do occur at the surface.

(i)



We propose that IDENT$_{IO}$[+ATR] and IDENT$_{IO}$[+LOW] outrank ATR/LO^2, allowing this configuration to survive.

Thus, ATR/LO^2 is able to relativize *ATR...LO to the cases where a [+low] vowel violates ATR/LO, thereby preventing ALIGNment to the left of [+low, +ATR] vowels. By replacing *ATR...LO with ATR/LO^2 in the constraint hierarchy in (33), EVAL now correctly picks the form in which transparency is observed as shown in (33).[12]

(33)

UR	nIsU:pUmA:hkim +ATR	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	IDENT$_{OI}$
a.	nɪsʊ:pʊmɑ:hkim +ATR		*	ATR/LO: ok ATR...LO: ok		****!	
b.	nɪsu:pumə:hkim +ATR +ATR		*	ATR/LO: ☒ *! ATR...LO: ☒	*	**	* **
c. ☞	nɪsu:puma:hkim +ATR +ATR		*	ATR/LO: ok ATR...LO: ☒		***	* *

In (33), we present only candidates that satisfy IDENT$_{IO}$ and μμ (except for the one violation due to the nature of the input). In the nonharmonic (33a), descriptively the low retracted vowel is opaque. ATR/LO^2 is satisfied, as is ATR/LO, but ALIGN is fatally violated. The next failed candidate, (33b), contains the configuration from (32), which best satisfies ALIGN but which fatally violates ATR/LO^2. The optimal candidate is (33c), where the low vowel is transparent to harmony.

The constraint hierarchy developed so far is summarized below.

(34) **IDENT$_{IO}$ >> μμ, ATR/LO^2 >> ATR/LO >> ALIGN >> IDENT$_{OI}$**

Point 8: Opacity of /ə(:)/. The ranking in (34) predicts that /ə(:)/ is *opaque* to harmony. This is illustrated in the following tableau with a hypothetical example. In (35b), the failed candidate in which the low advanced vowel is "transparent", there is a fatal ATR/LO^2 violation, although this candidate is better ALIGNed than the optimal (35a).

(35)	UR	ɪɪ.ə.i	IDENT$_{IO}$	μμ	ATR/LO^2	ATR/LO	ALIGN	IDENT$_{OI}$
a.	☞	ɪɪ.ə.i		**	ATR/LO: ☒ ATR...LO: ok	*	*	
b.		ii.ə.i		**	ATR/LO: ☒ *! ATR...LO: ☒	*		*

This pattern does hold true of the Menomini pattern as exemplified below. The data in (36) show the opacity of short /ə/.

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[12] In addition to the obtained ranking of ATR/LO^2 >> ALIGN, ATR/LO^2 must dominate ATR/LO, since by definition, any locally conjoined constraint must outrank both of its components (see (30b)).

(36)	*Bloomfield*	*A&P*	*gloss*
a.	pe:htɛhki:ʔtaw	[pɪːhtəhkiːʔtaw]	'he sticks his head in'
b.	mo:nehpɛni:w	[mʊːnɪhpəniːw]	'he digs potatoes'
c.	we:qsakɛsewikamek	[wɪːʔsakəsɪwikamɪk]	'hospital'
d.	so:wa:nɛhki:qsew	[sʊːwaːnəhkiːʔsɪw]	'he has his hair blown back by the wind'

Likewise, long /ə:/ also blocks harmony (37).

(37)	*Bloomfield*	*A&P*	*gloss*
a.	ke:skenɛ:hcihɛw	[kɪ:skɪnə:hcihəw]	'he cuts off his fingers'
b.	se:kenekɛwikamek	[sɪ:kɪnɪkəwikamɪk]	'saloon'
c.	po:tawɛ:temi:w	[pʊ:tawə:tɪmi:w]	'Potawatomi'

As predicted, /ə(:)/ is opaque to the harmony.

Significantly, the opacity of low advanced vowels demonstrated here is not just an accident, but a logical consequence of constraint interaction in the hierarchy which has been set up to account for the observation that only high vowels "trigger" harmony. We have argued that the use of local conjunction accounts for this observation. Interestingly, this analysis extends to any harmony system with a restriction on "sources": such restrictions are necessarily accompanied by opacity. A segment which is unable to induce harmony will also block harmony from another source, provided it bears the harmonic feature.

A segment which cannot induce harmony despite bearing the harmonic feature will also prevent harmony from crossing it. Opacity in this case is due to the "source condition" and not due to ranking FAITHfulness (specifically IDENT$_{OI}$) above ALIGNment.

4.0 An Argument against the Domains approach

The research strategy employed in this analysis of Menomini harmony is to exhaust independently motivated phonological constructs prior to introducing novel ones. Representationally, our analysis is based on traditional autosegmental representations (Goldsmith 1976, A&P 1994a) which include no gapping (A&P 1994a). We have also assumed both underspecification (Archangeli 1984, A&P 1994a, Ito, Mester and Padgett 1995, Inkelas 1994) and no OCP violations (McCarthy 1986, Yip 1988, A&P 1994a), although neither of these points is crucial to the analysis. In terms of constraints, we account for the basic vowel harmony effect in terms of the interaction of ALIGNment (M&P 1993, Kirchner 1993, Pulleyblank 1994, to appear, A&P 1994b) and grounding conditions (A&P 1994a,b) with FAITHfulness, specifically IDENT$_{IO}$ and IDENT$_{OI}$. The puzzling properties of Menomini harmony are explained by invoking Sequential Grounding (SG) and Local Conjunction (LC).

Our innovation is the introduction of IDENT$_{IO}$ and IDENT$_{OI}$ (see also Pater 1995, C&K 1995). The two IDENT constraints distinguish between "insertion" and "deletion" effects, a distinction necessary in any system with single-valued features, whether due to underspecification of an equipollent feature or due to monovalent features.

The sequential constraints and the operation of local conjunction are both motivated independently of feature harmony systems. Their use here suggests confirmation of their necessity in OT. Smolensky (1993) introduces sequential grounding (SG) when discussing vowel harmony systems, but Suzuki (1995) demonstrates the necessity of SG independently of vowel harmony in order to account for sequential effects like low vowel raising when preceded or followed by a high vowel (Basque and Old High German respectively). (McCarthy (to appear) also argues for sequential constraints, though does not tie them to grounding.) Thus, both sequential constraints and sequential grounding are motivated independently of vowel harmony systems. Local conjunction is introduced in Smolensky (1993, 1995) to account for certain syntactic patterns and for coda/onset asymmetries. Suzuki (1995) makes use of LC to explain doubly-conditioned effect of Woleaian low vowel raising. Therefore, LC is motivated independently of vowel harmony systems as well.

This contrasts with the "Optimal Domains Theory" (ODT) analysis of Menomini and other harmony systems offered in Cole and Kisseberth (1994, 1995). ODT requires a specialized meaning to the term “Domain”, simply an abstract bracketed substring whose sole role is to define where features might surface.

At first glance, Domains are comparable to the span of segments to which a harmonic feature is associated under ALIGNment, in analyses like that presented here. A basic difference lies in whether or not the Domain must be independently identified. Under ALIGNment, the standard necessary properties of a morpho-phonological representation (linked or free features, morphological edges) are all that is needed. Domains, however, are not independently motivated. Under ODT, each Domain is defined independently of the morpho-phonological representation (although it may be defined in terms of some morpho-phonological domain), thereby adding a layer of structure that is unmotivated except in order to account for feature locations. Furthermore, a Domain does not necessarily contain a realized feature. Feature specifications are independent of the Domains. In short, under ODT, Domains may be defined independently of features and of other phonological and morphological structure. By contrast, the analysis offered here makes use only of the *necessary* phonological and morphological properties of a representation suffice to explain phonological phenomena: no further otherwiseunmotivated structure is required.

By comparing the two approaches, we arrive at the conclusion that the ALIGNment approach developed here is necessary and sufficient, whereas the ODT approach (Cole and Kisseberth 1994a, 1994b, 1995) is sufficient, but not necessary. As shown here, even the complex patterns found in Menomini do not warrant increasing the size of our theoretical arsenal.

5.0 Conclusion

The analysis offered here reflects that of A&P (1994a) by recognizing the importance of the antagonistic relation between [+ATR] and [+low] which is active not only paradigmatically, but also syntagmatically in Menomini. On the one hand, the paradigmatic incompatibility of [+ATR] and [+low] is responsible for the *transparency* of low vowels; on the other hand, the syntagmatic incompatibility of [+ATR] and [+low] is responsible for the fact that low advanced vowels neither trigger harmony nor are transparent to it, but rather are *opaque*.

On the theoretical side, we have argued that the ALIGNment approach is able to account for Menomini harmony with appealing only to constraints that are motivated independently of vowel harmony systems with one exception. We have added to Pater's (1995) argument that it is necessary to expand IDENT into two constraints, IDENT_{IO} ("no deletion of features") and IDENT_{OI} ("no insertion of features"). Importantly, we make no appeal to novel abstract phonological representations.

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