

# Menominee vowel harmony revisited: A height-based underspecification account\*

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The Algonquian language Menominee has a vowel harmony process that raises /e, o/ to /i, u/ when a high vowel follows anywhere in the word. Importantly, an intervening /æ/ blocks harmony, but /a/ does not. The prevailing ATR-based analysis of this process entails an arguably distorted view of the Menominee vowel system and requires a stipulation to explain the asymmetrical blocking properties of the low vowels. As an alternative, I propose an underspecification analysis that is less stipulative and more phonetically natural, as it employs height rather than ATR. The analysis follows from the contrastive structure of the vowel system inherited from Proto-Algonquian, thus situating Menominee harmony in a broader analytical framework and providing continuity with the analysis of other Algonquian vowel systems.

## 1. Introduction

Menominee vowel harmony is one of the few Algonquian phonological processes to have become a standard case in the theoretical phonological literature, with general consensus that the process is best analyzed as involving ATR harmony (after Archangeli and Pulleyblank 1994). I will argue, however, that the ATR analysis has significant empirical and analytical drawbacks, and that the main reason for its widespread adoption is the fact that the more concrete height-based analysis appears impossible to formulate. I will remove this obstacle by showing that an elegant height-based analysis can in fact be straightforwardly formulated under a model of contrastive underspecification in which contrastive features are specified according to a hierarchy. In addition to hugging the phonetic ground more closely, this new height-based analysis is also less stipulative than the ATR approach, and it has the added benefit of integrating the Menominee facts into an analytical framework that can express a variety of diachronic generalizations across the Algonquian family as a whole. I will conclude that a height-based analysis of Menominee harmony is at least as plausible as the prevailing ATR analysis, and may indeed be preferable to it.

The paper is organized as follows. Sections 2 and 3 introduce the Menominee vowel system and describe the harmony process, while Section 4 critiques the existing analyses. Section 5 lays the theoretical groundwork for a new height-based analysis, which is proposed in Section 6.

## 2. The Menominee vowel system

The Menominee vowel system comprises six qualities plus a length contrast, as shown in (1) (Bloomfield 1962; Miner 1979). The vowel quality that Algonquianists conventionally symbolize

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using <ε> is represented here with the symbol <æ> in order to better reflect its phonetic realization (which is usually [æ], as shown in (2) below).

(1) MENOMINEE VOWEL SYSTEM

i:	i	u:	u
e:	e	o:	o
æ:	æ	a:	a

While the long vowels usually have the phonetic values suggested by their symbolizations in (1), the short vowels undergo almost complete neutralization. As shown in (2), all short front vowels tend to surface as [ɪ] and can be reliably distinguished only before a laryngeal.

(2) MENOMINEE SHORT-VOWEL NEUTRALIZATION (phonetic values from Miner 1979:12)

LONG VOWELS		SHORT VOWELS		
		__ h, ʔ	ELSEWHERE	
/i:/	[i:]	/i/	[ɪ]	[ɪ]
/e:/	[e:]	/e/	[ɪ]	[ɪ]
/æ:/	[æ:]	/æ/	[æ]	[ɛ~ɪ]

Vowel length does not appear to play a role in harmony (despite reports to the contrary, discussed in Section 3 below), so the following exposition will abstract away from length where it is not relevant, using, for example, the symbol /i/ to represent both short /i/ and long /i:/.

### 3. Description of Menominee vowel harmony

Menominee vowel harmony is—on the surface, at least—a height harmony process that raises mid vowels before a following high vowel (Bloomfield 1962:96, Miner 1979, Milligan 2000), as stated in (3a). On its own, this raising may not be particularly remarkable, but the condition in (3b) adds an interesting complication: the low vowels, which are both neither triggers nor targets of harmony, nevertheless have asymmetric blocking properties. This surprising asymmetry has proven to be the most analytically challenging aspect of Menominee harmony.

(3) MENOMINEE VOWEL HARMONY

- a. /e, o/ → /i, u/ (iteratively) when a high vowel follows anywhere in the word.
- b. Intervening /æ/ blocks harmony, but intervening /a/ does not.

The examples in (4), from Bloomfield 1962, illustrate the major properties of Menominee vowel harmony. (As noted above, I rewrite Bloomfield's <ε> as <æ>.) In these examples, targets and potential targets are shown in boldface, triggers and potential triggers are underlined, and intervening vowels are boxed. In order to establish the underlying form of the harmonizing vowels, each example of harmony is accompanied by a morphologically related example in which the trigger for harmony is absent, thus allowing the underlying vowel quality to surface.

(4) EXAMPLES OF MENOMINEE VOWEL HARMONY

- a. RAISING OF /e/ (Bloomfield 1962:3)  
 Non-harmonizing: /ke:wæ:w/ ‘he goes home’ → [ke:wæ:w]  
 Harmonizing: /ke:wianæ:w/ ‘he takes him home’ → [ki:wianæ:w]
- b. RAISING OF /o/ (Bloomfield 1962:186)  
 Non-harmonizing: /pi:tok/ ‘when he brings it’ → [pi:tok]  
 Harmonizing: /pi:tokuaq/ ‘when they bring it’ → [pi:tukuaq]
- c. TRANSPARENCY OF /a/ (Bloomfield 1962:3)  
 Non-harmonizing: /mo:skamow/ ‘he emerges’ → [mo:skamow]  
 Harmonizing: /mo:skamit/ ‘if he emerges’ → [mu:skamit]
- d. OPACITY OF /æ/ (Bloomfield 1962:130)  
 /ne:cenæniw/ ‘my fellow man’ → [ne:cenæniw] (not \*[ni:cinæniw])

The role of vowel length in Menominee harmony is a subject of some confusion. While the triggering high vowel may be long or short, it has been reported that the targeted mid vowel must be long (e.g. Archangeli and Pulleyblank 1994). These reports stem from Bloomfield’s (1962:96) description, which states that harmony applies to long /e:, o:/ and short /o/ before /ʔ/. The obvious implication is that short /e, o/ are otherwise excluded as targets, as in (5).

(5) MID VOWELS AS TARGETS (strong interpretation of Bloomfield 1962)

VOWEL AND ENVIRONMENT	STATUS
long /e:, o:/	harmony applies
short /o/ before laryngeal <sup>1</sup>	harmony applies
short /e, o/ elsewhere	<b>harmony does not apply</b>

However, Milligan (2000) argues that this conclusion likely goes beyond what Bloomfield intended to express. Recall from above that Menominee short vowels are neutralized everywhere except before laryngeals. As a result, outside of pre-laryngeal position, it is impossible to tell whether a given short vowel is underlyingly mid /e, o/ or high /i, u/, which consequently makes it impossible to tell whether or not height harmony applies to short vowels in these positions. Only in pre-laryngeal position can the effects of harmony on short vowels be determined—and it is in precisely this position that Bloomfield recorded the application of harmony to short /o/. It seems, then, that Bloomfield was simply being conservative in his description, recording the application of harmony only when it had an audible effect on the surface form, as summarized in (6).

<sup>1</sup> Presumably short /e/ would be included here as well, but due to an accidental gap, no relevant examples of short /e/ before a laryngeal are attested (Milligan 2000).

## (6) MID VOWELS AS TARGETS (revised interpretation of Bloomfield 1962, after Milligan 2000)

VOWEL AND ENVIRONMENT	STATUS
long /e:, o:/	harmony applies
short /o/ before laryngeal	harmony applies
short /e, o/ elsewhere	<b>harmony may or may not apply; application has no effect on surface form due to height neutralization</b>

We therefore cannot conclude from Bloomfield's description that short vowels are excluded from harmony—in fact, as Milligan points out, the application of harmony to pre-laryngeal short /o/ confirms that harmony *can* target short vowels. The most parsimonious analysis, therefore, is one in which *all* short mid vowels can undergo harmony, just as all long mid vowels can; due to the independent factor of neutralization, the effect of harmony on mid vowels is usually, but not always, obscured on the surface. I will follow Milligan in adopting this view, and I will simplify the analyses reviewed below by removing any apparatus designed to exclude short vowels as targets of harmony. This should be a welcome simplification, as the issue of length is entirely separate from the more interesting issue of the blocking asymmetry noted above for /æ/ and /a/.

As an epilogue to the description of Menominee vowel harmony, it is worth noting that its properties may not necessarily be as clear-cut as they appear in the phonological literature. As Goddard (1987) and Milligan (2000) discuss, Bloomfield presented his examples using a normalized phonemic orthography. The reality of Menominee, however, may not be as tidy as these perfectly consistent forms imply—for example, Nevins (2004:259) notes a neglected passage of Bloomfield 1962 that mentions exceptions to the opacity of /æ/ (p. 97). In a sense, then, what we are analyzing is in fact Bloomfield's idealization of Menominee.

#### 4. Previous analyses of Menominee vowel harmony

Menominee harmony has been analyzed in two basic ways: as HEIGHT HARMONY and as TONGUE ROOT HARMONY. The height approach was taken by Steriade (1987), Cole (1987/1991), and Cole and Trigo (1988), while the tongue root approach was proposed by Archangeli and Pulleyblank (1994, 2007) and subsequently adopted or accepted by Archangeli and Suzuki (1995), Milligan (2000), Nevins (2004, 2010), Walker (2009), and Rhodes (2010). I will review these two approaches in turn and will conclude that all existing analyses are problematic.

##### 4.1 Height harmony analyses

When Menominee vowel harmony first appeared in the theoretical literature, it was treated as height harmony, as Bloomfield's description implies. However, subsequent work has shown that the proposed height-based analyses are inadequate. Steriade's (1987) analysis is admittedly incomplete, as she sets aside the issue of the opacity of /æ/, while the analysis proposed by Cole (1987/1991) and Cole and Trigo (1988) depends on an incorrect interpretation of the Menominee vowel system. As Milligan (2000) points out, it appears that Cole and Trigo were misled (understandably) by Bloomfield's confusing use of the symbol <ε> to represent the low vowel more accurately characterized as /æ/. Taking the symbol <ε> at face value, Cole and Trigo analyze the vowel in question as a non-low lax vowel—the only lax vowel in the Menominee inventory, as shown in (7a). Cole and Trigo then use the unique [–tense] specification of /æ/ (their /ε/) to explain this vowel's unique blocking behaviour.

- (7) a. COLE AND TRIGO 1988
- |   |        |   |
|---|--------|---|
| i |        | u |
| e | ɛ      | o |
|   | [-TNS] | a |
- b. MINER 1979; MILLIGAN 2000
- |   |   |
|---|---|
| i | u |
| e | o |
| æ | a |

Unfortunately for Cole and Trigo’s analysis, the characterization in (7a) cannot be defended on phonetic grounds, as it is clear that /æ/ is in fact a low vowel. Although the neutralization of short vowels means that short /æ/ varies in height, long /æ:/ is consistently transcribed as low [æ] (Miner 1979, Milligan 2000) and has the same F1 value as long /a:/ (Milligan 2002). Even if we set aside this empirical issue, there is an analytical flaw in Cole and Trigo’s account as well: as Archangeli and Pulleyblank (1994:466) point out, Cole and Trigo are “forced to assume an ad hoc feature [-tense] to identify the single vowel quality that is opaque, a feature that has no motivation in Menominee independent of harmony.”

Looking beyond the particular weaknesses of Cole and Trigo’s analysis, it is difficult to imagine how *any* height-based analysis of Menominee harmony could explain the blocking asymmetry between /æ/ and /a/. Assuming feature specifications along the lines shown in (8), it is easy to capture the triggers and targets of harmony, but the only difference between the non-participating vowels /æ/ and /a/ is the value of [±back], a feature that is wholly unrelated to height and is thus unlikely to explain why /æ/ should block height harmony while /a/ does not.

- (8) i [-back, +high, -low]      u [+back, +high, -low]      (**triggers:** [+high])  
 e [-back, -high, -low]      o [+back, -high, -low]      (**targets:** [-high, -low])  
 æ [-back, -high, +low]      a [+back, -high, +low]

Faced with this analytical challenge, it is reasonable to conclude, as Milligan (2000) does, that a height-based analysis of Menominee vowel harmony is simply unworkable.

#### 4.2 Tongue root harmony analyses

Archangeli and Pulleyblank (1994, henceforth A&P) propose a striking alternative to the ill-fated height-based approach. A&P reanalyze the Menominee vowel inventory as shown in (9b), replacing the traditional height-based system with an ATR-based system. The former mid vowels /e, o/ are reanalyzed as the high [-ATR] vowels /i, u/, and the low vowels /æ, a/ are now distinguished by [±ATR] rather than by backness.<sup>2</sup>

- (9) a. TRADITIONAL SYSTEM
- |          |       |       |
|----------|-------|-------|
|          | -BACK | +BACK |
| +HIGH    | i: i  | u: u  |
| -HI, -LO | e: e  | o: o  |
| +LOW     | æ: æ  | a: a  |
- b. ARCHANGELI AND PULLEYBLANK 1994
- |      |        |      |        |      |
|------|--------|------|--------|------|
|      | -ROUND |      | +ROUND |      |
|      | +ATR   | -ATR | +ATR   | -ATR |
| -LOW | i: i   | I: I | u: u   | U: U |
| +LOW | æ: æ   | a: a |        |      |

Under this reanalyzed system, the harmonizing feature becomes [±ATR] rather than height—the triggers /i, u/ are [+ATR] while the targets /I, U/ are [-ATR]. The important breakthrough of A&P’s approach is that the non-participating vowels /æ, a/ are *also* distinguished by the harmonizing

<sup>2</sup> A&P write the low vowel /æ/ as /a/, but I will continue to use the more conventional symbol.

feature: /æ/ is [+ATR] while /a/ is [-ATR]. This correspondence gives us the tools to develop a principled explanation for the asymmetrical blocking behaviour of /æ/ and /a/.

The success of the tongue root approach is indicated by its widespread adoption in subsequent work (Archangeli and Suzuki 1995; Milligan 2000; Nevins 2004, 2010; Walker 2009; Rhodes 2010).<sup>3</sup> Nevertheless, in the remainder of this section, I will argue that there are both empirical and analytical reasons to be uneasy with the tongue root analysis.

Empirically, there is little motivation for A&P’s reanalysis of mid /e, o/ as high /ɪ, ʊ/. Referring to Bloomfield 1962, A&P (375–6) note that there is “considerable variation” in the realization of certain Menominee vowels; in particular, they take the fact that short /e, o/ can be pronounced as [ɪ, ʊ] to support their reanalysis of these vowels as /ɪ, ʊ/. However, as we saw in Section 2, the “considerable variation” that A&P discuss is in fact limited to the *short* vowels, which are pronounced so weakly that their height contrasts are almost totally neutralized—in fact, as shown in (2) above, *all* of the short front vowels, not just /e/, can be pronounced as [ɪ], so this pronunciation tells us little about the underlying status of /e/. In view of this pervasive neutralization, it is dubious to use the short vowels to justify an analysis of the vowel inventory, especially when the realization of the long vowels is perfectly clear—and the sources are unanimous that long /e:, o:/ are pronounced as mid [e:, o:] (e.g., Miner 1979). Phonetically, then, A&P’s reanalysis of the mid vowels as high vowels finds little support.

Perhaps in recognition that their analysis departs from phonetic reality, A&P correctly point out that the phonological status of a segment is not determined by phonetics alone. They then claim that “[i]n terms of phonological patterns, the evidence comes down clearly in favor of an interpretation of Bloomfield’s *e* and *o* as high vowels, not mid” (466). This could indeed be the case, but the only such “phonological pattern” that A&P go on to cite is the fact that their interpretation makes the analysis of harmony work, while the traditional interpretation does not. While this may well be a reason to accept A&P’s analysis, it certainly does not constitute an independent phonological pattern in favour of their reinterpretation of the vowel system.

I feel that the above considerations provide ample grounds to be uncomfortable with A&P’s proposal that mid /e, o/ are actually high /ɪ, ʊ/. To avoid this issue, we could follow Milligan (2000) and Nevins (2004), who adopt the ATR analysis but discard the concomitant reanalysis of the mid vowels as high, as shown in (10).

(10) MENOMINEE VOWEL FEATURES FROM NEVINS 2004:258

	[-BACK, -ROUND]	[+BACK, -ROUND]	[+BACK, +ROUND]
-LOW	+ATR    i:    i		+ATR    u:    u
	-ATR    e:    e		-ATR    o:    o
+LOW	+ATR    æ:    æ	-ATR    a:    a	

This approach requires us to allow considerable variation in the phonetic realization of the [±ATR] contrast: among the non-low vowels, the contrast is realized by height, while among the low vowels, it correlates with backness. Although this is certainly possible, I would suggest that, other things being equal, a phonetically concrete analysis is preferable to an abstract one. Nevins also suggests an acoustic argument in favour of the ATR analysis of the vowel system: citing an acoustic study by

<sup>3</sup> I note, as well, that A&P’s commitment to their reanalysis of the Menominee vowel system is such that they recast Bloomfield’s transcriptions using their symbols and place these revised transcriptions in square brackets, thus implying their phonetic reality. Some subsequent works that cite A&P (e.g. Walker 2009; Rhodes 2010) therefore present a “Menominee” that looks quite different from the language found in the pages of Bloomfield 1962.

Milligan (2002), he notes that the /i, e/ and /u, o/ pairs are each distinguished by an F1 difference of 100 Hz. However, it is unclear to me why this fact should be taken to indicate that the relevant contrast must involve [ $\pm$ ATR]—it is at least equally possible that the uniform F1 difference between /i, u/ and /e, o/ could be evidence of a perfectly symmetric height contrast. It seems, then, that even though the approach taken by Milligan and Nevins avoids the major pitfall of A&P’s account, the empirical evidence for the ATR interpretation of the Menominee vowel system remains no stronger than that for the traditional height interpretation.

The preceding discussion was intended to show that there are empirical reasons to be less than fully satisfied with the ATR interpretation of the Menominee vowel system. On their own, these considerations are not sufficient to discredit the tongue root analysis of Menominee harmony. However, a closer examination of the analysis of harmony itself reveals a further problem. Compare the ATR-based interpretation of the vowel system with the traditional analysis:

	(11) a. TRADITIONAL SYSTEM		b. ATR-BASED SYSTEM																															
	<table style="border-collapse: collapse; margin: auto;"> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">-BACK</td> <td style="border: none; text-align: center;">+BACK</td> </tr> <tr> <td style="border: none; text-align: center;">+HIGH</td> <td style="border: 1px solid black; text-align: center;">i</td> <td style="border: 1px solid black; text-align: center;">u</td> </tr> <tr> <td style="border: none; text-align: center;">-HI, -LO</td> <td style="border: 1px solid black; text-align: center;">e</td> <td style="border: 1px solid black; text-align: center;">o</td> </tr> <tr> <td style="border: none; text-align: center;">+LOW</td> <td style="border: 1px solid black; text-align: center;">æ</td> <td style="border: 1px solid black; text-align: center;">a</td> </tr> </table>		-BACK	+BACK	+HIGH	i	u	-HI, -LO	e	o	+LOW	æ	a	<table style="border-collapse: collapse; margin: auto;"> <tr> <td style="border: none;"></td> <td colspan="2" style="border: none; text-align: center;">-ROUND</td> <td colspan="2" style="border: none; text-align: center;">+ROUND</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">+ATR</td> <td style="border: none; text-align: center;">-ATR</td> <td style="border: none; text-align: center;">+ATR</td> <td style="border: none; text-align: center;">-ATR</td> </tr> <tr> <td style="border: none; text-align: center;">-LOW</td> <td style="border: 1px solid black; text-align: center;">i</td> <td style="border: 1px solid black; text-align: center;">e</td> <td style="border: 1px solid black; text-align: center;">u</td> <td style="border: 1px solid black; text-align: center;">o</td> </tr> <tr> <td style="border: none; text-align: center;">+LOW</td> <td style="border: 1px solid black; text-align: center;">æ</td> <td style="border: 1px solid black; text-align: center;">a</td> <td style="border: 1px solid black;"></td> <td style="border: 1px solid black;"></td> </tr> </table>		-ROUND		+ROUND			+ATR	-ATR	+ATR	-ATR	-LOW	i	e	u	o	+LOW	æ	a		
	-BACK	+BACK																																
+HIGH	i	u																																
-HI, -LO	e	o																																
+LOW	æ	a																																
	-ROUND		+ROUND																															
	+ATR	-ATR	+ATR	-ATR																														
-LOW	i	e	u	o																														
+LOW	æ	a																																

Under the traditional system, the triggers of height harmony, /i/ and /u/, are the natural class of [+high] phonemes. Under the ATR-based system, however, things are not so simple, as not all of the [+ATR] vowels are triggers of tongue root harmony: while /i, u/ are triggers, /æ/ is not. Since /æ/ bears the triggering feature, why should it not trigger harmony? Archangeli and Pulleyblank (1994:379) must add a condition to their harmony rule to prevent the spreading of [+ATR] from a [+low] vowel; similarly, Nevins (2004:258, 2010:187) has to stipulate that the source of a copied [+ATR] feature must also be [-low]. The ATR account thus relies on an arbitrary, stipulated link between [ $\pm$ ATR] and [ $\pm$ low]. While this is still an improvement over Cole and Trigo’s (1988) height analysis, we have essentially traded one stipulation (the arbitrary [-tense] feature on /æ/) for another (the arbitrary ban on /æ/ spreading its [+ATR] feature). We therefore still lack a true explanation of the unique behavior of /æ/.

In summary, I have argued that the reinterpretation of the Menominee vowel system required by Archangeli and Pulleyblank’s (1994) analysis of harmony is phonetically questionable. While a more abstract understanding of the [ $\pm$ ATR] contrast obviates this empirical objection, it remains the case that the ATR analysis of harmony depends on an arbitrary restriction against spreading [+ATR] from a [+low] vowel. I would suggest, then, that the only real argument in favour of the ATR analysis is the apparent impossibility of a height analysis. However, in the remainder of the paper, I will show that an elegant height analysis is indeed available, as long as we adopt a more nuanced understanding of contrastive underspecification.

## 5. An underspecification analysis of the Menominee vowel system

This section develops an analysis of the Menominee vowel system, which provides a framework for the account of harmony presented in the following section.

## 5.1 Theoretical framework

I adopt the approach to contrastive underspecification known as Modified Contrastive Specification (Dresher et al. 1994; Dresher 2009). This approach has two basic principles:

- (12) a. Only contrastive features are phonologically active.  
 b. Contrastive feature specifications are determined by successively dividing the inventory according to a ranking of features (a “contrastive hierarchy”).

To illustrate these principles, consider the hypothetical three-vowel inventory /i a u/. For simplicity, let us restrict ourselves to the unary features [low], [labial], and [coronal]. Three of the possible contrastive hierarchies are shown in (13), together with the feature specifications they determine. The tree diagrams illustrate the scope of each contrast in the inventory; the symbol “∅” represents the unmarked member of a unary contrast.

- (13) a. [low] > [labial]                      b. [low] > [coronal]                      c. [labial] > [coronal]
- ```

graph TD
  A["[low]"] --- B["a"]
  A --- C["[∅]"]
  C --- D["[lab]"]
  C --- E["[∅]"]
  D --- F["u"]
  D --- G["i"]

```

/a/ [low]  
 /u/ [lab]  
 /i/ [∅]

```

graph TD
  A["[low]"] --- B["a"]
  A --- C["[∅]"]
  C --- D["[cor]"]
  C --- E["[∅]"]
  D --- F["i"]
  D --- G["u"]

```

/a/ [low]  
 /i/ [cor]  
 /u/ [∅]

```

graph TD
  A["[lab]"] --- B["u"]
  A --- C["[∅]"]
  C --- D["[cor]"]
  C --- E["[∅]"]
  D --- F["i"]
  D --- G["a"]

```

/u/ [lab]  
 /i/ [cor]  
 /a/ [∅]

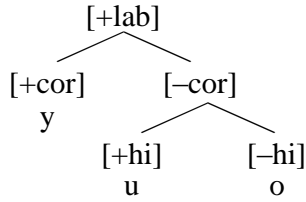
In light of principle (12a), the different feature specifications determined by each contrastive hierarchy are critically important, as they make different predictions about which processes the language in question should allow. Hierarchy (13a) allows for lowering triggered by /a/ and labialization triggered by /u/, but predicts that /i/ should not be able to trigger palatalization, as it is not contrastively [coronal]. Similarly, (13b) allows for lowering and palatalization but not labialization, while (13c) allows for labialization and palatalization but not lowering. The interplay of the principles in (12) thus produces a strongly constrained theory of inventories and processes.

The Modified Contrastive Specification approach is compatible with either binary or unary features. If we use unary features, we are in fact employing two different kinds of underspecification at once, as we are omitting redundant features (due to contrastive underspecification) as well as the unmarked values of contrastive features (due to the use of unary features).<sup>4</sup> The proposed analysis of Menominee vowel harmony is compatible with either binary or unary features, but if unary features are chosen, it is important to clarify the effects that unary contrasts have on underlying representations. As an example, let us consider a hypothetical language that has the three round vowels /y u o/. I will assume that /y/ is distinguished by its coronal place, leaving /u/ and /o/ to contrast for height. The binary and unary representations of these contrasts are compared in (14).

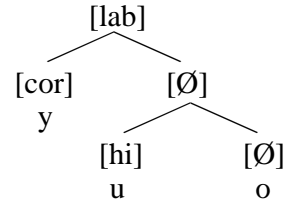
<sup>4</sup> This point was brought to my attention by Daniel Currie Hall.



(14) a. BINARY FEATURES

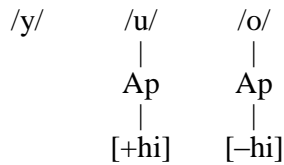


b. UNARY FEATURES

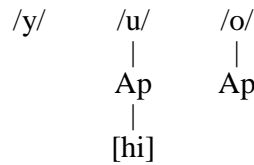


In particular, let us consider the underlying representation of height features. I will assume a feature-geometric representational model in which height features are dependents of the Aperture node. Focusing only on this node, the representations of /y, u, o/ that derive from (14) are as follows:

(15) a. BINARY FEATURES



b. UNARY FEATURES



In both cases, /y/ will have no underlying Aperture node, as it enters into no height contrasts at all. Using binary features, the /u–o/ contrast results in symmetrical representations, as both vowels bear a contrastive height feature. Using unary features, on the other hand, the /u–o/ contrast is asymmetrical, as /u/ is contrastively specified for a height feature but /o/ is not. Importantly, however, this does not mean that /o/ lacks an underlying Aperture node altogether—instead, its representation contains an Aperture node with no daughter. The presence of this Aperture node is forced by Avery and Rice’s (1989) Node Activation Condition, stated in (16). The basic insight of this condition is that all contrasts must be minimal, involving only a single structural difference.

(16) NODE ACTIVATION CONDITION (GENERALIZED)<sup>5</sup>

If a given node is the sole distinguishing feature between two segments, then the parent node is activated for the segments distinguished. Active nodes must be present in underlying representations.

Even if we adopt unary features, then, there is still an underlying representational difference between segments that do not enter into a contrast at all (such as /y/) and segments that are the unmarked member of a unary contrast (such as /o/).

Note that the empirical predictions of the binary and unary models differ: in (15a), the presence of the [–high] feature on /o/ predicts that it could trigger lowering, but in (15b), this is not possible. However, /o/ is not totally inert in (15b), as it does still bear an Aperture node that could spread or de-link. The unary model therefore still allows the unmarked member of a contrast to be phonologically active, but to a lesser extent than is predicted by the binary model. In any case, the choice between binary and unary representations is not critical for the proposed analysis of Menominee harmony, as illustrated below by the presentation of both binary and unary formulations.

<sup>5</sup> In Avery and Rice’s formulation, the NAC holds only between a secondary content node (such as [retroflex]) and the primary content node that dominates it (in this case, [coronal]). I have extended the condition to hold between a primary content node (such as [high]) and the organizing node that dominates it (in this case, [Aperture]). The insight of both formulations is the same: all contrasts must be minimal, involving only a single difference in underlying representations. If two segments contrast for a given feature, minimality requires the parent of this feature to be present in the representation of both segments.

## 5.2 Vowel system of Proto-Algonquian

With the theoretical preliminaries established, I will now propose an analysis of the Menominee vowel system. I begin, however, by considering the vowel system of Proto-Algonquian, the reconstructed ancestor of Menominee and the other Algonquian languages. Abstracting away from length, Proto-Algonquian is reconstructed as having the four-vowel system shown in (17).<sup>6</sup>

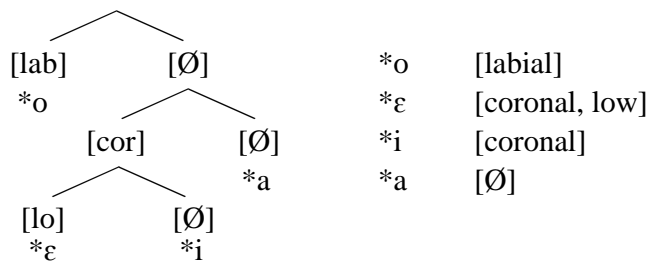
(17) PROTO-ALGONQUIAN (Bloomfield 1946)

|    |    |
|----|----|
| *i | *o |
| *ε | *a |

In other work (Oxford 2011), I have shown that the phonological properties of Proto-Algonquian vowels are best explained by the contrastive hierarchy in (18) (using unary features for simplicity).

(18) CONTRASTIVE HIERARCHY FOR PROTO-ALGONQUIAN VOWELS (Oxford 2011)

[labial] > [coronal] > [low]



In brief, the feature specifications determined by this hierarchy account for the triggering of palatalization by \*/i/ (since \*/i/ is contrastively [coronal])<sup>7</sup>, the perseverance of the labiality of \*/o/ in coalescence (since \*/o/ is contrastively [labial]), and the partial neutralization of short \*/i/ and \*/ε/ (since they differ only by the lowest-ranked feature that distinguishes them). Oxford (2011) also demonstrates that a wide range of diachronic changes across the Algonquian family follow either from this hierarchy or from minimal subsequent alterations to it.

## 5.3 Vowel system of Menominee

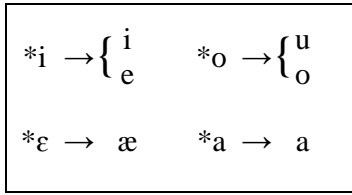
Continuing to abstract away from length, the vowel system of Menominee developed from that of Proto-Algonquian by the split of \*/i/ and \*/o/ into high and mid vowels and the lowering of \*/ε/ to /æ/, as shown in (19).<sup>8</sup>

<sup>6</sup> The vowel that I write as \*/ε/ is conventionally phonemicized by Algonquianists as \*/e/. Despite the use of the symbol <e>, however, the vowel is generally considered to be low, and its reflex is realized as [ε] or [æ] in most Central Algonquian languages (Miner 1979:11), a grouping that includes Menominee, where the reflex of \*/ε/ is /æ/.

<sup>7</sup> The failure of \*/ε/ to trigger palatalization presumably results from a constraint against spreading [coronal] from a low vowel, as proposed by Barrie (2003) for Cantonese. Such a constraint accords well with cross-linguistic palatalization patterns, as palatalization is rarely triggered by low front vowels (Kochetov 2011).

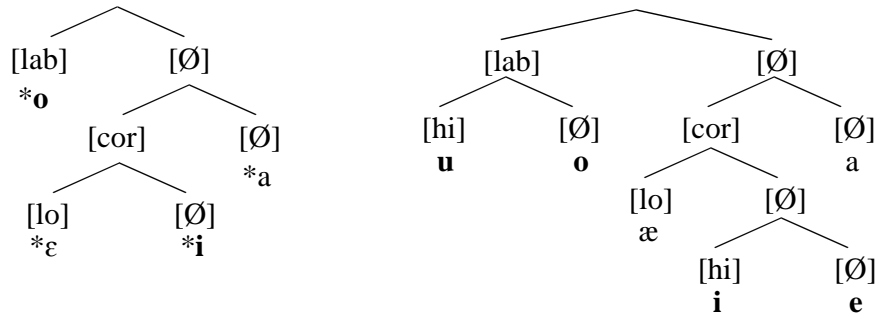
<sup>8</sup> This simplified description is sufficient for the purposes of the current paper, but see Miner 1979 for the full details. Note that the “lowering” of \*/ε/ to /æ/ may simply be a consequence of the chosen phonemicizations, as the phonetic range of Proto-Algonquian \*/ε/ may well have included [æ].

(19) FROM PROTO-ALGONQUIAN TO MENOMINEE (Bloomfield 1946; Miner 1979)



Starting from the Proto-Algonquian contrastive hierarchy, we can analyze the Menominee vowel split by adding a second height contrast within the scope of the original [low] contrast, as in (20). This has the effect of dividing the original *\*/i/* and *\*/o/* into /i–e/ and /u–o/ pairs.

- (20) a. PROTO-ALGONQUIAN                      b. MENOMINEE  
 [labial] > [coronal] > [low]                      [labial] > [coronal] > [low] > [high]



Note that /i/ and /u/ differ from /e/ and /o/ only in the lowest-ranked feature that distinguishes them (i.e. [high]). As pointed out to me by Daniel Currie Hall, the close structural relationship between the high and mid vowels mirrors the fact that these vowels are closely related both diachronically (as they have a common origin) and synchronically (as they take part in the vowel harmony alternation).

This analysis of the vowel system entails that Menominee vowel harmony must be height harmony. The analysis of vowel harmony thus depends on the contrastive Aperture specifications that result from (20b). These specifications are shown in (21) in both unary and binary form.

- (21) a. UNARY APERTURE SPECIFICATIONS                      b. BINARY APERTURE SPECIFICATIONS
- |      |    |      |    |      |    |            |            |       |    |       |       |
|------|----|------|----|------|----|------------|------------|-------|----|-------|-------|
| i    | e  | æ    | a  | u    | o  | i          | e          | æ     | a  | u     | o     |
|      |    |      |    |      |    |            |            |       |    |       |       |
| Ap   | Ap | Ap   | Ap | Ap   | Ap | Ap         | Ap         | Ap    | Ap | Ap    | Ap    |
|      |    |      |    |      |    |            |            |       |    |       |       |
| [hi] |    | [lo] |    | [hi] |    | [–lo, +hi] | [–lo, –hi] | [+lo] |    | [+hi] | [–hi] |

6. An underspecification analysis of Menominee vowel harmony

Regardless of whether we use binary or unary features, the specifications in (21) give us the tools to capture all the properties of Menominee vowel harmony without need for stipulations:

- (22) a. /i, u/, the triggers, are the natural class **[+high]** (binary) or **[high]** (unary).  
 b. /e, o/, the targets, are the natural class **[–high]** (binary) or **[Ap [Ø]]** (unary).  
 c. The opaque vowel /æ/ has the Aperture feature **[+low]** (binary) or **[low]** (unary).  
 d. The transparent vowel /a/ has **no underlying Aperture node**.

The classes in (22) straightforwardly characterize the triggers and targets of harmony according to their height features, while the asymmetry between the non-participating vowels /æ/ and /a/ follows from the fact that opaque /æ/ is specified for a height feature while transparent /a/ is not. We have thus succeeded in linking the blocking asymmetry of the low vowels to the harmonizing dimension while maintaining the phonetically concrete interpretation of this dimension as height rather than ATR.

With the feature specifications in (22) in place, the task of formulating a harmony rule becomes straightforward. A possible feature-geometric formulation is given in (23) in both binary and unary implementations. Although harmony applies only to the feature [high] (not to [low]), the process cannot be confined to the [high] tier alone, as it is blocked by the [low] vowel /æ/. To capture the intervention of a [low] vowel in a [high]-harmony process, I formulate the process as involving spreading of the Aperture node as a whole, conditioned by the presence of a [high] dependent.

- (23) a. MENOMINEE VOWEL HARMONY (BINARY)      b. MENOMINEE VOWEL HARMONY (UNARY)



The binary formulation states that a [-high] Aperture node is replaced by an immediately following [+high] Aperture node, while the unary formulation states that an Aperture node with no dependent is replaced by a following [high] Aperture node. The transparency of /a/ therefore follows from the fact that it lacks an Aperture node altogether, as shown in (24).

- (24) TRANSPARENCY OF /a/ (RESULT: /o...a...i/ → /u...a...i/)

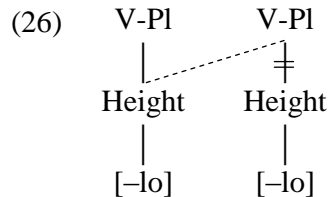


The opacity of /æ/ follows equally straightforwardly. Unlike /a/, the underlying representation of /æ/ does contain an Aperture node, as /æ/ is contrastively [low]. Since its Aperture node bears neither [+high] nor [-high], /æ/ is neither a trigger nor a target of harmony. However, the presence of the Aperture node still prevents the spreading of a more distant Aperture node, as shown in (25).

- (25) OPACITY OF /æ/ (RESULT: /o...æ...i/ remains unchanged)



It could be argued that this analysis is still not stipulation-free, as it requires two assumptions: first, that [high] and [low] are both dependents of a single Aperture node, and second, that a non-terminal Aperture node may spread (contra Halle 1995 and Halle, Vaux, and Wolfe 2000). However, both of these assumptions are often employed in the literature. The grouping of height features under a single node is commonplace (e.g. Clements and Hume 1995), while the possibility of spreading a non-terminal Aperture (or Height) node is illustrated by the analysis shown in (26), from Odden 1991:282—a formulation that closely mirrors the one proposed for Menominee in (23) above.<sup>9</sup>



The assumptions required by the proposed height-based account thus have ample precedent in the literature, unlike the arbitrary restriction against spreading [ATR] from a [low] vowel that must be stipulated in the ATR-based account.

## 7. Conclusion

Contrary to the general impression in the literature, a straightforward height-based analysis of Menominee vowel harmony is indeed available, provided that we accept a hierarchical model of contrastive underspecification. This approach to Menominee harmony has several advantages. In recognizing height as the harmonizing feature, it hugs the phonetics as closely as possible, allowing us to maintain the traditional understanding of the Menominee vowel system and avoid the controversial use of [±ATR] as an “ersatz feature employed to encode height distinctions” (Vaux 1996:175 paraphrasing Clements 1990). Unlike the ATR account, the contrastive height analysis does not require a stipulation in order to rule out /æ/ as a trigger of harmony, as /æ/ does not bear the triggering feature [high]. Similarly, the blocking asymmetry between /æ/ and /a/ falls out from the fact that /æ/ is specified for a height feature while /a/ is not. Furthermore, in its use of a contrastive hierarchy inherited from Proto-Algonquian, the analysis integrates Menominee harmony into a more general analytical framework. This provides diachronic and cross-linguistic continuity with the wide range of Algonquian phonological developments examined in Oxford 2011 and ensures that the premises underlying the proposed analysis of Menominee harmony are not tailor-made to explain this process alone. For all these reasons, I conclude that Menominee vowel harmony is best regarded as height harmony, as originally reported, not as ATR harmony, as commonly repeated in the literature.

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<sup>9</sup> This is an analysis of height harmony in Kimatuumbi (Bantu). This process involves the spreading of the entire Height node (which, for Odden, has the dependents [high], [low], and [ATR]), but it applies only to [–low] vowels.

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