



PATTERNS OF CONTRAST IN PHONOLOGICAL CHANGE:  
EVIDENCE FROM ALGONQUIAN VOWEL SYSTEMS

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This article proposes that patterns of phonological contrast should be added to the list of factors that influence sound change. It adopts a hierarchically determined model of contrast that allows for a constrained degree of crosslinguistic variation in contrastive feature specifications. The predictions of this model are tested against a database comprising the set of vowel changes in the Algonquian languages. The model reveals striking commonalities in the underlying sources of these changes and straightforwardly predicts the previously unrecognized patterning of the languages into two groups: (i) those in which \*/ε/ tends to merge with \*/i/ and palatalization is triggered by \*/i/, and (ii) those in which \*/ε/ tends to merge with \*/a/ and palatalization is triggered by \*/ε/. In addition to providing a new argument for the relevance of contrast to phonology, the model also gives us a way to import traditional philological findings into a framework that brings them to bear on theoretical questions.\*

*Keywords:* sound change, contrast, vowel systems, Algonquian, phonology, historical linguistics, merger

**1. INTRODUCTION.** Sound change has long been a central concern of linguistic theory, and the factors that govern it have been studied from various perspectives. Sociolinguistic research has clarified our understanding of the triggering and spread of changes (e.g. Labov 1994, 2001, 2010). Other work has examined the role of phonetic factors (e.g. Greenlee & Ohala 1980, Ohala 1981) and the relationship between such factors and synchronic phonology (e.g. Blevins 2004). Still other work has considered the influence of central notions of phonological theory, such as markedness and symmetry (e.g. Lahiri 2000). This article examines the role of an even more basic phonological notion: contrast. It is argued that a simple model of the diachronic role of contrast allows us to identify underlying relationships among sound changes that would not otherwise be evident. The insights that can be gained from such a model are illustrated through its application to a body of data that has not previously been brought to bear on phonological theory: the broad and diverse set of vowel changes attested in the evolution of the Algonquian languages.

The article proceeds as follows. Since the goal is to explore the explanatory power of contrast, the article begins by adopting the restrictive axiom that only contrastive features can be phonologically active. Further considerations lead to the conclusion that contrastive feature specifications are subject to crosslinguistic variation, thus constituting a parameter of phonological change that is formalized in a simple, constrained model. The remainder of the article tests this model by applying it to the set of Algonquian vowel changes, beginning with Proto-Algonquian and continuing through all of the major daughter languages. The model provides new insights into the patterning of the Algonquian vowel changes, revealing the shared underlying origins of a variety of developments whose connections would not otherwise be obvious. The Algonquian case study thus provides new evidence that contrast plays an important role in sound change.

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The scope of the article includes all of the major vowel changes in all of the approximately twenty adequately attested Algonquian languages, which were chosen as a test case for two reasons: their diversity, which presents a formidable test for a unified phonological analysis, and the relative simplicity of their vowel systems, which makes this test manageable to carry out. While the phonological history of Algonquian is well documented, these important philological findings have heretofore received little theoretical interpretation, perhaps due to the significant barriers that the specialist literature presents to non-Algonquianists. In fact, the current article appears to be the first to gather and summarize the major Algonquian vowel changes in a unified manner, thus hopefully making them accessible to a broader audience of phonologists of all theoretical orientations.

Certain limitations of the article's scope should be noted. First, the article remains within the bounds of the existing philological literature and contains no new empirical work on Algonquian historical phonology. Second, the article focuses only on the major vowel-related changes in each Algonquian language, which are taken to include changes in the vowel inventory (e.g. mergers and shifts) and vowel-related phonological processes (e.g. palatalization). Third, while the article accounts for important synchronic processes such as Menominee vowel harmony, it does not pretend to arrive at a complete synchronic analysis of the phonology of each Algonquian language, a task that is beyond the scope of a single survey article. Finally, in no sense does the article claim that contrast is the only factor in sound change, nor even the most important factor. The claim is simply that recognizing a role for phonological contrast in sound change can deepen our understanding of diachronic patterns and enable us to identify new patterns that would not otherwise be evident.

**2. CONTRAST AND SOUND CHANGE.** This section sets out the theoretical assumptions of the article, beginning by discussing the notion of phonological contrast (§2.1) and the basic properties of sound change (§2.2). These two strands are then combined in the formulation of a model of the role of contrast in sound change (§2.3).

**2.1. CONTRAST.** The fundamental assumption of this article is the principle stated in 1, which Hall (2007) refers to as the **CONTRASTIVIST HYPOTHESIS**.

- (1) **CONTRASTIVIST HYPOTHESIS:** Only contrastive features are phonologically active.

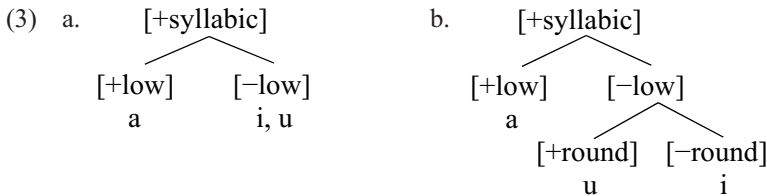
This hypothesis has a long pedigree, dating back to the work of de Saussure (1916) and Trubetzkoy (1939) and playing a significant role in the theories of **CONTRASTIVE SPECIFICATION** (Steriade 1987, Clements 1988) and **RADICAL UNDERSPECIFICATION** (Kiparsky 1982, Archangeli 1984, Pulleyblank 1986). Although its importance has lessened under **OPTIMALITY THEORY** (OT; e.g. Itô et al. 1995), the feature-ranking approach to underspecification adopted in this article has been argued in Mackenzie & Dresher 2004 and Mackenzie 2013 to be compatible with OT.

The important role attributed to contrastive features under the contrastivist hypothesis requires us to be explicit about how to determine which features are contrastive in a given inventory. Contrastive features are typically computed using what Dresher (2009) refers to as the 'minimal pairs' method: a feature is taken to be contrastive for a given phoneme if another phoneme exists that differs only in the value of that feature. Dresher (2008a,b, 2009, 2010) has argued at length that this intuitive method is in fact logically flawed and that, in many cases, it requires the analyst to tacitly decide that certain features are more important than others. Dresher (2012) illustrates this point using the feature specifications assumed by Nevins (2010:26) for Turkish vowels. As shown in 2a,

Nevins follows the traditional analysis by employing the features [back], [round], and [high], which neatly organize the eight vowels such that each has a counterpart differing only in the specification of a given feature—for example, /e/ and /a/ differ only in the value of [back]. However, Dresher points out that this tidy analysis hinges on the assumption that only the features [back], [round], and [high] can be contrastive in Turkish. If the feature [low] were added to the computation, as in 2b, the analysis would break down, as /e/ and /a/ now differ in the values of both [back] AND [low] and the ‘minimal pairs’ method cannot coherently apply.

(2) a.		[−back]		[+back]					
		[−rnd]	[+rnd]	[−rnd]	[+rnd]				
	[+hi]	i	ü	i	u				
	[−hi]	e	ö	a	o				
b.		[−back]		[+back]					
		[−rnd]	[+rnd]	[−rnd]	[+rnd]				
	[+hi]	i	ü	i	u				
	[−hi]	e	ö		o	[−lo]			
				a		[+lo]			

The ‘minimal pairs’ approach to contrastive specification thus relies on an implicit ranking of features: in Turkish, for example, contrasts involving the features [back], [round], and [high] must be computed first, thus guaranteeing that other features, such as [low], will be redundant. Dresher (2008a,b, 2009, 2010) and colleagues (Dresher, Piggott, and Rice 1994, Dresher & van der Hulst 1998, Dresher & Zhang 2005) have argued for an alternative approach to contrastive specification that avoids this pitfall by making the ranking of features explicit rather than tacit—a method employed implicitly by Trubetzkoy and developed formally in Jakobson, Fant, & Halle 1952 and Jakobson & Halle 1956. Instead of simultaneously comparing all of the segments in an inventory, this method determines contrasts in a dichotomous fashion, successively dividing the inventory into smaller classes until all segments are contrastively specified. Let us take the three-vowel system /i a u/ as an example. If we first divide these vowels according to the feature [low], /a/ will be contrastively [+low] and /i, u/ [−low], as in 3a. We may then use the feature [round] to distinguish the remaining /i, u/, as in 3b. Note that the [round] contrast is not relevant for /a/, since the preceding [low] contrast was sufficient to distinguish /a/ from the other vowels. Such scopal relationships among contrasts are illustrated by tree diagrams like 3b.



The contrastive feature specifications determined by this method depend upon the order in which contrasts are applied. The ranking of contrasts, which Dresher refers to as the CONTRASTIVE HIERARCHY, appears to be at least partly language-particular and is thus a fundamental source of crosslinguistic variation. Under the ranking in 3b, for example, /u/ is contrastively [+round], but if the [round] contrast were replaced with [coronal], /i/ would be contrastively [coronal] and /u/ would be unmarked. Given the contrastivist hypothesis, this difference is important, since it makes predictions about

possible processes: rounding triggered by /u/ should only be possible in languages where /u/ is contrastively [+round], while palatalization triggered by /i/ should only be possible in languages where /i/ is contrastively [coronal]. Combining the contrastivist hypothesis with hierarchical contrastive specification thus produces a strongly and explicitly constrained model of phonological activity and typology.<sup>1</sup> It is this model that the current article is designed to test, using the Algonquian family as a database.

To implement this model, we must also assume some model of the features themselves. This article employs the place features [labial], [coronal], and [dorsal] (equivalent to [round], [front], and [back]), the height features [low] and [high], and the length feature [long] (discussed below). The analysis of Menominee vowel harmony (§4.4) also assumes a simple model of feature geometry in which height features are dependents of an Aperture node (Clements 1991, Clements & Hume 1995). Features are treated as privative, with only the marked (positive) value taken to be underlyingly present; unmarked values are represented as [Ø]. Privativity is not an obligatory component of this model, but it makes the model maximally restrictive, since it predicts that only the marked values of contrastive features will be phonologically active.

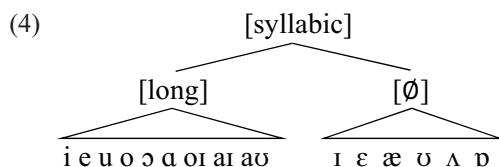
The use of a [long] feature warrants comment, as there is convincing evidence that vowel length is represented structurally rather than featurally, either in a skeletal tier (McCarthy 1979, 1982, Clements & Keyser 1983) or as moraic weight (Hayes 1989). This evidence notwithstanding, vowel length still appears to have phonemic status in many languages. The English tense/lax contrast, for example, is often argued to be an abstract length contrast (Labov 1994, Durand 2005), but few would go as far as to claim that long /i/ and short /i/ are thus not separate phonemes. It seems, then, that even though vowel length is not featurally represented, it can still serve to establish phonemic contrasts within an inventory. I employ the feature [long] in this abstract contrastive sense, with the assumption that the contrast is realized in underlying representations not as a feature, but as the appropriate skeletal or moraic structure.

**2.2. SOUND CHANGE.** Sound change has been studied extensively from various perspectives: philological (e.g. Hoenigswald 1960), theoretical (e.g. Kiparsky 1995), and sociolinguistic (e.g. Labov 1994, 2001, 2010). This section outlines some of the major linguistic factors that affect sound change. While cognitive and sociocultural factors also play important roles, they are less relevant to the current article, which focuses solely on the consequences of sound change for phonological contrast.

An overarching factor in the patterning of sound change is the notion of SUBSYSTEMS—partitions of the inventory that behave autonomously with respect to mergers, chain shifts, and phonetic dispersion (Labov 1994). Labov divides the English vowel system into long and short subsystems, which often pattern differently; for example, the Canadian shift (Clarke et al. 1995) is confined to the short subsystem. Labov's subsystems cannot simply be equated with natural classes because they are inflexible: while an inventory can be divided into a variety of cross-classifying natural classes, its subsystems are rigid. Labov (1994:271) states that subsystems are 'indissolubly connected to the notion of hierarchy' and that '[i]f all features were at the same level of abstractness, there would be no subsystems'. These statements are strikingly compatible with the hierarchical model of contrast proposed above: if contrasts apply to the inventory in a dichotomous fashion, the highest-ranked contrast (the most abstract, in Labov's terms) will always produce two separate subinventories. If we assume, for example,

<sup>1</sup> For a discussion of the phonetic implementation of this model, see Hall 2011.

that length is the highest-ranked vowel contrast in English, the division in 4 will result, with the lower-ranked contrasts then applying separately within each subsystem.



Different languages may determine vowel subsystems using different features, including length, nasality, glottalization, and creaky voice (Labov 1994:272). Under the model proposed here, such differences would indicate that the relevant feature is ranked at the top of the contrastive hierarchy of the language in question.

Perhaps the most dramatic form of sound change is the chain shift, which Labov (2010:92) divides into two types: GENERALIZABLE chain shifts apply within a subsystem and can be expressed as a unified rule (e.g. lowering), while SEQUENTIAL chain shifts cross subsystem boundaries and involve at least two distinct processes (e.g. the nasalization of \*/a/ to /ã/ followed by the backing of \*/ɛ:/ to /a:/ in Massachusetts (§5.5)).

Mergers are far more frequent than chain shifts (Labov 1994:310) and result from at least three distinct mechanisms. In MERGER BY APPROXIMATION, the phonetic target of /a/ gradually converges with that of /b/; the outcome may be realized as either [a], [b], or intermediate [c]. Such mergers are regular, affecting all eligible instances of /a/ (Trudgill & Foxcroft 1978, Labov 1981). In MERGER BY TRANSFER, instances of /a/ are categorically replaced with /b/ in a word-by-word fashion, diffusing gradually through the lexicon (Wang 1969, Trudgill & Foxcroft 1978). Finally, in MERGER BY EXPANSION, the phonetic ranges of /a/ and /b/ expand until they are coextensive, resulting in a single phoneme that is phonetically realized as [a ~ b], with the distribution of [a] and [b] determined allophonically (Herold 1990, Labov 1994). For the purposes of this article, the end result of each type of merger is the same—the loss of a phonemic contrast—but the recognition of different mechanisms explains why the outcome of merger is sometimes categorical and sometimes intermediate, as we will observe in the Algonquian data.

Mergers are typically classified according to their extent: in a CONDITIONED merger, a contrast is lost in a particular environment, while in an UNCONDITIONED merger, a contrast is lost everywhere (Hoenigswald 1960, Gordon 2002). An alternative classification, however, is tacitly assumed in the informal use of the terms ‘coloring’ and ‘falling together’ in philological work. A ‘coloring’ merger results from the application of an assimilatory process, thus reflecting the syntagmatic influence of one segment on another. For example, imagine a harmony process that backs /e/ to [o] before /u/. If subsequent changes rendered the conditioning environment opaque, the derived instances of [o] could be reanalyzed as underlying /o/, thus effecting a partial merger of /e/ with /o/. I refer to such segmentally triggered mergers as MUTATION MERGERS. In a ‘falling together’ merger, by contrast, the paradigmatic contrast between two segments simply disappears, either in a particular conditioning environment (as in the English *pin–pen* merger) or everywhere (as in the English *cot–caught* merger). I refer to such mergers as STRUCTURAL MERGERS. This distinction will bring clarity to the phonological model of mergers proposed below.

In addition to shifts and mergers, sound change also involves the development of phonological processes, which follow the well-known life cycle in 5 (Kiparsky 1995, Bermúdez-Otero 2007, 2011, Bermúdez-Otero & Trousdale 2012).

- (5) The life cycle of a phonological process
- Articulatory, acoustic, or auditory phenomenon
  - Language-specific pattern of gradient phonetic implementation
  - Categorical phrase-level phonological process
  - Categorical phonological process with narrowing domain (word, stem)
  - Morphological process or lexicalized residue

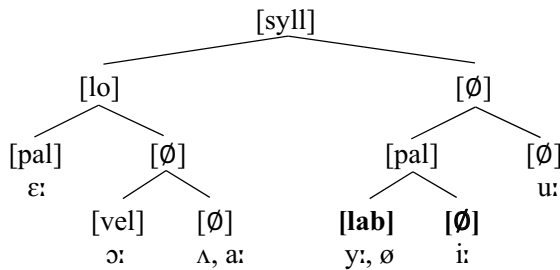
Only at the stages in 5c–d does a process provide evidence about the phonological system (such as the activity of features). Unfortunately for phonologists, most processes in the Algonquian languages appear to be at stage 5e, as observed by Wier (2004:426) for Meskwaki. However, the diachronic approach I take allows us to sidestep this issue. Since any given process must have passed through stages 5c–d at some point, we can draw conclusions about the status of the phonological system AT THAT POINT regardless of the contemporary status of the process in question.

Kiparsky (1995) makes several proposals of a more theoretical nature. Like the current article, he argues that underspecification is important diachronically as well as synchronically. He also points out that ‘sound change is not blind’ in that it tends not to produce typologically unusual results, plausibly due to a learning bias that disfavors the selection of unusual innovations. With regard to processes, Kiparsky suggests that assimilation should not be able to spread the unmarked value of a feature and that neutralization should favor the unmarked value. Both proposals are consistent with the use of privatively specified features in the current article.

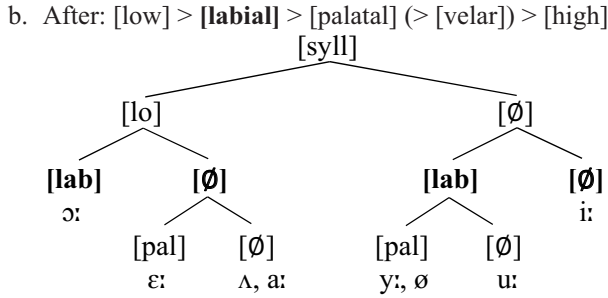
**2.3. THE ROLE OF CONTRAST IN SOUND CHANGE.** With the essential properties of contrast and sound change established, we are now prepared to combine these concepts in the formulation of a model of the role of contrast in sound change. Before proposing such a model, I first survey previous work that has touched on this issue within the approach to contrast adopted in this article.

**PREVIOUS WORK ON CONTRAST AND SOUND CHANGE.** Some previous work has examined sound change from a hierarchical perspective, but the issue has usually been addressed on a smaller scale than in the current article. For example, Barrie (2003) has proposed that the Hong Kong Cantonese contrastive hierarchy recently underwent the reranking in 6, in which [labial] was promoted above [palatal].<sup>2</sup> This reranking accounts for two separate changes: the loss of the contrastive [palatal] feature on /i:/ explains why /i:/ has ceased to trigger palatalization, while the addition of a contrastive [labial] feature on /ɔ:, u:/ explains why /ɔ:, u:/ are now subject to a constraint on cooccurrence with labiovelar consonants.

- (6) a. Before: [low] > [palatal] > [velar] > **[labial]** > [high]



<sup>2</sup> To save space, the low-ranked [high] contrast is omitted from these diagrams.



Dresher and Zhang (2005) discuss Classical Manchu, in which an [ATR] (advanced tongue root) contrast distinguished two pairs of phonemes: /u, ʊ/ and /ə, a/. Subsequently, however, /u, ʊ/ fell together, leaving /ə, a/ as the only [ATR] pair in Manchu. Since /ə, a/ are not a canonical example of an [ATR] contrast, Dresher and Zhang propose that the /ə, a/ pair was reanalyzed as contrasting for [low], a feature that was already active elsewhere in the Manchu inventory. The reanalysis of /ə/ as a contrastively non-[low] vowel made it necessary to distinguish /ə/ from the existing non-[low] vowel /u/. Dresher and Zhang propose that the feature [labial] was pressed into service for this purpose, thus making /u/ contrastively [labial]. Given the contrastivist hypothesis, this predicts that /u/ should gain the ability to trigger labialization—a prediction that is borne out by the subsequent development of a labialization process. This example shows that a segment (in this case, /u/) can gain new phonological properties purely as a side-effect of a change in the contrastive status of some other segment (in this case, /ə/).

The most extensive diachronic application of the hierarchical model of contrast is found in the work of Ko (2010, 2011, 2012) on Korean, Mongolic, and Tungusic, and the analysis developed in the current article is largely compatible with Ko's proposals. To account for the patterning of phonological mergers, Ko (2010:191, 2012:35–37) proposes the MINIMAL CONTRAST PRINCIPLE, which is similar to the SISTERHOOD MERGER HYPOTHESIS that I propose in 10 below.

- (7) MINIMAL CONTRAST PRINCIPLE: Phonological merger operates on a minimal contrast—that is, on two segments that share a terminal branching node under a given contrastive hierarchy.

Ko (2010) proposes that the vowel systems of Middle Korean and Early Modern Korean were organized by the contrastive hierarchies in 8. Two major changes occurred in the Early Modern Korean system: the [RTR] (retracted tongue root) contrast was replaced by a higher-ranked [high] contrast, and the vowel /ʌ/ was reanalyzed as [labial] due to its phonetic rounding.

- (8) a. Middle Korean: [coronal] > [low] > [labial] (excludes /ʌ/) > [RTR]  
 b. Early Modern Korean: [coronal] > [low] > **[high]** > [labial] (includes /ʌ/)

Under the hierarchy in 8a, /ʌ/ contrasted with /i/ only for [RTR], the lowest-ranked feature, thus qualifying the /ʌ, i/ pair as a candidate for merger under Ko's minimal contrast principle—and a partial merger of /ʌ/ with /i/ indeed occurred. This relationship was disrupted, however, by the reranking in 8b, which left /ʌ/ in a minimal contrast with /a/ for [labial], the lowest-ranked feature, thus correctly predicting the merger of the remaining instances of /ʌ/ with /a/ rather than /i/ in Early Modern Korean. Ko analyzes subsequent mergers in Modern Korean in the same way: further rerankings ensure that all mergers involve the loss of the lowest-ranked contrast.

Ko (2011) extends the minimal contrast principle to the vowel systems of the Mongolic languages. He posits the contrastive hierarchy in 9a for Old Mongolian. In Mon-



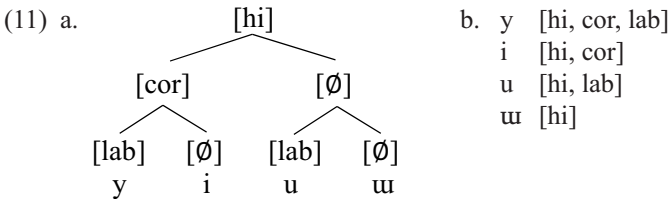
golic languages that retain this hierarchy, such as Dagur, mergers involve the loss of the lowest-ranked [low] contrast, as predicted. Ko proposes that the other Mongolic languages promoted the height contrast, giving the hierarchy in 9b; mergers are now predicted to involve the [RTR] contrast, as attested in the Monguor group. Finally, Ko proposes that Kalmyk and Oirat reanalyzed the [RTR] contrast as [dorsal], as in 9c, which is taken to explain a shift in vowel harmony patterns.

- (9) a. Old Mongolian: [coronal] > [labial] > [RTR] > [low]
- b. Promotion of height: [coronal] > [low] > [labial] > [RTR]
- c. Reanalysis of RTR: [coronal] > [low] > [labial] > [dorsal]

A MODEL OF THE ROLE OF CONTRAST IN SOUND CHANGE. Building upon the work summarized above, this section sets out four hypotheses regarding the role of contrast in phonological change, beginning with the two in 10. The first hypothesis, repeated from 1 above, should be expected to hold at any diachronic stage.

- (10) a. Contrastivist hypothesis: Only contrastive features are phonologically active.
- b. SISTERHOOD MERGER HYPOTHESIS: Structural mergers apply to ‘contrastive sisters’.

The second hypothesis refers to structural mergers, in which two phonemes fall together without external assimilatory or dissimilatory influence. Such mergers thus simply appear to involve the loss of a contrast. However, the implications of this statement depend on what a ‘contrast’ is understood to involve: is it simply a matter of contrastive feature specifications, or does it refer to a hierarchical relationship in the inventory? For concreteness, let us consider a language with the high-vowel subsystem /i, y, u, ʊ/ and the contrastive hierarchy [high] > [coronal] > [labial]. The resulting contrastive hierarchical relationships and feature specifications are shown in 11.



If, on the one hand, contrast is simply a matter of contrastive feature specifications, then a structural merger—the loss of a contrast—should simply involve the loss of a contrastive feature. This featural model of merger predicts that the inventory in 11 could undergo the four structural mergers in 12a, each resulting from the loss of a different feature. (Let us temporarily confine ourselves to mergers involving only two phonemes.) On the other hand, if contrast is a dichotomous hierarchical relationship in the inventory, the loss of a contrast should instead involve the collapse of a particular hierarchical branch. This model predicts the possibility of fewer structural mergers, as shown in 12b. For example, whereas the featural model predicted that /y/ could merge with either /i/ or /u/ (by losing either [labial] or [coronal]), the hierarchical model predicts that /y/ can only merge with /i/, since /i/ is the only phoneme that /y/ is in direct hierarchical contrast with.

- (12) a. Featural mergers
  - /y/ > /i/ (loss of [lab] feature)
  - /y/ > /u/ (loss of [cor] feature)
  - /i/ > /ʊ/ (loss of [cor] feature)
  - /u/ > /ʊ/ (loss of [lab] feature)
- b. Hierarchical mergers
  - /y/ > /i/ (loss of [lab] contrast)
  - /u/ > /ʊ/ (loss of [lab] contrast)

The hierarchical model of merger is consistent with the hierarchical approach to contrast and is also more restrictive and thus more interesting than the featural model, so I adopt it as the sisterhood merger hypothesis: structural mergers always involve ‘contrastive sisters’, defined hierarchically as any two nodes that are immediately dominated by the same node. This definition is broader than that of Ko’s minimal contrast principle in 7 above, since it predicts that structural mergers can affect any hierarchical contrast, not just the lowest-ranked one. The loss of a higher-ranked contrast will produce a merger of CLASSES rather than single phonemes. In 11, for example, the loss of the [coronal] contrast would bring about the merger of the coronal vowels /y, i/ with the noncoronal vowels /u, ʊ/ (i.e. the parallel merger of /y/ > /u/ and /i/ > /ʊ/). While the complexity of such classwise mergers makes them less likely than typical pairwise mergers, we observe one such merger in Cheyenne and Arapaho-Atsina in §6.2.

The sisterhood merger hypothesis predicts which mergers are possible, but predicting the outcome of a given merger is less clear-cut, since the three mechanisms of merger (§2.2) behave differently, with only merger by transfer consistently producing outcomes that are categorically the same as one of the input phonemes. In such categorical cases, the conception of merger as the loss of a contrast does predict the outcome: since merger eliminates a marked feature value, the outcome should bear the unmarked value of the merged contrast, as proposed by Kiparsky (1995) for neutralization.

Taken on their own, the two hypotheses in 10 strongly restrict the analysis of genetically related languages, as they imply that all phonological developments in all daughter languages should be consistent with the contrastive hierarchy of the parent language. The work reviewed in the preceding section indicates that this restriction is, in fact, too strong, so we must add the CONTRAST SHIFT HYPOTHESIS to allow for change in the contrastive organization of the inventory (cf. Ko 2012:31–34).

(13) CONTRAST SHIFT HYPOTHESIS: Contrastive hierarchies can change over time. This hypothesis recognizes ‘contrast shift’—change in the ranking of contrasts—as a fundamental mechanism of phonological change and thus a fundamental factor in phonological typology, akin to the use of constraint reranking in OT (Zubritskaya 1997, Anttila & Cho 1998). While the contrast shift hypothesis appears to be necessary, it also reduces the restrictiveness of the model, so it must be applied with care: an analysis that proposes a dramatic reorganization of contrasts at every diachronic stage would obviously be ad hoc and would provide little in the way of explanation. Let us therefore constrain the contrast shift hypothesis by requiring contrast shifts to be as minimal as possible, ideally involving either the addition or deletion of a single contrast or the reranking of a single contrast by a single step. The more an analysis adheres to this constraint, the more explanatory it may be considered.

To further constrain the action of contrast shift, let us assume that contrast shifts are influenced (and perhaps motivated) by the vaguely defined but generally recognized forces of drift, markedness, and symmetry. Drift refers to the tendency for successive changes to continue in the same direction along a given dimension (Sapir 1921:165), thus favoring an analysis in which a contrast undergoes consecutive promotions or demotions over one in which its ranking vacillates. Markedness refers to the tendency for changes to disfavor typologically unusual properties (e.g. Lahiri 2000). It has been proposed, for example, that vocalic contrastive hierarchies begin with a height contrast by default (Jakobson & Halle 1956:41), so we might expect a tendency for hierarchies that begin with some other feature to undergo shifts involving the promotion or addition of a height contrast (as we observe below in both of the divergent Algonquian branches). Finally, the force of symmetry favors changes that increase the symmetry of the inven-

tory (Martinet 1952, 1955), thus maximizing feature economy (Clements 2003, 2009). We may regard a proposed contrast shift that obeys these forces as having a stronger motivation than one that does not.

The final hypothesis regarding the diachronic role of contrast is the SEGMENTAL REANALYSIS HYPOTHESIS (cf. Ko 2012:34).

- (14) SEGMENTAL REANALYSIS HYPOTHESIS: A segment may be reanalyzed as having a different contrastive status.

The possibility of segmental reanalysis arises when a contrastive hierarchy provides alternative ways to contrastively specify a given segment. Such reanalysis occurred in the Manchu shift discussed by Drescher and Zhang (2005) (§2.2 above), in which the segments /ə, a/ originally contrasted for [ATR] but were reanalyzed as contrasting for [low]. Segmental reanalysis is especially likely in cases where phonetic change has caused a phoneme to become a marginal exemplar of the contrastive feature that originally distinguished it.

**2.4. SUMMARY: CONTRAST AND SOUND CHANGE.** Building on existing work, this section has proposed that the role of contrast in phonological change is subject to the four hypotheses in 15.

- (15) a. Contrastivist hypothesis: Only contrastive features are phonologically active.  
 b. Sisterhood merger hypothesis: Structural mergers apply to ‘contrastive sisters’.  
 c. Contrast shift hypothesis: Contrastive hierarchies can change over time.  
 d. Segmental reanalysis hypothesis: A segment may be reanalyzed as having a different contrastive status.

Taken together, these hypotheses provide a constrained model of the role of contrast in diachronic phonology: the contrastivist hypothesis and the sisterhood merger hypothesis constrain the phonemic changes that can occur in a given inventory, while the contrast shift hypothesis and the segmental reanalysis hypothesis constrain the degree to which the contrastive structure of the inventory can change. We thus have a principled means of relating the phonological analysis proposed for a particular diachronic stage of a given language to other diachronic stages and other related languages.

The remainder of the article tests the hypotheses in 15 by applying them to the vowel systems of the Algonquian languages. The data includes all major vowel changes and vocally conditioned consonant changes from across the family, beginning with reconstructed Proto-Algonquian. The analytical strategy is as follows. I take the stability of the contrastive hierarchy to be the null hypothesis, so each change in the data will first be compared with the existing hierarchy. Whenever a change is not compatible with the existing hierarchy, I mechanically posit whatever contrast shift must have occurred in order to enable the change in question. At the end of the article, I review the set of posited contrast shifts to determine whether they deepen our understanding of the data. We will see that they do: many contrast shifts account for changes beyond those for which they were posited, thus providing a shared underlying source for changes that would otherwise appear to be random and chaotic. The contrast shifts themselves are also strikingly consistent with the constraints proposed above.

Before we proceed, it is worth clarifying that this article offers a model of the phonological implications of sound change, not a model of sound change itself. The single-minded focus on contrast in the following sections may give the misleading impression of a ‘phonology-first’ theory of change, but the actual goal is simply to isolate those as-

pects of sound change that are phonologically relevant—regardless of their ultimate cause—and extract their contrastive implications. A more complete model of sound change must no doubt also recognize the influence of phonetic and sociolinguistic factors, particularly in the triggering and spread of changes, but this article abstracts away from these factors in an attempt to focus narrowly on those aspects of sound change to which phonological investigation can bring the most insight.

**3. THE ALGONQUIAN LANGUAGES AND PROTO-ALGONQUIAN.** This section outlines the members of the Algonquian family (§3.1), which provide a database for testing the hypotheses proposed above. The reconstructed vowel system of Proto-Algonquian (PA) is then described (§3.2), analyzed (§3.3), and compared with the system of its parent, Proto-Algic (§3.4). The analysis proposed for PA serves as a starting point for the analysis of all subsequent developments in the daughter languages.

**3.1. THE ALGONQUIAN FAMILY.** The Algonquian family ranges from the western plains to the eastern seaboard of North America. The languages are traditionally separated into Central, Plains, and Eastern subgroups, as shown in Figure 1, but only Eastern Algonquian is generally considered to be a genetic branch (Goddard 1974b, 1980). Two languages spoken on the Pacific coast, Yurok and Wiyot, are also genetically related to Algonquian (Haas 1958, Goddard 1975), but are not regarded as Algonquian languages—instead, they are considered to be sisters of PA, descending from a further protolanguage known as Proto-Algic. This article does not examine Yurok and Wiyot, but it does consider how the vowel system of PA may have developed from that of Proto-Algic (§3.4).



FIGURE 1. Approximate locations of major Algonquian/Algic languages (adapted from Goddard 1996).

The languages and language continua covered in this article are listed in Table 1, with classifications based on Goddard 1996 and Mithun 1999. This coverage includes all of the major Algonquian linguistic groups for which adequate documentation exists.

The traditional classification in Table 1 recognizes only Eastern Algonquian as a genetic branch; the Central and Plains groupings are geographical. Modern work has arrived at a more sophisticated understanding of the genetic and areal relationships among the languages (Rhodes 1985, 1989, 1992, 2006, Denny 1989, 1991, 1992, Goddard 1994). It is now thought that speakers of Proto-Algonquian migrated from west to

CENTRAL ALGONQUIAN	PLAINS ALGONQUIAN	EASTERN ALGONQUIAN
Meskwaki-Sauk-Kickapoo	Blackfoot	Mi'gmaq
Shawnee	Cheyenne	Maliseet-Passamaquoddy
Miami-Illinois	Arapaho-Atsina	Abenaki
Ojibwe-Potawatomi		Southern New England Algonquian (represented here by Massachusett)
Cree-Montagnais-Naskapi		Mahican
Menominee		Delaware (Munsee and Unami)
		Nanticoke
		Powhatan

TABLE 1. Languages and language continua covered in this article.

east, with smaller groups of speakers splitting off along the way. The group of speakers that shared in new innovations thus became more and more restricted as the eastward migration proceeded, giving rise to the cline in Figure 2, in which the deepest time-depth is in the west and the shallowest is in the east. The story does not end here, however, as subsequent migrations led to the spread of innovations among neighboring groups of languages that originally belonged to different layers of the west-to-east cline, as shown in Figure 3.

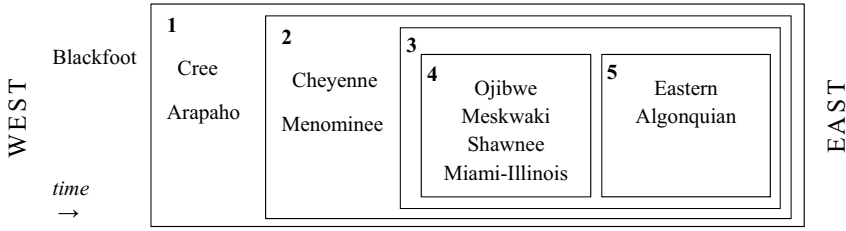


FIGURE 2. Original west-to-east cline (based on Goddard 1994). **1:** All languages other than Blackfoot, the most divergent member of the family. **2:** Languages that merge \*/θ/, l/. **3:** Languages that merge \*/ʔC/ and \*/hC/ clusters. **4:** Languages that shift \*/ʔl, hl/ to /hs/. **5:** Languages that merge \*/i:/ with /i/ and \*/o:/ with /o/.

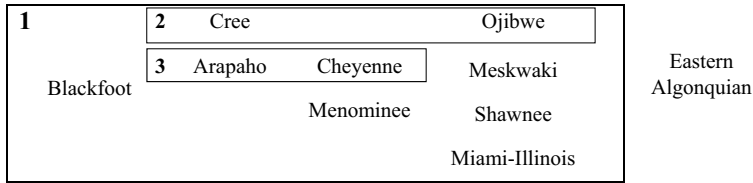


FIGURE 3. Significant instances of secondary contact (based on Goddard 1994). **1:** Western Algonquian \*/we/ > /o/ and \*/#e/ > /i/. **2:** Cree-Ojibwe \*/e/ > /i/. **3:** Cheyenne-Arapaho \*/o, o:, w/ > /i, i:, j/.

This article makes no attempt to account for the complex interrelations in Figs. 2 and 3. Instead, each of the daughter languages is examined in isolation. While it would ultimately be worthwhile to trace the genetic and areal origins of each sound change, these origins are not particularly relevant to the current article, as the final phonological outcome—a changed vowel system—is the same regardless of how the change originated. Since the focus here is primarily phonological rather than historical, the discussion is not structured according to the relationships in Figs. 2 and 3. Instead, languages that have undergone similar vowel changes, regardless of their historical origins, are discussed together. For this purpose, the traditional classification of the languages into

Central, Plains, and Eastern groupings is in fact the most useful: the Eastern languages are a clear genetic branch in any case, and the vowel systems of the Central languages are relatively conservative while those of the Plains languages are innovative. The structure of the article thus follows the traditional classification of the Algonquian languages, but for phonological rather than historical reasons.

**3.2. PHONOLOGICAL SKETCH OF PROTO-ALGONQUIAN VOWELS.** The eight-vowel system in 16 is reconstructed for PA, consisting of four qualities doubled by a length contrast (Bloomfield 1946). The short \*/o/ phoneme is somewhat marginal, since most, though not all, of its occurrences can be derived from Pre-PA \*/wɛ/ (Goddard 1979a:75).

(16) Proto-Algonquian

\*i: \*i                    \*o   \*o:  
\*ɛ: \*ɛ   \*a   \*a:

Judging by their reflexes, it is likely that the high vowels \*/i(:), o(:)/ ranged phonetically from high [i, u] to higher-mid [e, o],<sup>3</sup> while low front \*/ɛ(:)/ ranged from [ɛ] to [æ].<sup>4</sup> Short \*/i, o/ had the semivowels [j, w] as prevocalic allophones, but since the semivowels have become distinct phonemes in many of the daughter languages, they are conventionally written as the phonemes \*/j, w/ in PA as well (Bloomfield 1946:86).

The three phonological processes in 17 have obvious relevance to the contrastive status of PA vowels.

- (17) a. CORONAL PALATALIZATION: \*/t, θ/ > \*[tʃ, ʃ] before \*/i(:), j/ (Pentland 1983)  
b. \*/wɛ/-COALESCENCE: non-postvocalic \*/wɛ/ > \*/o/<sup>5</sup>  
c. HEIGHT NEUTRALIZATION: the contrast between short \*/i, ɛ/ is neutralized in word-initial syllables (Pentland 1979:403)

Height neutralization bears further comment. It must have been a late PA development, since the underlying vowel was still recoverable in prefixed forms (Pentland 1979:403). The vowel quality that resulted from this neutralization in PA is not entirely clear, as its reflexes in the daughter languages vary: some languages have a uniform reflex, but Shawnee, Meskwaki, Pre-Cheyenne, and Proto-Arapaho-Atsina have /i/ word-initially and /ɛ/ postconsonantly, as shown in 18.

(18) Reflexes of PA neutralized \*/i-ɛ/ in initial syllables<sup>6</sup>

LANGUAGES	#	—	#C	—
Cree, Ojibwe, Miami-Illinois	i		i	

<sup>3</sup> High reflexes of \*/i(:)/ are widely attested, while lower-high or mid reflexes of \*/i(:)/ are found in Menominee (Hockett 1981), Mahican (Masthay 1991:13), Munsee Delaware (Goddard 1982:19), and Cheyenne (Pentland 1979:402). The reflexes of PA \*/o(:)/, which could equally well be phonemicized as \*/u(:)/, range from [o] to [u] in Shawnee (Pentland 1979:161), Ojibwe (Valentine 2001:37), Montagnais (Clarke 1982:4), Narragansett (Pentland 1979:242), and Cheyenne (Pentland 1979:402), among others.

<sup>4</sup> Despite its conventional phonemicization as \*/ɛ(:)/ by Algonquianists, this vowel is generally referred to as a low front vowel (e.g. Bloomfield 1946:86 and Pentland 1979:391), with Hockett (1981:53) speculating that it was ‘conceivably as low as [æ]’. Miner (1979:11) notes that its reflexes in most of the Central languages are ‘lower-than-mid’, ranging from [ɛ] to [æ].

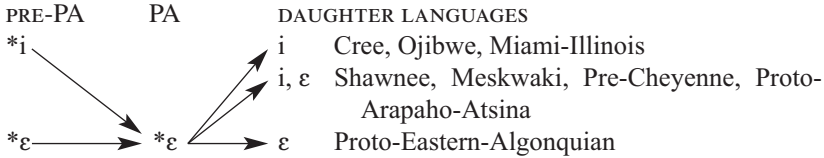
<sup>5</sup> As mentioned above, many instances of apparent PA \*/o/ can be derived from \*/wɛ/, and it is unclear whether the phonemic status of such instances is best analyzed as \*/o/ or \*/wɛ/ within PA itself. In any case, coalescence of \*/wɛ/ to \*/o/ must have occurred at some point, either in PA or in all daughter languages except Proto-Eastern-Algonquian (Goddard 2001:75).

<sup>6</sup> Sources for these reflexes: Cree, Ojibwe, Meskwaki from Bloomfield 1946; Miami-Illinois from Costa 2003; Shawnee from Miller 1959; Pre-Cheyenne from Goddard 1986; Proto-Arapaho-Atsina from Goddard 1974a; Eastern Algonquian represented by Munsee Delaware from Goddard 1982.

Shawnee		i	i, ε
Meskwaki, Pre-Cheyenne, Proto-Arapaho-Atsina		i	ε
Proto-Eastern-Algonquian (PEA */ə/ < PA */ε/)		ə	ə

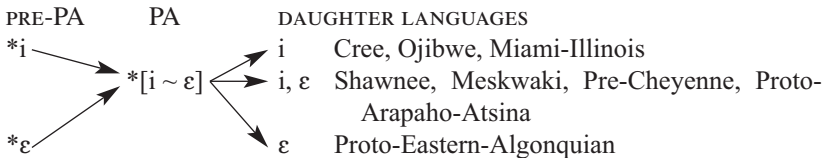
Bloomfield (1925) originally reconstructed PA following the Meskwaki pattern, but his definitive 1946 sketch posits \*/ε/ in both positions. Although descriptively adequate, this reconstruction is theoretically problematic, because it introduces circularity: neutralization caused Pre-PA \*/i/ to lower to \*/ε/, but many of the daughter languages subsequently raised the resulting \*/ε/ back to /i/. This implied trajectory is illustrated in 19.

(19) Trajectory of short \*/i, ε/ in initial syllables (assuming Bloomfield 1946)



Since Bloomfield’s time, advances in our understanding of the mechanisms of merger (§2.2) have made another analysis possible. Since the reflexes suggest that the neutralization of \*/ε, i/ had both \*/ε/ AND \*/i/ as outcomes, it may in fact have been a case of merger by expansion, in which the outcome encompasses the range of both of the merged phonemes (§2.2). We could thus represent the PA outcome as \*[i ~ ε], as in 20.

(20) Trajectory of short \*/i, ε/ in initial syllables (neutralization analysis)



Since this neutralization was a late PA development, the resulting \*[i ~ ε] would likely have persisted in the earliest stages of the daughter languages. Different daughter languages then evidently analyzed these allophones in different ways, coming to identify them either completely with \*/i/, completely with \*/ε/, or with a contextually determined mix of \*/i/ and \*/ε/ (as in 18). This account allows us to describe the treatment of \*/i, ε/ in any given Algonquian language as involving only a single merger rather than the two independent (and opposite) processes of lowering and raising required by Bloomfield’s (1946) account. It simply happens that this merger began in late PA and reached its endpoint after the daughter languages had begun to differentiate.<sup>7</sup>

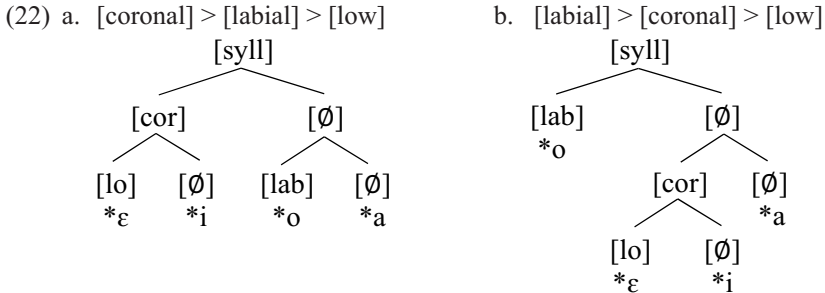
**3.3. A CONTRASTIVE HIERARCHY FOR PA VOWELS.** The description above indicates that the features in 21 are active in the phonology of PA vowels.

- (21) a. High front \*/i, i:/, the triggers of palatalization, are contrastively [coronal], assuming that palatalization is triggered by [coronal] (Clements 1991, Lahiri & Evers 1991, Hume 1992, etc.).
- b. Round \*/o/, whose rounding persists in the coalescence of \*[wε] (underlying \*/oε/) to /o/, is contrastively [labial], assuming that qualities that persist in coalescence reflect contrastive features of the input (e.g. Buckley 1994, Causley 1999, St-Amand 2012).

<sup>7</sup> In Cree and Ojibwe, the \*/i, ε/ merger was eventually expanded such that ALL instances of short \*/ε/ merged with /i/, thus removing short \*/ε/ from the vowel system altogether (§§4.2–4.3).

- c. Short front *\*/i, ε/*, which undergo height neutralization, differ only in the value of the height feature [low], assuming the sisterhood merger hypothesis (§2.3).<sup>8</sup>

Under the model adopted in this article, these specifications must result from the ranking of features determined by the PA contrastive hierarchy. Which rankings will produce the desired results? Let us begin by temporarily abstracting away from the length contrast, leaving the four qualities *\*/i, ε, a, o/*. We know from 21 that the hierarchy must involve [coronal], [labial], and [low]. Of the six logically possible rankings of these features, only the two shown in 22, in which [low] is the lowest-ranked feature, generate the required contrastive specifications. The other four rankings all fail to predict either that *\*/i/* is contrastively [coronal] or that *\*/o/* is contrastively [labial].



Although both rankings generate the required feature specifications, they establish different contrastive relationships among the vowel phonemes: in 22a, *\*/ε, i/* and *\*/o, a/* are both sisters, while in 22b, *\*/ε, i/* are sisters but *\*/o, a/* are not. Under the sisterhood merger hypothesis, the arrangement in 22b is more consistent with the PA facts, since PA has *\*/ε, i/* neutralization but no parallel *\*/o, a/* neutralization (which, in fact, is not found in ANY Algonquian language). This PA-internal evidence is admittedly weak, but the choice of the [labial]-initial ranking in 22b is strongly confirmed by subsequent developments in the daughter languages, which are overwhelmingly consistent with a high ranking of [labial]. In Potawatomi (§4.2) and Montagnais (§4.3), for example, short *\*/i, ε, a/* fall together to /ə/ but short *\*/o/* remains distinct, a pattern that is consistent with the grouping of *\*/i, ε, a/* in contrast with *\*/o/* in 22b, while in Eastern Algonquian (§5.1) and Cheyenne/Arapaho-Atsina (§6.2), where a new height contrast makes *\*/i/* and *\*/o/* sisters, *\*/o/* patterns as contrastively [labial] while */i/* patterns as unmarked, just as the ranking of [labial] over [coronal] in 22b predicts.

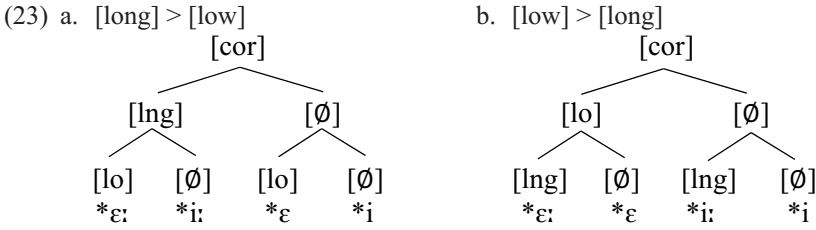
The hierarchy in 22b makes one prediction that may appear to be incorrect: [coronal] is contrastively specified not only for *\*/i/*, which triggers palatalization, but also for *\*/ε/*, which does not. In light of the crosslinguistic tendency for low front vowels to be excluded as palatalization triggers (Kochetov 2011), I follow Barrie (2003) in attributing the inactivity of *\*/ε/* to an independent factor: a constraint against spreading [coronal] from a contrastively [low] vowel.

To complete the PA contrastive hierarchy, we must determine the rank of the length contrast, which I represent by using the feature [long] in an abstract contrastive sense (§2.1). Evidence for its rank comes from the partial neutralization of short *\*/i, ε/*. Under the sisterhood merger hypothesis, this neutralization indicates that short *\*/i, ε/* must be sisters, which can only be the case if [long] outranks [low], as in 23a, thus grouping the

<sup>8</sup> I employ [low] rather than [high] because *\*/i/* appears to have ranged as low as mid [e] (§3.2) and was thus likely contrastively non-[low] rather than contrastively [high].



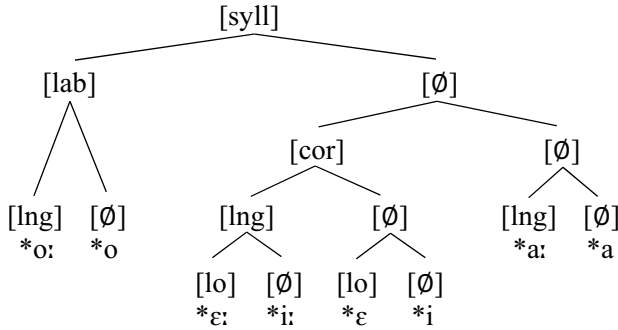
front vowels into pairs according to their length. Under the opposite ranking, shown in 23b, the front vowels are instead incorrectly grouped according to their height.



Predicts height neutralization (✓)      Predicts length neutralization (✗)

We may thus conclude that [long] outranks [low] in PA. I rank [long] directly above [low], since there is no evidence for ranking it any higher than this. (The next section shows that this ranking follows from a minimal change to the Proto-Algic ranking.) The complete contrastive feature specifications of the PA vowels are shown in 24.

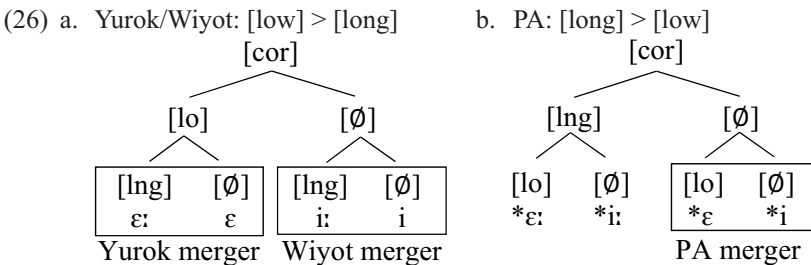
(24) PA: [labial] > [coronal] > [long] > [low]



**3.4. FROM PROTO-ALGIC TO PROTO-ALGONQUIAN.** The remainder of this article is concerned with the evolution of the system in 24 in the daughter languages, but it is worthwhile to briefly consider how this system relates to that of its parent, Proto-Algic. Proulx (1984:182) reconstructs Proto-Algic with the same eight-vowel system as PA.

(25) Proto-Algic vowels  
 \*i: \*i                      \*o \*o:  
 \*ε: \*ε \*a \*a:

PA, Yurok, and Wiyot, the three known daughters of Proto-Algic (§3.1), have each undergone a front-vowel merger. As we have seen, the PA \*i, ε/ merger involved the loss of a height contrast. In both Yurok and Wiyot, however, the front-vowel mergers instead involved the loss of a LENGTH contrast: Yurok merged \*ε, ε:/ while Wiyot merged \*i, i:/ (Proulx 1984:182). Under the sisterhood merger hypothesis, these mergers indicate that [low] must have outranked [long] at the relevant stage in both Yurok and Wiyot, as in 26a—the reverse of the PA ranking in 26b.



Since two of the daughter languages (Yurok and Wiyot) have the ranking [low] > [long] while only one (PA) has the ranking [long] > [low], the ‘majority wins’ principle (Campbell 2004:131) suggests the reconstruction of the former ranking for Proto-Algic. The PA ranking will then be derived through the promotion of [long] by a single step, as in 27. This minimal contrast shift explains why PA front vowels merge along a different dimension from those of Yurok and Wiyot.

- (27) a. Proto-Algic: [labial] > [coronal] > [low] > **[long]**  
 b. Proto-Algonquian: [labial] > [coronal] > **[long]** > [low]

Subsequent developments support the proposal that PA promoted [long] instead of the opposite analysis in which both Wiyot and Yurok demoted [long]. If PA did indeed promote [long], then drift—the tendency for successive changes to continue in the same direction—would predict that future rerankings of [long] in the Algonquian languages should also tend to involve promotion rather than demotion. And in fact, this is the case: several of the daughter languages have subsequently promoted [long] by a further step (Ojibwe-Potawatomi (§4.2), Montagnais-Naskapi (§4.3), Massachusetts (§5.5), and Blackfoot (§6.1)), and in the Betsiamites Innu dialect of Montagnais, [long] has recently become the highest-ranked contrast (§4.3). It seems, then, that with the reranking in 27b, PA set in motion a trend that would continue up to the present.

**3.5. SUMMARY: PROTO-ALGONQUIAN VOWEL FEATURES.** This section has proposed that PA vowel features are specified by the hierarchy in 28. The crucial outcomes of this hierarchy are that \*/o, o:/ are contrastively [labial], front vowels are contrastively [coronal], and short \*/i, ε/ are sisters, differing only in the value of [low].

- (28) [labial] > [coronal] > [long] > [low]

Starting from this hierarchy, the next three sections examine the evolution of the PA vowel system in all major daughter languages. Each Algonquian subgroup is examined in turn: Central (§4), Eastern (§5), and Plains (§6). Changes to the inventory are summarized using annotated vowel charts, which employ the conventions in 29.

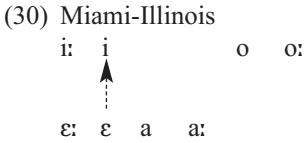
- (29) Vowel chart conventions

- |   |      |   |
|---|------|---|
| a | b    | Parent-language phonemes /a, b/ retained                |
| a | b    | Parent-language phonemes /a, b/ lost                    |
| Ⓐ | Ⓑ    | New phonemes /a, b/ in daughter language                |
| a | → b  | Merger of parent-language /a/ with existing /b/         |
| a | ⋯→ b | Partial merger of parent-language /a/ with existing /b/ |
| a | → Ⓑ  | Phonetic shift of parent-language /a/ to new /b/        |

**4. CENTRAL ALGONQUIAN VOWEL REFLEXES.** Of the three Algonquian subgroups, the Central languages have altered the PA vowel system the least, with most changes following from the PA contrastive hierarchy. This section examines the Central languages in order from the most conservative to the most innovative, grouping languages that developed similarly: Meskwaki, Shawnee, and Miami-Illinois (§4.1), Ojibwe and Potawatomi (§4.2), Cree-Montagnais-Naskapi (§4.3), and Menominee (§4.4).

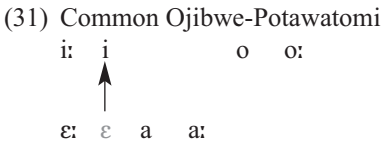
**4.1. MESKWAKI, SHAWNEE, AND MIAMI-ILLINOIS.** The only major vowel change in Meskwaki (also known as Fox; Bloomfield 1946) and Shawnee (Miller 1959, Pentland 1979) was the merger of short \*/i, ε/ in initial syllables, a change that began in PA (§3.2). The Meskwaki and Shawnee reflexes of PA neutralized \*[i ~ ε] are split between /i/ and /ε/, conditioned by position: word-initially, both languages have /i/, while following a word-initial consonant, Meskwaki has /ε/ and Shawnee has either /i/ or /ε/ with unknown conditioning (Miller 1959:20). The partial \*/i, ε/ merger expanded its domain in Miami-Illinois, occurring not only in initial syllables as in PA, but also in metrically

weak syllables and after /k/ (Costa 2003:122, 134). Unlike in Meskwaki and Shawnee, the outcome is uniformly /i/.



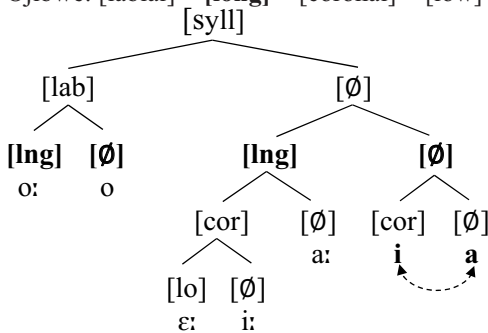
As shown in 24 above, this merger is consistent with the sisterhood of \*/i, ε/ under the PA contrastive hierarchy. Since this is the only major vowel change in Meskwaki, Shawnee, and Miami-Illinois, we need not assume any changes to the PA hierarchy in these languages.

**4.2. OJIBWE AND POTAWATOMI.** The closely related Ojibwe and Potawatomi languages form a genetic subgroup (e.g. Rhodes 2006). Both languages expanded the domain of the PA \*/i, ε/ merger further than Miami-Illinois, merging short \*/i, ε/ to /i/ in all positions (Bloomfield 1946, Hockett 1948). As we have already seen, this merger is consistent with the sisterhood of PA \*/i, ε/.<sup>9</sup>



All Ojibwe dialects retain the resulting seven-vowel system (Valentine 1994:132), but there is an asymmetry among the remaining short vowels: /i, a/ often undergo neutralization while /o/ does not (Valentine 1994:134). We can account for this asymmetry by positing a minor contrast shift in which Ojibwe promotes the length contrast one step above its PA rank, as in 32.

(32) Ojibwe: [labial] > [long] > [coronal] > [low] (cf. PA ranking in 24)

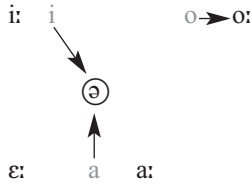


The promotion of [long] above [coronal] makes /i, a/ sisters, predicting the possibility of their merger, while the higher ranking of [labial] keeps short /o/ hierarchically separate, explaining why it remains distinct. The asymmetric neutralization of Ojibwe short vowels therefore follows from a minimal change to the PA contrastive hierarchy.

In addition to the \*/i, ε/ merger shared with Ojibwe, Potawatomi underwent two further mergers, which are strikingly asymmetric: while short \*/i, a/ merged with each other (becoming /ə/), short \*/o/ merged with long \*/o:/ (Hockett 1948).

<sup>9</sup> Although the outcome of the \*/i, ε/ merger is conventionally phonemicized as /i/, Ojibwe /i/ can be realized as [i], [ɪ], or [e] depending on the environment (Valentine 1994:133). The resulting phoneme thus encompasses the phonetic range of both of its antecedents, as expected in a merger by expansion (§2.2). Rhodes (1989) has argued that Ojibwe borrowed the \*/i, ε/ merger from Cree (§4.3).

(33) Subsequent mergers in Potawatomi



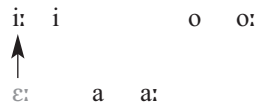
The asymmetry of these mergers follows directly from the contrast shift proposed for Ojibwe in 32 above: the intermediate ranking of [long] between [coronal] and [labial] makes short /i, a/ sisters while leaving short /o/ as the sister of long /o:/, thus predicting both of the attested mergers. It seems, then, that a single, minimal change to the PA hierarchy—the promotion of [long] by a single step—accounts for all of the major Ojibwe-Potawatomi vowel changes. This shift is consistent with the force of drift (§2.3), since it follows an earlier promotion of [long] in PA (§3.4).

**4.3. CREE-MONTAGNAIS-NASKAPI.** The Cree-Montagnais-Naskapi (CMN) dialect continuum stretches from Alberta to Labrador (Pentland 1978, 1979, MacKenzie 1980). Like Ojibwe, CMN merged short \*/ε/ with \*/i/ everywhere (Bloomfield 1946). Most Cree dialects retained the resulting asymmetrical seven-vowel system, but two north-western dialects (Woods and Northern Plains Cree) subsequently merged long \*/ε:/ with long \*/i:/, restoring symmetry to the vowel system (Pentland 1979:104).

(34) a. Common CMN

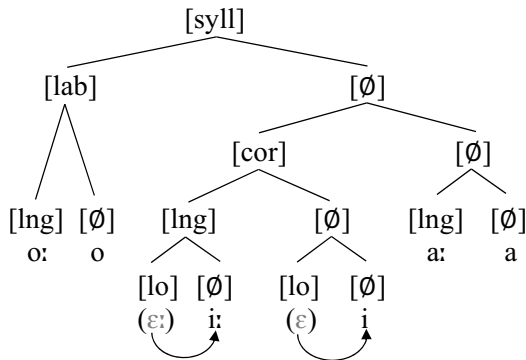


b. Northwestern Cree



Both mergers follow from the proposed PA contrastive hierarchy, under which the \*/i, ε/ and \*/i:, ε:/ pairs are both sisters, as shown in 35. The outcomes of the two mergers—/i/ and /i:/—are the unmarked members of each pair.

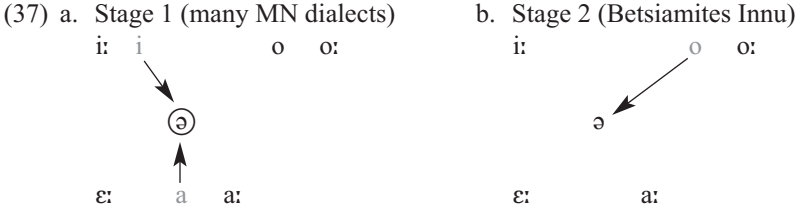
(35) PA/Common CMN: [labial] > [coronal] > [long] > [low]



The Montagnais-Naskapi (MN) dialects (namely East Cree, Innu, and Naskapi), which lie at the eastern end of the CMN continuum, share with Cree the short \*/i, ε/ merger, but have also undergone further innovations. Two sound shifts distinguish MN from Cree: velar palatalization and short-vowel rounding (Michelson 1939:73, MacKenzie 1980:51, 129), described informally in 36. Both shifts are consistent with the feature specifications in 35, as they are triggered by the classes of contrastively [coronal] and [labial] vowels, respectively.

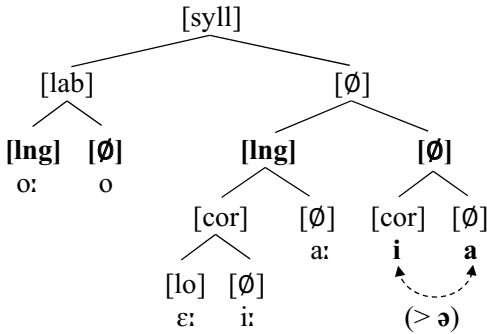
- (36) a. PALATALIZATION: \*/k/ > /tʃ/ before /i, i:, ε:/ (i.e. before all contrastively [coronal] vowels)
- b. ROUNDING: \*/i, a/ > /o/ if the following syllable contains /o(:)/ (contrastively [labial])

In addition to these sound shifts, MN has undergone further short-vowel mergers. Like Potawatomi (§4.2), many MN dialects have merged short \*/i, a/ to /ə/ (MacKenzie 1980:135, Dyck et al. 2010). The Betsiamites Innu dialect has gone even further, merging the last distinct short vowel, /o/, with /ə/ as well (Drapeau 1979, MacKenzie 1980:141).



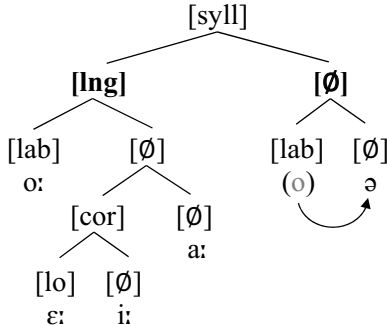
To account for the /i, a/ merger, we may posit a promotion of the length contrast in order to make short /i/ and /a/ sisters, as discussed above for Potawatomi and shown in 38. The merger then involves the loss of the [coronal] contrast in the /i, a/ pair. Independent evidence for the loss of [coronal] comes from the recent innovation of a palatalization process in Betsiamites Innu, a dialect that has undergone the /i, a/ merger. As expected, the new palatalization process is triggered by long /i:/ but not by /ə/ from original short \*/i/ (Drapeau 1981:344), thus confirming that /ə/ from \*/i/ is no longer contrastively [coronal].

- (38) Stage 1 (many MN dialects): [labial] > [long] > [coronal] > [low]



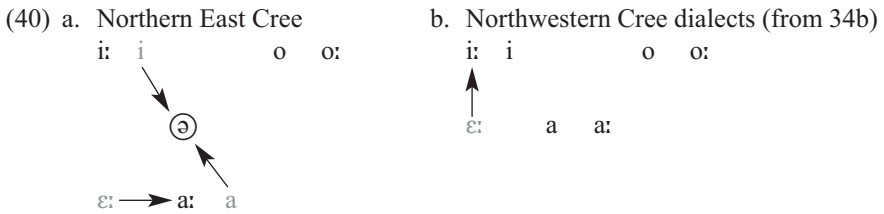
The subsequent /o, ə/ merger in the Betsiamites dialect is not predicted by 38, as /o/ and /ə/ are not sisters. To make them sisters, we must posit one final promotion of [long], shown in 39.

- (39) Stage 2 (Betsiamites Innu): [long] > [labial] > [coronal] > [low]

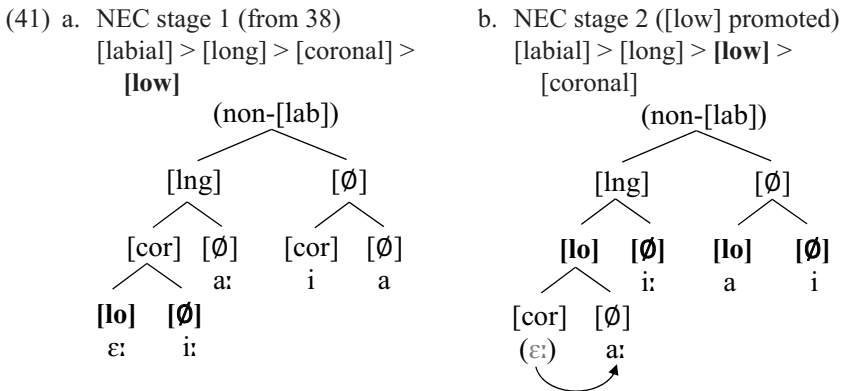


In general, then, the length contrast has undergone a gradual upward drift, beginning at the bottom of the hierarchy in Proto-Algic (§3.4) and undergoing subsequent promotions in Proto-Algonquian, Potawatomi/Montagnais-Naskapi, and finally Betsiamites Innu, where it became the highest-ranked contrast. This gradual promotion has given us a unified account of a variety of length-related changes. In this respect, it is interesting to compare Betsiamites Innu with Potawatomi (§4.2). Both languages reached a system of four full vowels plus /ə/ after the loss of short \*/o/, but the fate of \*/o/ differed: it merged with /ə/ in Betsiamites Innu but with /o:/ in Potawatomi. This difference follows from the promotion of [long] over [labial] in Innu but not in Potawatomi, which made /o/ pattern according to its length in Innu and its quality in Potawatomi.

One final MN change remains: like the northwestern Cree dialects discussed above, Northern East Cree (NEC), a ‘Montagnais’ dialect, has merged long \*/ε:/ with another vowel. However, whereas the northwestern dialects merged \*/ε:/ with /i:/, NEC instead merged it with /a:/ (MacKenzie 1980:97–98), as shown in 40. (NEC has also undergone the previously discussed /i, a/ merger (Dyck et al. 2010).)



As shown in 35 above, the \*/ε:/, i:/ merger in the northwestern dialects was consistent with the PA contrastive hierarchy, under which the sister of \*/ε:/ was \*/i:/. In order for the sister of \*/i:/ to change to /a:/ in NEC, we must posit a contrast shift. The promotion of [low] over [coronal] in 41b has the desired effect, causing \*/ε:/ to pattern according to its height (with low /a:/) rather than its frontness (with front /i:/). The merger of /ε:/, a:/ then follows.



All of the rerankings posited before this point involved the promotion of the length contrast and could thus all be attributed to drift initiated by the promotion of [long] in PA. Why, then, did NEC instead promote the height contrast? MacKenzie (1980:229) suggests that the NEC \*/ε:/, a:/ merger may be due to contact, since it occurred in exactly the area where there has been long-term shared settlement and intermarriage with speakers of Inuktitut, a genetically unrelated language with only the three long vowels /i:, a:, u:/. Interestingly, Compton and Drescher (2011) have proposed that a height contrast is ranked at the top of the Inuktitut contrastive hierarchy, which they argue to be [low] > [labial] > [coronal]. It is thus possible that the promotion of the NEC height contrast in 41b reflects the influence of the Inuktitut phonological system. Such an ex-

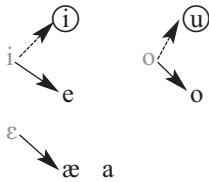
ternally driven shift away from the PA ranking would explain why NEC is the only Central Algonquian language in which \*/ε(:)/ merges with \*/a(:)/ rather than \*/i(:)/.

In summary, we have seen a range of vowel-related changes in CMN. The \*/ε, i/ and \*/ε:, i:/ mergers and the development of palatalization and rounding are consistent with the PA hierarchy. The short-vowel mergers in MN indicate a gradual promotion of the length contrast, but the NEC \*/ε:, a/ merger is discrepant, as it requires a promotion of the height contrast, possibly due to contact.

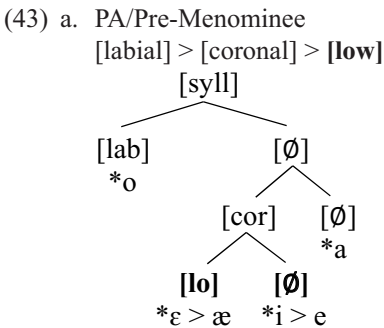
**4.4. MENOMINEE.** Menominee underwent the now-familiar partial merger of short \*/i, ε/, not just initially as in PA, but in several other contexts as well (Hockett 1981, rules S9, S11, S14, S20, S21). The outcome is unsurprisingly the reflex of \*/i/, the unmarked member of the \*/i, ε/ pair in PA (see 24).

A more dramatic change in Menominee was the development of new vowel phonemes in an event that has been dubbed the ‘Great Menominee vowel shift’ (Miner 1979). For simplicity, the remainder of this section abstracts away from the length contrast, since it played little role in the quality changes that occurred.<sup>10</sup> The shift can be described as in 42, although its components may not have been so neatly divided. The end result was essentially a split of PA \*/i/ and \*/o/ into Menominee /i, e/ and /o, u/ respectively.

- (42) Menominee vowel shift (Miner 1979, Hockett 1981:S13, S18)
1. Front-vowel lowering: PA \*/i/ > /e/ and \*/ε/ > /æ/
  2. Development of new phoneme /i/ from glide-vowel coalescence
  3. Raising of /e, o/ to /i, u/ when /i/ or a postconsonantal glide follows later in the word and /æ/ does not intervene

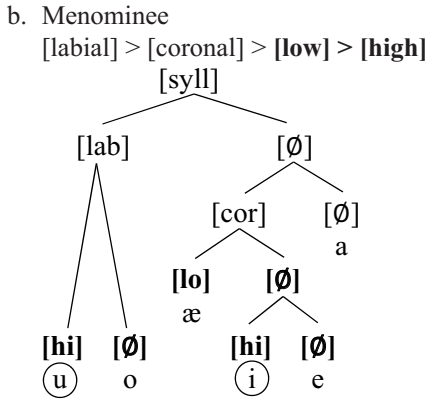


This shift requires only a small change to the PA contrastive hierarchy. The lowering of PA \*/i, ε/ to /e, æ/ remains within the phonetic ranges predicted by the original [low] contrast, as indicated in 43a.<sup>11</sup> The new high vowels /i, u/ can be accommodated by adding a second height contrast within the scope of the [low] contrast, as shown in 43b. This ranking groups the /i, e/ and /u, o/ pairs as sisters, reflecting their common origin as well as their alternation in vowel harmony (discussed below). In keeping the same general configuration of contrasts as PA, the Menominee system remains very much within the Central Algonquian mold despite the addition of new phonemes.



<sup>10</sup> See Milligan 2000 for a convincing argument that length is not relevant for Menominee vowel harmony, contrary to other reports (e.g. Archangeli & Pulleyblank 1994).

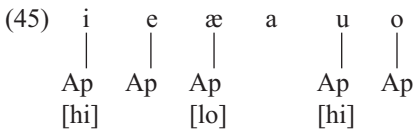
<sup>11</sup> Indeed, this ‘lowering’ may simply be a matter of notation, since PA \*/i/ and \*/ε/ may well have had [e] and [æ] as allophones to begin with (§3.2).



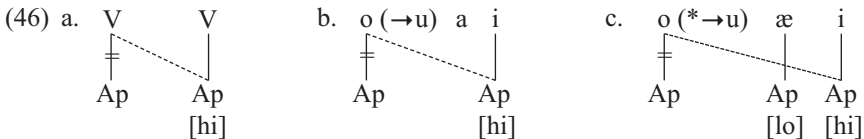
The conditioned raising of /e, o/ in stage 3 of the Menominee vowel shift created a synchronic alternation that may be characterized as vowel harmony, as shown in 44.

- (44) Menominee vowel harmony (Bloomfield 1962, Milligan 2000)
- a. /e, o/ → /i, u/ when a high vowel (/i, u/) or postconsonantal glide follows anywhere in the word.
    - (i) [ki:wianæ:w] ‘he takes him home’ (cf. [ke:wæ:w] ‘he goes home’)
    - (ii) [pi:tu:kuaq] ‘when they bring it’ (cf. [pi:tøk] ‘when he brings it’)
  - b. Intervening /æ/ blocks harmony, but intervening /a/ does not.
    - (i) [ne:ce<sup>h</sup>niw] ‘my fellow man’ (\*[ni:cinæ:niw])
    - (ii) [mu:skamit] ‘if he emerges’ (cf. [mø:skamow] ‘he emerges’)

In order to sketch a feature-geometric analysis of this process, let us assume that height features are dependents of an Aperture node (Clements 1991, Clements & Hume 1995). In the spirit of underspecification, I take this node to be underlyingly present only on phonemes that enter into height contrasts (cf. Avery and Rice’s (1989) NODE ACTIVATION CONSTRAINT). The contrastive feature specifications in 43b thus translate to the underlying representations in 45. Note that each of the classes relevant to harmony receives a distinct Aperture specification: the triggers /i, u/ are [high]; the targets /e, o/, which contrast with /i, u/ for [high], have an unspecified Aperture node (equivalent to [–high], using binary features); opaque /æ/ is [low]; and transparent /a/ has no underlying Aperture node at all, since it enters into no height contrasts.



Harmony can then be analyzed as involving the replacement of an unspecified Aperture node with a following [high] Aperture node, as in 46a. Spreading is unaffected by an intervening /a/, but is blocked by the incompatible Aperture specification of /æ/ (46b–c).



Regardless of the details of the analysis, the central problem presented by Menominee harmony—the asymmetrical blocking behavior of the low vowels—can be linked to the asymmetry of their contrastive features: /æ/ is [low], while /a/ has no height features. The difficulty of attaining such a result in other frameworks led Archangeli and Pulleyblank (1994:374–85) to abandon the height-based analysis of the Menominee

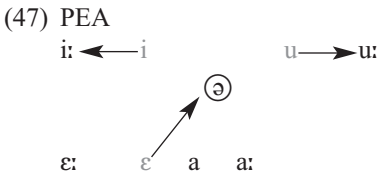


vowel system altogether and recast it in terms of ATR (see also Nevins 2010:186–87). The primary motivation for this reanalysis appears to be analytical convenience, as little independent evidence suggests that ATR is relevant in Menominee (Oxford 2015). More critically, however, the ATR analysis can only explain the opacity of /æ/ with a stipulation against spreading [ATR] from a [low] vowel. This arbitrary link between [low] and [ATR] is avoided in the analysis proposed above, which depends solely upon height features. The height-based analysis also has stronger diachronic and crosslinguistic grounding, since it falls out from a contrastive hierarchy that was inherited from PA and accounts for various other developments across the Algonquian languages.

**4.5. SUMMARY: CENTRAL ALGONQUIAN VOWEL REFLEXES.** All of the major vowel-related changes in the Central languages follow either from the contrastive hierarchy proposed for PA or from minimal changes to it—namely the promotion of the length contrast in Ojibwe-Potawatomi and Montagnais-Naskapi, the promotion of the height contrast in Northern East Cree, and the addition of a second height contrast in Menominee. This limited set of assumptions has given us a principled account of a wide range of phonological developments, including the direction of mergers and the conditioning of new processes.

**5. EASTERN ALGONQUIAN VOWEL REFLEXES.** Goddard (1980) has proposed that the Eastern Algonquian languages constitute a genetic subgroup, deriving from the intermediate protolanguage Proto-Eastern-Algonquian (PEA). This section accounts for the reconstructed PEA vowel system (§5.1) before turning to the daughter languages, grouping languages that developed similarly: Powhatan and Nanticoke (§5.2), Delaware (§5.3), Maliseet-Passamaquoddy and Mi'gmaq (§5.4), Massachusetts and Abenaki (§5.5), and Mahican (§5.6). We will see that PEA underwent a significant contrast shift that sent the Eastern languages on a different path from the Central languages, which mostly preserved the PA system.

**5.1. PROTO-EASTERN-ALGONQUIAN.** Two major vowel changes occurred in PEA (Goddard 1980): short \*/ɛ/ shifted to \*/ə/, and the length contrast was lost among the high vowels \*/i, i:/ and \*/o, o:/ (henceforth written \*/u, u:/).<sup>12</sup>



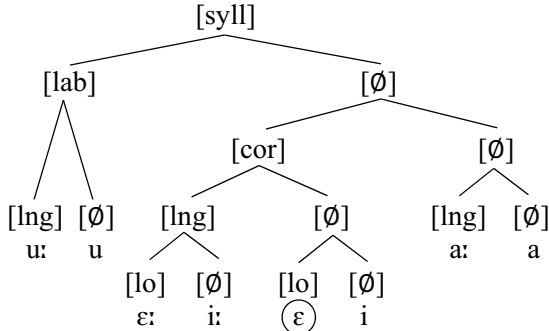
In principle, the shift of short \*/ɛ/ to \*/ə/ could simply be a phonetic change, but the diachronic evidence shows that it was indeed phonemic. Two Eastern languages underwent subsequent changes that could only occur if original short \*/ɛ/ had shifted elsewhere: Delaware developed a new short counterpart to long \*/ɛ:/ (§5.3), while Mi'gmaq developed a new long /ɛ:/ after reanalyzing original long \*/ɛ:/ as short (§5.4). In addition, Massachusetts developed a palatalization process that was triggered by long \*/ɛ:/ but not by the reflex of short \*/ɛ/ (§5.5), a split that would follow from the reanalysis of short \*/ɛ/ as non-[coronal] \*/ə/. I thus conclude that PA \*/ɛ/ shifted phonemically to \*/ə/ in PEA, losing its [coronal] status and ceasing to pattern as the short counterpart of \*/ɛ:/. As a case

<sup>12</sup> Recall from §3.2 that PA \*/o/ could also be phonemicized as \*/u/. My choice of \*/u/ here reflects the patterning of this vowel with \*/i/ in PEA. The validity of analyzing PEA \*/u/ as a phonologically high vowel is confirmed by the subsequent addition of a new nonhigh /o/ in Mi'gmaq and Delaware. Considering their reflexes, it appears that the PEA high vowels ranged phonetically from high to upper-mid. For example, \*/i, u/ are reflected as [i ~ e, u ~ o] in Mahican (Masthay 1991:13) and [i:, o:] in Munsee (Goddard 1982:19).

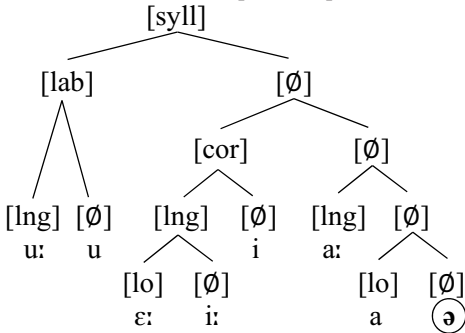
of segmental reanalysis, this shift has no implications for the ranking of features; \*/ə/ simply moves to a different hierarchical position, as shown in 48.

(48) PA/Pre-PEA: [labial] > [coronal] > [long] > [low]

a. PA: \*/ɛ/ is [coronal], contrasts with \*/i/



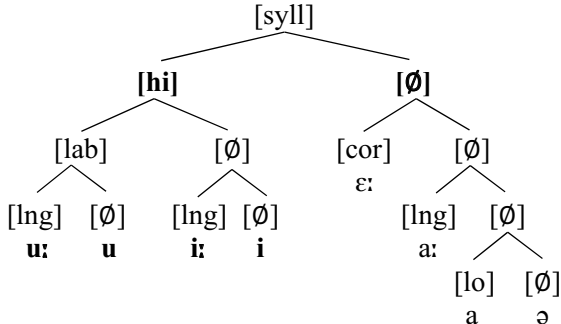
b. Pre-PEA: \*/ə/ is non-[coronal], contrasts with \*/a/



The loss of the length contrast on the high vowels has more dramatic implications, since it is a change in which the high vowels \*/i, i:/ and \*/u, u:/ pattern together—a pattern that is not predicted by the PA hierarchy, under which the top-ranked [labial] contrast prevents \*/u(:)/ from sharing any contrastive features with \*/i(:)/ (see 48 above). In order for the high vowels to become a class in PEA, we must posit a contrast shift in which a height contrast is placed at the top of the hierarchy, since this is the only way to keep the existing top-ranked [labial] contrast from separating \*/u(:)/ from \*/i(:)/. In principle, the required height contrast could involve either [high] or [low], but since PEA employs [low] in a different function (distinguishing between the nonhigh vowels \*/a/ and \*/ə/), I use [high] to distinguish the high vowels, as in 49. As a result of this contrast shift, the high vowels become the natural class [high], and their symmetrical mergers follow from the loss of the length contrast in the \*/u, u:/ and \*/i, i:/ pairs.

(49) Pre-PEA contrast shift: add [high] to the top of the PA hierarchy

**[high]** > [labial] > [coronal] > [long] > [low]

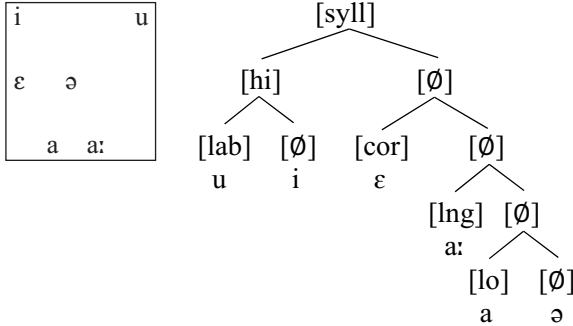


This is a significant shift, since the addition of a new top-ranked contrast forces a major reorganization of the contrastive relationships in the vowel system. As discussed in §2.3, we should be wary of positing such dramatic shifts, particularly on the basis of a single piece of data. However, we see below that this shift is strongly confirmed by subsequent developments in the Eastern languages, which are uniformly consistent with the predictions of the reorganized system in 49 rather than that of PA. The shift in 49 can be seen, then, as the event that definitively split the Eastern vowel system from the rest of the Algonquian family.<sup>13</sup>

In addition to the shift of \*/ε/ to \*/ə/ and the loss of length on high vowels, one minor aspect of the PEA vowel system remains to be addressed. Recall from §3.2 that a partial merger of short \*/i, ε/ was initiated in PA and reached various conclusions in the daughter languages—normally either \*/i/ or a positionally determined mix of \*/i/ and \*/ε/, but uniformly \*/ε/ (> \*/ə/) in PEA. The exceptional PEA outcome follows from the contrast shift posited in 49. As discussed earlier, it appears that the neutralized vowel in PA was not uniformly as high as [i]. This would have been inconsequential in PA, since [high] was not a contrastive feature. When [high] became contrastive in the PEA shift, however, the insufficient height of the neutralized vowel would prevent it from being classified as contrastively [high], thus severing its link with \*/i/ and leaving \*/ə/ as the only remaining phoneme that it could become identified with.

In summary, the PEA vowel system and its proposed contrastive hierarchy are shown in 50.<sup>14</sup> Two contrast-related changes distinguish the PEA system from that of PA: the reanalysis of [coronal] \*/ε/ as non-[coronal] \*/ə/, and the addition of a new top-ranked height contrast in a dramatic contrast shift that made the high vowels a natural class.

(50) PEA: [high] > [labial] > [coronal] > [long] > [low]



Beyond the specific PEA developments that they were posited to explain, these contrast changes have other unintended consequences: unlike in PA, \*/ε/ is no longer the sister of \*/i/, \*/i/ is no longer contrastively [coronal], and \*/a/ is now the sister of \*/ə/. The predictions made by each of these side-effects will be borne out by subsequent developments in the Eastern languages. Note, as well, that the contrasts in the proposed PEA system are highly asymmetrical: [labial] applies only to the high vowels, [coronal] applies only to the nonhigh vowels, and little use is made of the [long] and [low] contrasts.

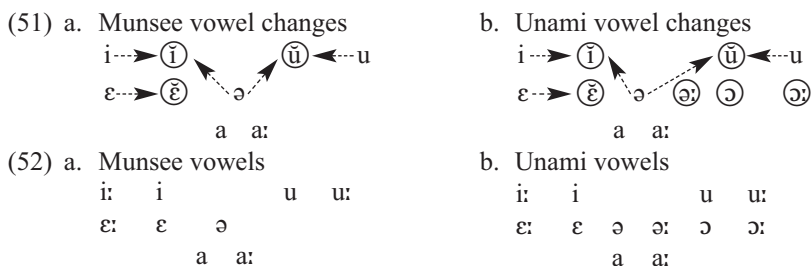
<sup>13</sup> Although this article does not generally attempt to explain the triggering of contrast shifts, the significance of the shift in 49 warrants a comment on its possible origins. Recall Jakobson and Halle's (1956) proposal that contrastive hierarchies always begin with a height contrast (§2.3). While I have not adopted this as a universal principle, there could still be a universal tendency for learners to assume a top-ranked height contrast in the absence of evidence to the contrary—a bias that we would then expect to surface when reanalysis occurs. We see below that a similar shift occurred independently in Plains Algonquian (§6), lending additional plausibility to the idea of a height-based bias.

<sup>14</sup> I no longer write length marks on \*/i, u, ε/ as they no longer participate in the length contrast.

In isolation, this may appear to be an inelegant analysis, but we will see that its asymmetry is in fact a virtue, since many of the subsequent developments in the Eastern languages can be understood as remedying the asymmetries in 50, either by eliminating marginal contrasts or by making greater use of them.

**5.2. POWHATAN AND NANTICOKE.** According to Siebert (1975:295) and Pentland (1979:314–17), the scanty records of long-extinct Powhatan and Nanticoke indicate the retention of the full PA vowel system, including the maintenance of the /i, i:/ length contrast in contradiction of Goddard's PEA hypothesis. Goddard (1980:149) dismisses this interpretation as unpersuasive, however, suggesting that Powhatan and Nanticoke instead preserved the PEA system in 50 above. Despite Siebert's analysis, his notes furnish two pieces of evidence that are more consistent with Goddard's view. First, Siebert must stipulate that Powhatan short /ɛ, a/ are 'weak', since they undergo syncope while 'strong' short /i, u/ do not (pp. 295, 417). Under the PEA analysis in 50, no such stipulation is required, since short /ɛ, a/ (Goddard's /ə, a/) are the only contrastively short vowels. Second, Siebert notes that PA word-initial short \*/ɛ/ merges with \*/a/ in Powhatan (p. 424). This merger is consistent with the PEA hierarchy in 50, in which the sister of \*/ɛ/ (Goddard's \*/ə/) is \*/a/, but not with the PA hierarchy, in which the sister of \*/ɛ/ is \*/i/. In any case, there is little to be said about Powhatan and Nanticoke in the current article, as, by all accounts, they have preserved the system of either PA or PEA.

**5.3. DELAWARE.** The Delaware group consists of two closely related languages (Goddard 1979b): Munsee (Goddard 1982) and Unami (represented here by Southern Unami; Goddard 1997).<sup>15</sup> As shown in 51, both languages added the new short vowels /ĩ, ě, ũ/ from the shortening of PEA \*/i, ɛ, u/ and the coloring of PEA \*/ə/.<sup>16</sup> Unami also extended the length contrast to /ə/ and added the new nonhigh back vowels /ɔ, ɔ:/, which derived from earlier \*/wa, wa:/ (Goddard 1997:45). Since these changes involve the reintroduction of length contrasts, the resulting vowel systems are rewritten in 52 so that the length contrasts may be consistently represented.

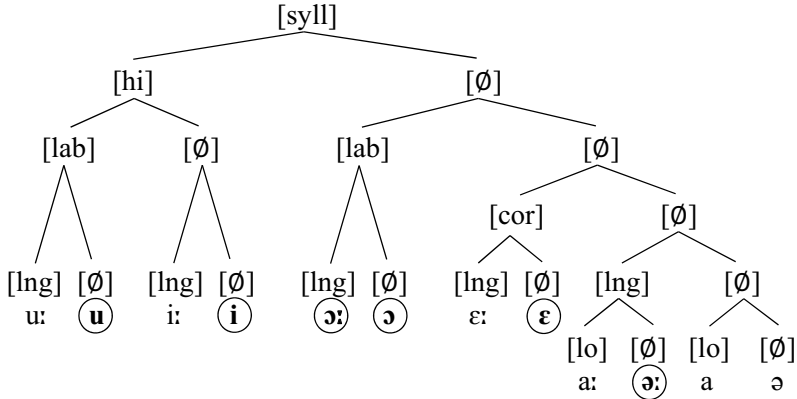


All of the Delaware changes are consistent with the contrastive hierarchy posited for PEA. Each change can be seen as increasing the symmetry of the vowel system by making greater use of the existing contrasts. The addition of short /i, ɛ, u/ in both languages remedied the PEA length asymmetry by extending the length contrast across the entire vowel system, while the addition of /ɔ, ɔ:/ in Unami remedied a quality asymmetry by extending the [labial] contrast to the nonhigh vowels. The 'filling-in' effect of these developments is shown for Unami in 53. The fact that we can straightforwardly characterize the Delaware changes as filling the contrastive gaps in the PEA system provides a retroactive confirmation of the asymmetrical analysis proposed for PEA.

<sup>15</sup> Mahican is also genetically related to Delaware, but is discussed separately (§5.6) since it shares vowel changes with other languages as well.

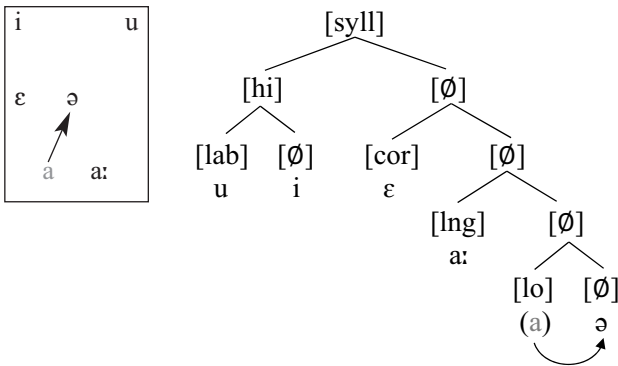
<sup>16</sup> For simplicity, I have represented the development of Unami short /ĩ, ě, ũ/ as matching that described for Munsee in Goddard 1982, but the reader is directed to Goddard 1979b for the full Unami details. Following the practice I adopted for PEA, I write <u> for Goddard's <0>.

(53) Unami: [high] > [labial] > [coronal] > [long] > [low] (retained from PEA)



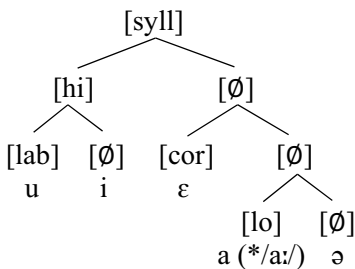
5.4. MALISEET-PASSAMAQUODDY AND MI'GMAQ. Maliseet-Passamaquoddy (LeSourd 1993) and Mi'gmaq (Hewson 1973) are neighboring languages that 'form an innovating nucleus' (Goddard 1978:76). Both languages collapsed the PEA \*/a, ə/ pair to /ə/, the unmarked member of the [low] contrast.

(54) Maliseet-Passamaquoddy and Mi'gmaq  
 [high] > [labial] > [coronal] > [long] > [low] (retained from PEA)

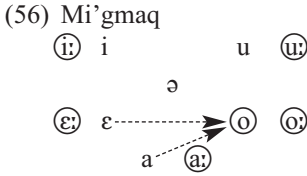


This merger left /ə/ in a contrast with /a:/ for [long], the last remaining vestige of the PA length contrast. However, the /ə, a:/ pair is hardly a paradigm example of a length contrast, as the vowels also differ phonetically in height. In the absence of a length contrast elsewhere in the inventory, we might expect learners to analyze the /ə, a:/ pair as contrasting for quality instead. Let us assume that such a reanalysis did occur: the length contrast was demoted by a single step, thus becoming irrelevant, leaving [low] to distinguish between /ə/ and /a:/—which we may now represent as /a/, since length is no longer relevant.

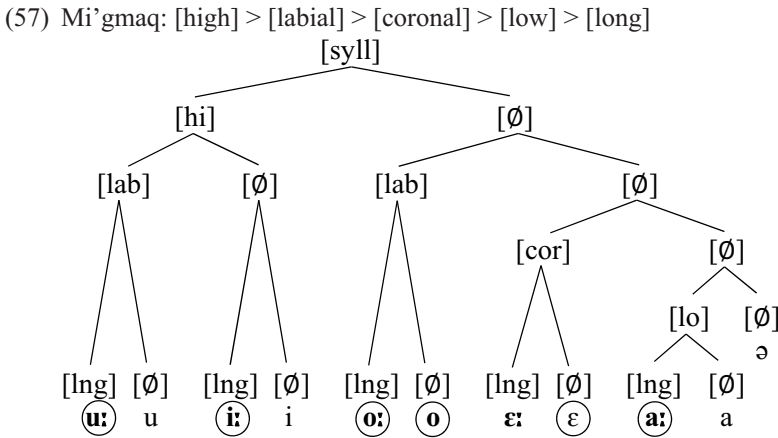
(55) Maliseet-Passamaquoddy and Mi'gmaq  
 [high] > [labial] > [coronal] > [low] (> **[long]**)



Two further changes occurred in Mi'gmaq: the addition of a new /o/, primarily through the coloring of /a, ε/ before /kw/, and the creation of a new series of long vowels /i:, ε:, a:, o:/ through the coalescence of V-glide-V and V-/h/-V sequences.



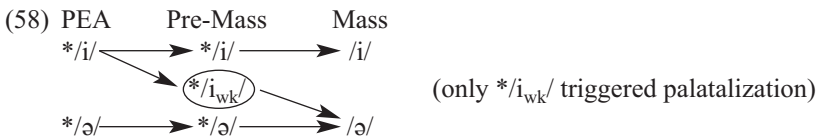
As in Unami (§5.3), adding /o/ increased symmetry by extending the [labial] contrast to the nonhigh vowels. The development of new long vowels created a long-short pair for each existing vowel (except /ə/); these pairs fit well with the low ranking of [long] that was arrived at in 55 above. The addition of a new long /a:/ also confirms the proposal in 55 that original \*/a:/ lost its contrastive length, since a new /a:/ could develop only if original \*/a:/ no longer existed. The resulting Mi'gmaq contrasts are shown in 57.



**5.5. MASSACHUSETT AND ABENAKI.** The geographically contiguous Eastern languages Massachusetts and Abenaki share an important shift in the low vowels but are distinguished by other changes.<sup>17</sup>

**MASSACHUSETT.** Two major developments occurred in Massachusetts: velar palatalization and the low vowel shift (Goddard 1981, 1990). Palatalization must have occurred first, since its trigger, \*/ε:/, was backed to /a:/ in the vowel shift.

The development of velar palatalization is intertwined with another change: the ‘weakening’ of \*/i/, a partial merger of \*/i/ with \*/ə/ under certain metrical conditions (Goddard 1981:86–95). Weakening played a role in the conditioning of Massachusetts palatalization, as \*/k/ shifted to /tj/ before \*/ε/ and ‘weakened \*/i/’, but NOT before regular \*/i/ or \*/ə/.<sup>18</sup> At the time of palatalization, then, ‘weakened \*/i/’ must have been distinct from both its origin \*/i/ and its endpoint \*/ə/, as indicated in 58.

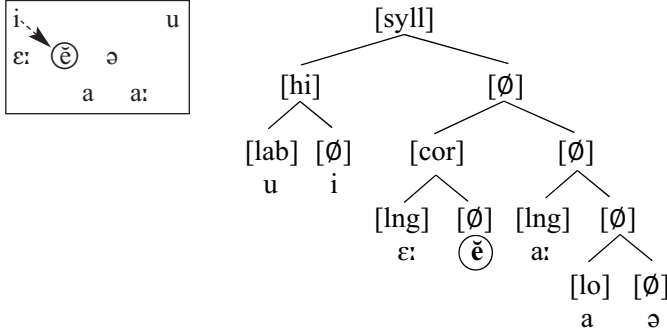


<sup>17</sup> I have chosen Massachusetts (Goddard 1981, 1990) to represent the Southern New England Algonquian dialect continuum, which also includes Narragansett, Mohegan-Pequot-Montauk, Quiripi, Unquachog, and ‘Loup A’/Nipmuck (Siebert 1975, Costa 2007). See Pentland 1979 and Rudes 1997 for details on Narragansett and Quiripi. Pentland’s analysis of palatalization differs significantly from that of Goddard.

<sup>18</sup> This description is simplified. For the full details, the reader is directed to Goddard 1990.

We must assign a phonemic value to this ‘weakened \*/i/’ in order to formulate an analysis of palatalization. Considering its trajectory from \*/i/ to \*/ə/, weakened \*/i/ is likely to have been a shortened and lowered version of \*/i/, though not yet centralized enough to be considered \*/ə/. I accordingly phonemicize it as \*/ě/, which the PEA contrastive hierarchy can neatly accommodate as the short counterpart of \*/e/ (henceforth written \*/ε:/ due to its contrastive length).

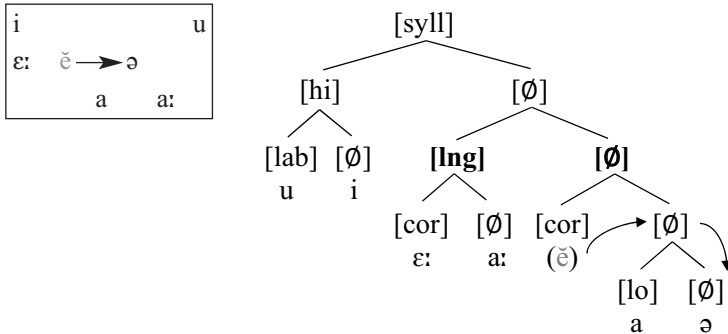
(59) Pre-Mass 1: [high] > [labial] > [coronal] > [long] > [low] (from PEA)



The PEA hierarchy also explains the unusual conditioning of palatalization: the two triggering vowels, \*/ε/, ɛ̃/, are the only contrastively [coronal] vowels in the inventory, thus predicting the surprising exclusion of \*/i/ as a trigger. The possibility of formulating such an analysis is an advantage of a hierarchical model of underspecification. In this case, it was not even necessary to posit this analysis—it fell out from a contrastive hierarchy that was determined on independent grounds in the parent language.

After palatalization occurred, the weakening of \*/i/ concluded via the merger of \*/ě/ with \*/ə/. This merger is not predicted by the PEA hierarchy in 59, since \*/ě/ and \*/ə/ are not sisters. However, if we posit a contrast shift in which [long] is promoted by a single step, as in 60, \*/ě/ will become the sister of the \*/a, ə/ pair. The loss of the [coronal] contrast would then correctly predict the merger of \*/ě/ with \*/ə/, the unmarked member of the \*/a, ə/ pair.<sup>19</sup>

(60) Pre-Mass 2: [high] > [labial] > [long] > [coronal] > [low]



The promotion of the length contrast is not a surprising development, since we have also seen it occur in Ojibwe-Potawatomi (§4.2) and Montagnais-Naskapi (§4.3). It can be attributed to drift, since it follows an earlier promotion of the length contrast in PA (§3.4).

<sup>19</sup> This configuration is unusual, as the sister of \*/ě/ is a class rather than a single phoneme. The outcome of the merger follows directly from our model, however, since the loss of the [coronal] contrast renders \*/ě/ featurally identical to \*/ə/, thus causing their merger. The merger of \*/ě/ with \*/a/ is ruled out because it would require \*/ě/ to gain the feature [low], an operation that our model does not permit.

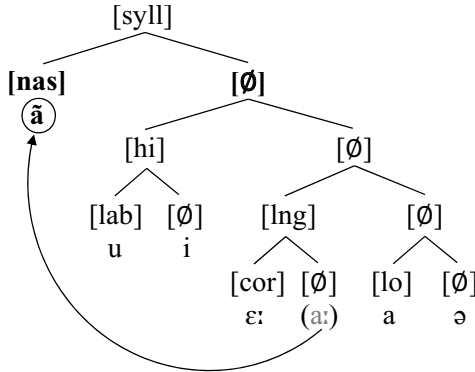
The promotion posited in 60 also accounts for the patterning of the next major development in Massachusetts: the low vowel shift, a chain shift in which (i) \*/a:/ was nasalized to /ã/ and (ii) \*/ɛ:/ was backed to new /a:/, as shown in 61. The nasalization portion of this shift may have resulted from contact with Iroquoian languages (Goddard 1971:140, Pentland 1979:404), perhaps together with universal phonetic factors (Whalen & Beddor 1989).

(61) Massachusetts vowel shift



I propose that the newly nasalized /ã/ was set apart from the oral vowels by the addition of a nasality contrast to the hierarchy, as shown in 62. The high ranking of the nasality contrast is suggested by the gradual centralization of nasalized /ã/ to [ã̃] in closely related Narragansett (Pentland 1979:264–65), a phonetic development that follows naturally if /ã/ enters into no place or height contrasts.

(62) Massachusetts: [nasal] > [high] > [labial] > [long] > [coronal] > [low]



The removal of \*/a:/ from the class of oral vowels left its former sister \*/ɛ:/ without a contrastive [coronal] specification, since it no longer contrasted with a noncoronal vowel. The loss of [coronal] predicts the expansion of the phonetic range of \*/ɛ:/ to include noncoronal realizations such as [a:], exactly as attested in the Massachusetts chain shift. Under this analysis, the ‘backing’ of \*/ɛ:/ in 61 is simply a broadening of its range to encompass the area vacated by its former sister.<sup>20</sup> This straightforward account of the chain shift depends crucially upon the promotion of [long] that was originally posited to account for the \*/ɛ̃, ə/ merger in 60, since it was this promotion that also grouped \*/ɛ:, a:/ as sisters. The promotion of [long] thus explains two independent developments.

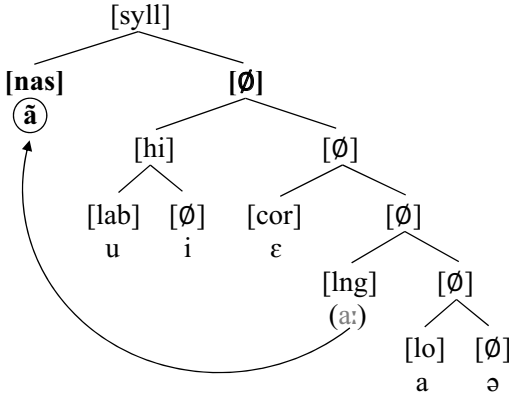
ABENAKI. The low vowel shift spread north from the Southern New England languages where it originated (represented here by Massachusetts) to Abenaki (Goddard 1978:75), but its Abenaki outcome differs from that of Massachusetts. To provide a basis for this difference, let us assume that Abenaki retained the PEA contrastive hierarchy rather than promoting [long] above [coronal] as Massachusetts did (see 61). If Abenaki

<sup>20</sup> In support of the range-expansion analysis, note that although \*/ɛ:/ is normally said to have backed to /a:/, Goddard (1981:69) states that ‘a relatively broad phonetic range in the allophones of /a:/ is implied by the variety of ways in which it is written’ in the available sources, which include <a, á, â, o, ea, au, ó, ai>, an array of spellings that is consistent with the reanalysis of \*/ɛ:/ as a more general nonhigh long vowel.



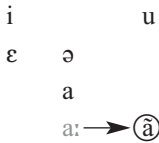
then borrowed the nasalization of \*/a:/ to /ã/ from its southern neighbors, the contrastive consequences would be as shown in 63.

(63) Pre-Abenaki: [nasal] > [high] > [labial] > [coronal] > [long] > [low]

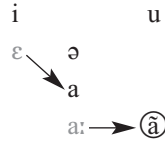


This result differs from that of Massachusetts (see 62) in an important way. The promotion of [long] in Massachusetts had grouped \*/a:, ε:/ as sisters contrasting for [coronal], so the removal of \*/a:/ from the class of oral vowels predicted the backing of \*/ε:/ by eliminating its [coronal] specification. However, under the Pre-Abenaki hierarchy in 63, \*/a:, ε/ are not sisters, so the removal of \*/a:/ has no effect whatsoever on the contrastive specification of \*/ε/. It should thus be possible for an Abenaki dialect to remain stable at the stage in 63 without backing \*/ε/, which, as shown in 64a, is exactly the case in Eastern Abenaki (Warne 1975). It is also possible, of course, for an Abenaki dialect to borrow the backing of \*/ε/ from a southern language just as nasalization was borrowed. This took place in Western Abenaki, but, as shown in 64b, the borrowing was imperfect: rather than chain-shifting to replace original long \*/a:/ as in Massachusetts, Western Abenaki \*/ε/ simply merged with existing \*/a/ (Warne 1975).

(64) a. Eastern Abenaki



b. Western Abenaki

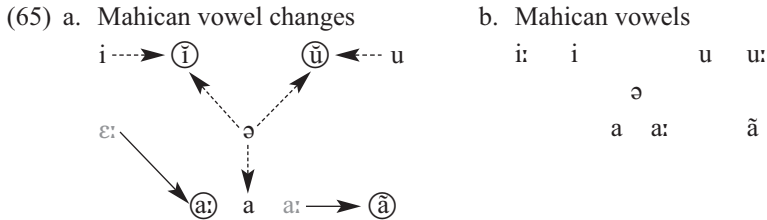


This unusual outcome gives the impression of a chain shift that went off target—which I suggest is exactly what took place. In Massachusetts, where the shift originated, an earlier promotion of the length contrast ensured that \*/ε:/ remained contrastively [long] even after \*/a:/ shifted to /ã/ (see 62), thus keeping backed \*/ε:/ distinct from non-[long] \*/a/. In Abenaki, by contrast, the lower-ranked length contrast did not apply to \*/ε/ and ceased playing any role at all in the system after \*/a:/ shifted to /ã/ (see 63). In the absence of a length contrast, Western Abenaki could not keep backed \*/ε/ separate from \*/a/, so any attempt to borrow the backing of \*/ε/ toward [a] from neighboring languages would inevitably result in a merger of \*/ε/ with \*/a/. The Western Abenaki outcome thus illustrates the complications that can arise when a sound change that originated in a different phonological system is borrowed.

Aside from the low vowel shift, Abenaki underwent two minor changes that lend additional support to the contrastive hierarchy proposed for PEA. First, word-initial \*/a, ə/ merged to /a/ (Warne 1975:39), an interaction that is consistent with the sisterhood of

\*/a, ə/ under the PEA contrastive hierarchy (see 63 above). Second, \*/u/ triggered the rounding of other vowels in certain contexts (Warne 1975:56), thus confirming its specification as contrastively [labial].

**5.6. MAHICAN.** Mahican forms a genetic subgroup with the Delaware languages (Goddard 1978:75, 2008) and shares with them the creation of new short high vowels from the coloring of PEA \*/ə/ and the shortening of PEA \*/i, u/ in certain contexts (§5.3). However, Mahican also shares changes with two other neighboring languages: it has undergone the low vowel shift that originated in the Southern New England languages (§5.5; Goddard 2008), and it shares the merger of \*/ə/ with \*/a/ word-initially and in certain other contexts with Abenaki (§5.5; Pentland 1991). These changes are shown in 65a; the resulting vowel system is rewritten in 65b in order to consistently represent the length contrast.



The Mahican changes can be given the same analyses that were posited for the other languages. The extension of the length contrast to the high vowels fills a gap in the asymmetric PEA inventory, as in Delaware. The vowel shift is a natural consequence of the nasalization of PEA \*/a:/, as in Massachusetts, as long as we assume that Mahican shared the promotion of the length contrast that was posited for Massachusetts in 60. The partial merger of \*/a, ə/ to /a/ is consistent with the sisterhood of \*/a, ə/ under the PEA contrastive hierarchy, as in Abenaki.

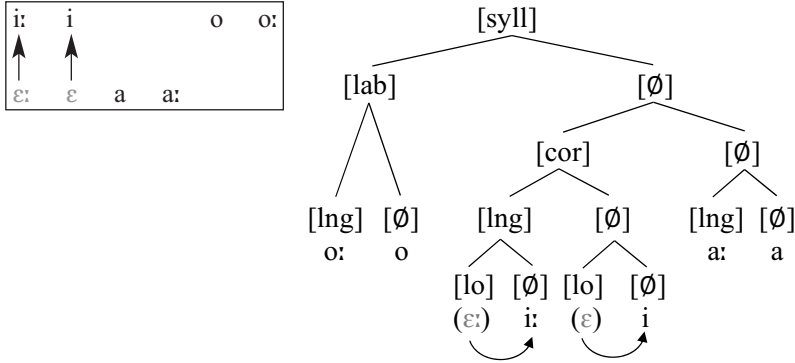
**5.7. SUMMARY: EASTERN ALGONQUIAN VOWEL REFLEXES.** Evidence internal to PEA required us to posit a significant contrast shift: the addition of a top-ranked height contrast. Together with the reanalysis of PA short \*/ɛ/ as non-[coronal] \*/ə/, the asymmetrical arrangement of contrasts created by this shift sent the Eastern languages on a path quite different from that of their Central relatives. With only minimal subsequent modifications—namely, the demotion of [low] in Mi'gmaq, the promotion of [long] in Massachusetts, and the addition of [nasal] in Massachusetts, Mahican, and Abenaki—the PEA hierarchy predicts the patterning of the major developments in the Eastern languages, including several mergers, the addition of new vowel qualities in Delaware and Mi'gmaq, the conditioning of Massachusetts palatalization, and the nuanced chain-shift patterns in Massachusetts and Abenaki. The PA/Central hierarchy, by contrast, would predict none of these developments. Systematic differences in the evolution of the Eastern and Central languages are discussed further in §7.

**6. PLAINS ALGONQUIAN VOWEL REFLEXES.** Plains and Central Algonquian are both areal rather than genetic groupings, but the Plains languages differ from their relatively conservative Central neighbors in that they have all undergone dramatic innovations. This section begins with Blackfoot (§6.1), the most divergent Algonquian language (Goddard 1974c:601), before turning to Cheyenne and Arapaho-Atsina (§6.2), which share an important change and have undergone 'startling, even bizarre, phonological innovations' (Goddard 1974c:602). Since the Plains languages are small in number, we lack the benefit of multiple daughter languages in which to test the predictions of the proposed contrast shifts, so the analysis is necessarily less conclusive than that pro-

posed for Central and Eastern Algonquian. Nevertheless, we still observe parallels between the Plains languages and their Central and Eastern relatives.

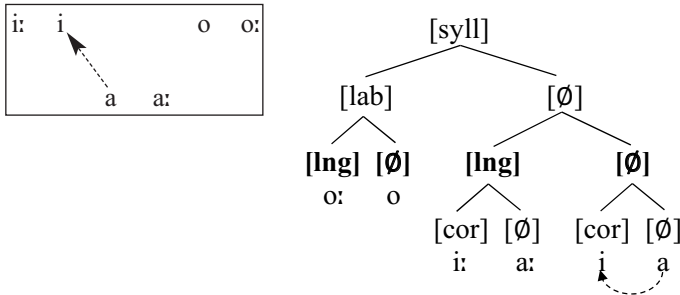
**6.1. BLACKFOOT.** Despite the divergent status of Blackfoot, the major vowel changes documented by Berman (2006:266) are rather simple. The most significant changes are the complete mergers of \*/ε/ with \*/i/ and \*/ε:/ with \*/i:/, which are consistent with the sisterhood of the \*/ε, i/ and \*/ε:, i:/ pairs under the PA contrastive hierarchy. The same mergers also occurred in neighboring northwestern Cree dialects (§4.3), so in this respect, Blackfoot has behaved no differently from a Central language.

(66) Pre-Blackfoot 1: [labial] > [coronal] > [long] > [low] (from PA)



The other major change, a partial merger of medial short \*/a/ with \*/i/, does not follow from the PA hierarchy in 66, since short \*/a, i/ will not be sisters even after the loss of \*/ε/. However, the sisterhood of \*/a, i/ can be brought about by a familiar contrast shift: the promotion of the length contrast by a single step, as in 67, thus grouping the nonlabial vowels according to their length rather than their frontness.

(67) Pre-Blackfoot 2: [labial] > [long] > [coronal] > [low]



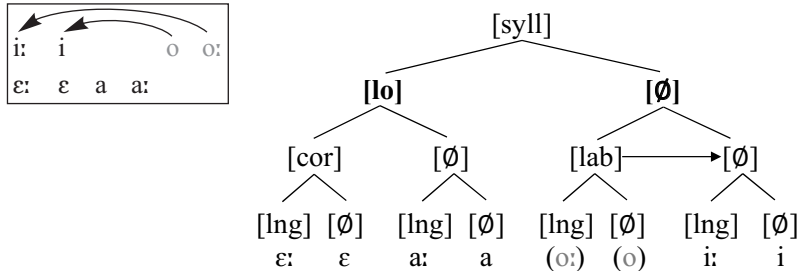
Two other developments are worth noting. The first is the rounding of PA \*/a, ε/ to /o/ before a syllable containing \*/o(:)/ (Berman 2006:279). The triggering of rounding by \*/o(:)/ is consistent with its specification as [labial] in 66. The second development is assibilation, which occurred in two stages (Proulx 1989:52–53, Berman 2006:265): prior to the \*/ε(:), i(:)/ and \*/a, i/ mergers, \*/k/ became /ks/ before \*/i(:)/, while after the \*/ε(:), i(:)/ and \*/a, i/ mergers, \*/t/ became /ts/ before /i(:)/. If we regard assibilation as a type of palatalization (cf. Kochetov 2011), then its triggering by /i(:)/ confirms the specification of /i(:)/ as [coronal] in 66. The consistency of these developments with the PA contrastive hierarchy indicates that, at least for a time, the vowel system of divergent Blackfoot retained a structure quite close to that of its parent.

**6.2. CHEYENNE AND ARAPAHO-ATSINA.** The remaining Plains languages share an important vowel shift, which is discussed first. Other developments differ in each language and are discussed separately.

THE PLAINS VOWEL SHIFT. Two vowel changes are common to both Pre-Cheyenne (Goddard 1986) and Proto-Arapaho-Atsina (PAA; Goddard 1974a): the merger of \*/o, o:/ with \*/i, i:/, and the shift of \*/a, a:/ to \*/ɔ, ɔ:/. The dramatic \*/o(:)/ with \*/i(:)/ merger is part of what Pentland (1979:402) has dubbed the ‘Great Plains sound shift’, which also involved the merger of \*/w/ and \*/j/ and the (partial) loss of \*/k/. Although Pre-Cheyenne and PAA share this sound shift, the languages are not considered to form a genetic subgroup—instead, it is thought that the shift ‘diffused across the languages after they were already differentiated’ (Goddard 1994:193).

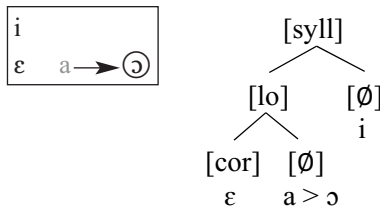
The merger of \*/o, o:/ with \*/i, i:/ is not predicted by the contrastive hierarchy inherited from PA, under which the high vowels are not a natural class (see 66). When the same situation arose in PEA (§5.1), we concluded that a height contrast must have been inserted at the top of the PA hierarchy, possibly for reasons of markedness. Let us thus posit such a shift for Pre-Cheyenne and PAA as well, as shown in 68, where the existing [low] contrast has been promoted to the top of the hierarchy (which is otherwise unchanged from PA).<sup>21</sup> The merger of \*/o, o:/ with \*/i, i:/ then follows from the loss of the [labial] contrast—the first case we have seen in which the ‘sisters’ in a merger are natural classes rather than single phonemes (a possibility discussed in §2.3).

(68) Pre-Cheyenne/PAA: [low] > [labial] > [coronal] > [long]



The \*/o(:), i(:)/ merger rendered the [labial] contrast irrelevant, as indicated in 69—where I begin to abstract away from length, since it is not relevant to later developments. A degree of symmetry was then restored to the vowel system by the shift of \*/a/ to \*/ɔ/, but as Goddard (1974a:108) notes, this shift does not necessarily have phonological consequences, as it remains within the phonetic range predicted by the specification of original \*/a/ as [low] and non-[coronal].<sup>22</sup>

(69) Pre-Cheyenne/PAA: [low] (> ~~[labial]~~) > [coronal]



Even with the shift of \*/a/ to \*/ɔ/, the resulting Pre-Cheyenne/PAA vowel system is typologically unusual, since it contains one high vowel quality and two low vowel qualities. It also shares with PEA (§5.1) the unintuitive situation in which \*/ε/ is con-

<sup>21</sup> In PEA, there was reason to believe that the new height contrast involved the feature [high] (§5.1), but in Pre-Cheyenne and PAA, any height feature appears to be equally adequate. I have arbitrarily chosen to promote the existing [low] contrast rather than adding a new [high] contrast. Further theoretical or empirical considerations could favor one alternative or the other, but either is sufficient for the purposes of this article.

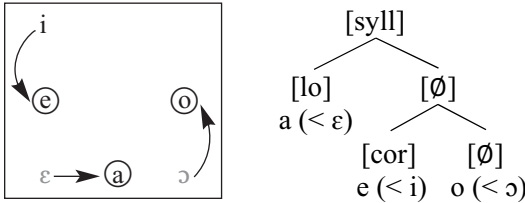
<sup>22</sup> I write <> for Goddard’s <o>, following the Arapaho phonetic value (Cowell & Moss 2008:14).

trastively [coronal] but \*/i/ is not. We will see below that Cheyenne and Arapaho-Atsina both resolved the instability of the system in 69, but in different ways: Cheyenne rotated the three vowels into a less marked arrangement, while Arapaho-Atsina created a symmetrical four-vowel system by adding a new vowel.

SUBSEQUENT CHANGES IN CHEYENNE. While its vowel system was at the stage in 69, Pre-Cheyenne underwent a development labeled ‘yodation’ by Goddard (1986), in which \*/kε/ became \*/kjε/. Goddard distinguishes yodation from palatalization because later developments treat the inserted \*/j/ as a separate segment. Given that this \*/j/ was inserted only between \*/k/ and the front vowel \*/ε/, however, it seems reasonable to assume that yodation originated with the palatalization of \*/k/ to [kʲ] before \*/ε/, with subsequent reanalysis of the inserted [j] as a separate segment.<sup>23</sup> It is interesting that the palatalization of \*/k/ to [kʲ] was not triggered by front \*/i/. As in Massachusetts (§5.5), the exclusion of \*/i/ as a trigger is predicted by the contrastive hierarchy, since the only contrastively [coronal] vowel in 70 is \*/ε/.

The Cheyenne vowels subsequently underwent the rotation shown in 70, in which the raising of \*/ɔ/ to /o/ and the backing of \*/ε/ to /a/ created a more prototypical system. Given the large gap in the vowel space left by the loss of original \*/o/, the raising of \*/ɔ/ was likely phonetically motivated, but it has important phonological consequences, since it left \*/ε/ as the only low vowel. Without a low back counterpart, low front \*/ε/ could no longer be contrastively [coronal], thus making its shift to /a/ inevitable—another parallel with Massachusetts (§5.5). The resulting vowel system and contrastive specifications are shown in 70.

(70) Cheyenne: [low] > [coronal] (hierarchy from Pre-Cheyenne, but vowels reorganized)



In addition to the \*/ε/ > /a/ and \*/ɔ/ > /o/ shifts, the remaining front vowel \*/i/ was lowered to the extent that it is normally phonemicized as /e/ rather than /i/, although in fact the nonlow vowels /e, o/ range phonetically from mid [e, o] to high [i, u] (Pentland 1979:402). This range is consistent with the specification of these vowels as contrastively non-[low] rather than [high] in 70.<sup>24</sup>

SUBSEQUENT CHANGES IN ARAPAHO-ATSINA. Arapaho and Atsina restored symmetry to the vowel system using a different strategy from that of Cheyenne: the arrangement of phonemes in 69 was left intact, but a new high back vowel was added through the conditioned backing of \*/i/, producing unrounded /w/ in Arapaho and rounded /u/ in

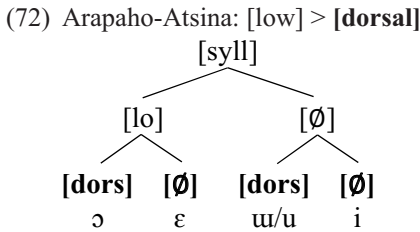
<sup>23</sup> A referee suggests an alternative analysis in which yodation instead involves the diphthongization of \*/ε/ > [je], as occurred in the development of the Romance languages from Vulgar Latin. However, this alternative does not explain why yodation took place only after \*/k/. The palatalization analysis captures this conditioning, as there is a well-known tendency for [k] to palatalize before a front vowel (see e.g. Montagnais-Naskapi and Massachusetts in this article). I am not aware of any parallel tendency for front vowels to diphthongize only after [k].

<sup>24</sup> Cheyenne also underwent an additional development that I do not address here: the Cheyenne reflex of PA vowel length is underlying high tone (Frantz 1972, Goddard 1986:345).

Atsina (Goddard 1974a:111). The possibility of an unrounded outcome indicates that this change truly involved backing rather than rounding.

- (71) a. PAA to Arapaho  
 i -----> (u)  
 ε           ɔ
- b. PAA to Atsina  
 i -----> (u)  
 ε           ɔ

The trigger of backing, \*/ɔ/, is not contrastively specified for a back feature under the PAA hierarchy in 69, where the low vowels \*/ε, ɔ/ are distinguished by [coronal]. We must posit the reanalysis of this contrast as [dorsal] in order to predict the triggering of backing by \*/ɔ/. Further evidence that \*/ɔ/ became contrastively [dorsal] is provided by low vowel harmony, in which /ɔ/ triggers the backing of /ε/ to /ɔ/ in a preceding syllable (Cowell & Moss 2008:21 for Arapaho). The reanalysis of PAA [coronal] as [dorsal] produces the contrastive hierarchy in 72.



This is the first time we have observed an inventory with full symmetry (i.e. maximal feature economy): each possible combination of the values of [low] and [dorsal] is manifested by a distinct phoneme. It is not likely a coincidence that symmetry arose only in these highly innovative languages: if the drive for symmetry helps to motivate contrast shift (§2.3), then the more contrast shifts an inventory undergoes, the higher the degree of symmetry we should expect it to achieve.

Arapaho and Atsina also independently underwent complex sets of consonant shifts conditioned by the vocalic environment, as summarized in Table 2 (Goddard 1974a:111).

PAA	PRE-ARAPAHO		
	__ {ɔ, u},	ɔ __ ε	__ {ε, i},
	{ɔ, u} __ #		{ε, i} __ #
*ʃ	x	x	s
*k	k	k	tʃ
*m	w	m	b

TABLE 2a. PAA to Pre-Arapaho.

PAA	PRE-ATSINA		
	__ ɔ	__ ε	__ {i, #}
*ʃ	θ	θ	s
*θ	t	t	c
*t	t	t	tʃ
*m	w	b	bʃ
*k	k	tʃ	c

TABLE 2b. PAA to Pre-Atsina.

These consonant shifts present a formidable analytical challenge, as some of them verge on being ‘crazy rules’ in the sense of Bach & Harms 1972 (e.g. Pre-Atsina \*m > b / \_\_ ε). A full understanding requires knowledge of the phonetic progression of each shift, which may simply be unrecoverable, despite the efforts of Picard (1994) (criticized by Goddard 1995). I thus do not undertake a detailed analysis of the consonant shifts in this article.

One aspect of the consonant shifts must be addressed, however, since it is particularly challenging for the model proposed in this article: the shifts appear to include cases of fronting triggered by front vowels (e.g. Pre-Arapaho \*k > tʃ / \_\_ i) as well as backing triggered by back vowels (e.g. Pre-Arapaho \*ʃ > x / \_\_ {ɔ, u}). It thus seems that both [coronal] and [dorsal] are active simultaneously—a state of affairs that is difficult to explain under my assumptions, since the front-back contrast in 72 can be taken to involve either [coronal] or [dorsal] but not both.

The Atsina consonant shifts in Table 2b suggest a possible solution to this problem. Several of the Atsina shifts appear to involve fronting or palatalization triggered by \*/i/ (\*j > s, \*θ > c, \*t > tʲ, \*m > bʲ, \*k > c). At first glance, these shifts suggest that \*/i/ is contrastively [coronal]. Importantly, however, these cases of fronting occurred not just before \*/i/, but also word-finally, as indicated in Table 2b and noted by Goddard (1974a:112). The environment for fronting is thus the disjunction {i, #} rather than any natural class of vowels. In other words, fronting in Atsina is in fact the ELSEWHERE CASE. This conclusion may be unusual, but the conditioning environments in Table 2b make it inevitable.

The 'elsewhere' analysis of fronting allows us to resolve the particularly problematic cases of apparent mirror-image conditioning in Arapaho: /ɔ, ʊ/ trigger backing of \*/j/ > [x], while /i, ε/ trigger fronting of \*/k/ > [tʃ]. If, as in Atsina, we analyze fronting as the elsewhere case, we can in fact regard both of these processes as involving only the feature [dorsal], as shown in 73: \*/j, k/ become dorsal [x, k] before the contrastively [dorsal] vowels /ɔ, ʊ/ and become [s, tʃ] elsewhere.

(73) Pre-Arapaho backing and fronting without mirror-image conditioning

SHIFT	CONDITIONED CHANGE	ELSEWHERE CHANGE
Backing	*j > x / [dorsal] (ɔ, ʊ)	*j > s elsewhere (i, ε)
Fronting	*k > k / [dorsal] (ɔ, ʊ)	*k > tʃ elsewhere (i, ε)

Since the Arapaho-Atsina consonant shifts can be modeled in a system in which vowels are specified for [dorsal] but not [coronal], as in 72, the shifts are not as problematic as they first appear.

**6.3. SUMMARY: PLAINS ALGONQUIAN VOWEL REFLEXES.** Despite the divergence of the Plains languages, this section has shown that their major vowel changes can be accounted for under assumptions no different from those required for the Central and Eastern languages. Blackfoot, in fact, appears to have retained much of its PA contrastive structure, while Cheyenne and Arapaho-Atsina underwent essentially the same height-based shift that occurred in the Eastern languages. By exposing these underlying parallels, the contrastive approach allows us to see the Plains vowel systems as being more prototypically 'Algonquian' than they may appear at first glance.

**7. DISCUSSION.** This section ties together the findings of the article by summarizing the diachronic developments and their analyses (§7.1) and evaluating the more general patterns that have arisen (§7.2). The implications of these findings for the role of contrast in sound change are then discussed (§7.3).

**7.1. SUMMARY OF CHANGES.** This article has described approximately fifty diachronic changes and accounted for them by positing a smaller number of contrast shifts. A complete list of the changes and their proposed analyses is given below, classified into five groups: structural mergers, vowel processes and mutation mergers (i.e. partial mergers brought about by vowel processes), phonetic and phonological shifts, the addition of new vowel phonemes, and consonant changes conditioned by vowels.

(74) STRUCTURAL MERGERS

- a. PA: neutralization of \*/ε, i/ in initial syllables (loss of [low] contrast)
- b. Miami-Illinois: \*/ε, i/ > /i/ in weak contexts (loss of [low] contrast)
- c. Ojibwe-Potawatomi, Cree-Montagnais-Naskapi, Blackfoot: \*/ε, i/ > /i/ (loss of [low] contrast)
- d. Ojibwe-Potawatomi, Montagnais-Naskapi: neutralization or merger of \*/i, a/ > /ə/ (loss of [coronal] contrast)
- e. Potawatomi: \*/o, ɔ:/ > /o:/ (loss of [long] contrast)

- f. Northwestern Cree dialects, Blackfoot: \*/ɛ/, i:/ > /i:/ (loss of [low] contrast)
  - g. Betsiamites Innu: \*/o, ə/ > /ə/ (loss of [labial] contrast)
  - h. Northern East Cree: \*/ɛ/, a:/ > /a:/ (loss of [coronal] contrast)
  - i. PEA: \*/i, i:/ > \*/i:/ and \*/u, u:/ > \*/u:/ (loss of [long] contrast in [high] class)
  - j. Mi'gmaq, Maliseet-Passamaquoddy: \*/a, ə/ > /ə/ (loss of [low] contrast)
  - k. Massachusetts: \*/ɛ̃, ə/ > /ə/ (loss of [coronal] contrast)
  - l. Western Abenaki: \*/ɛ, a/ > /a/ (borrowed backing of /ɛ/)
  - m. Mahican, Abenaki: initial \*/a, ə/ > /a/ (loss of [low] contrast)
  - n. Blackfoot: medial \*/i, a/ > /i/ (loss of [coronal] contrast)
  - o. Pre-Cheyenne, PAA: \*/o, o:/ > \*/i, i:/ (loss of [labial] contrast)
- (75) VOWEL PROCESSES AND MUTATION MERGERS
- a. Montagnais-Naskapi labial harmony: \*/i, a/ > /o/ before /o, o:/, w/ (triggers are [labial] class)
  - b. Menominee height harmony: /e, o/ > /i, u/ before a high vowel, /æ/ opaque, /a/ transparent (targets non-[high], triggers [high]; opaque /æ/ is [low], no height contrast for transparent /a/)
  - c. Abenaki rounding: some vowels assimilate to following \*/u/ (trigger is contrastively [labial])
  - d. Blackfoot rounding: \*/a, ɛ/ > /o/ before /o, o:/ (triggers are [labial] class)
  - e. Arapaho-Atsina backness harmony: /ɛ/ > /ɔ/ when /ɔ/ follows (trigger is contrastively [dorsal])
- (76) PHONETIC AND PHONOLOGICAL SHIFTS
- a. Menominee: lowering of \*/i, ɛ/ to /e, æ/ (remains within ranges determined by PA contrasts)
  - b. PEA: shift of \*/ɛ/ to \*/ə/ (phonetic change plus reanalysis as non-[coronal])
  - c. Massachusetts, Mahican, Abenaki: shift of \*/a:/ to /ã/ (nasalization likely from contact, vowel reanalyzed as [nasal])
  - d. Narragansett: shift of /ã/ to /ə̃/ (no contrastive place or height features)
  - e. Massachusetts, Mahican: shift of \*/ɛ:/ to /a:/ (wider range after loss of [coronal])
  - f. Pre-Cheyenne, PAA: shift of \*/a/ to \*/ɔ/ (within range predicted by [low], non-[coronal])
  - g. Cheyenne: shift of \*/ɔ/ to /o/ (phonetically motivated: large gap in vowel space from loss of PA \*/o/)
  - h. Cheyenne: shift of \*/ɛ/ to /a/ (wider range after loss of [coronal])
- (77) NEW VOWEL PHONEMES
- a. Menominee: new /i, u/ from \*/e, o/ or glide-vowel contraction (new [high] contrast added to system)
  - b. Delaware: new /ĩ, ẽ, ũ/ from \*/i, e, u, ə/ (existing [long] contrast extended)
  - c. Unami Delaware: new /ɔ, ɔ:/ from \*/wa, wa:/ (existing [labial] contrast extended)
  - d. Mi'gmaq: new /o/ from coloring of \*/a, e/ before \*/kw/ (existing [labial] contrast extended; trigger is [labial])
  - e. Mi'gmaq: new long /i:, e:, a:, o:, u:/ (new [long] contrast added)
  - f. Massachusetts: new \*/ɛ̃/ from reduction of \*/i/ (weakened allophone of \*/i/ reanalyzed as non-[high])



- g. Mahican: new /ĩ, ü/ from \*/i, u, ə/ (existing [long] contrast extended)
  - h. Arapaho-Atsina: backing of \*/i/ to new /u/ or /u/ after \*/ə/ (trigger is [dorsal]; increases symmetry)
- (78) CONSONANT CHANGES
- a. PA palatalization: \*/t, θ/ > \*/tʃ, ʃ/ before \*/i, i:/ (triggers are [coronal], but [coronal] \*/ε, ε:/ excluded because [low])
  - b. Montagnais-Naskapi palatalization: \*/k/ > /tʃ/ before /i, i:, ε:/ (triggers are the [coronal] class; [low] trigger permitted)
  - c. Betsiamites Innu palatalization: \*/t/ > [tʃ] before /i:/ but not former \*/i/ (trigger is [coronal]; former \*/i/ lost [coronal] in merger with \*/a/)
  - d. Massachusetts palatalization: \*/k/ > /tj/ before \*/ε:, ẽ/ (triggers are [coronal] class)
  - e. Blackfoot assibilation: \*/k, t/ > /ks, ts/ before /i, i:/ (triggers are [coronal]; were non-[low] when \*/ε, ε:/ existed)
  - f. Cheyenne yodation: \*/k/ > /kj/ before \*/ε/ (trigger is the [coronal] class)
  - g. Arapaho-Atsina consonant shifts: back reflexes conditioned by [dorsal] vowels, front reflexes elsewhere

To derive these changes from the PA system, it was necessary to posit the contrast shifts in 79. The assumption of these shifts allows nearly all of the above changes to be accounted for under a restrictive model of phonological change that obeys the contrastivist hypothesis and the sisterhood merger hypothesis.<sup>25</sup>

(79) Contrast shifts

a. RERANKING

- (i) Promotion of [long] by a single step (PA, Ojibwe-Potawatomi, Montagnais-Naskapi, Betsiamites Innu, Massachusetts, Mahican, Blackfoot)
- (ii) Demotion of [long] by a single step (Maliseet-Passamaquoddy, Mi'gmaq)
- (iii) Promotion of [high] by a single step (Northern East Cree)
- (iv) Promotion of [low] to the top of the hierarchy (Pre-Cheyenne, PAA)

b. ADDITION

- (i) Addition of [high] at the top of the hierarchy (PEA)
- (ii) Addition of [high] within the scope of existing [low] (Menominee)
- (iii) Addition of [nasal] at the top of the hierarchy (Massachusetts, Mahican, Abenaki)

c. FEATURE REANALYSIS

- (i) Reanalysis of [coronal] contrast as [dorsal] (Arapaho-Atsina)

d. SEGMENTAL REANALYSIS

- (i) PA [coronal] \*/ε/ > PEA non-[coronal] \*/ə/
- (ii) Allophones of PEA [high] \*/i/ > Massachusetts non-[high] \*/ẽ/

The proposed model is only interesting insofar as the contrast shifts in 79 are both limited and principled. These considerations appear to be satisfied: the set of shifts is relatively small, considering that almost fifty changes in twenty languages are accounted for, and most of the shifts are minimal, involving only a single feature or a single hier-

<sup>25</sup> Some of the Arapaho-Atsina consonant shifts remain unaccounted for. The partial mergers of Mahican-Abenaki \*/a, ə/ and Blackfoot \*/i, a/ are also somewhat problematic, because the outcome of both mergers is the sister that bore the marked value of the relevant contrastive feature rather than the unmarked value, as might be expected.

archical step. Many of the shifts are also nonarbitrary in that they respond to external pressures: the demotion of [long] in Maliseet-Passamaquoddy and Mi'gmaq occurred when other changes left the length contrast playing a marginal role in the inventory (§5.4), the [nasal] contrast was added in Massachusetts when vowel nasalization was introduced, likely via contact (§5.5), and the reanalysis of \*/ε/ as non-[coronal] \*/ə/ in PEA was presumably a response to the phonetic centralization of \*/ε/ to [ə] (§5.1). The set of posited shifts is evaluated further in §7.3 below.

**7.2. PATTERNS OF CONTRAST.** The contrastive approach to phonological change is beneficial not only in providing a principled account of a wide range of developments, but also in the relationships and patterns that it uncovers among these developments, many of which would not otherwise be obvious. To illustrate this point, this section discusses two types of emergent patterns: cases in which a single contrast change has multiple independent implications, and cases in which different languages independently undergo parallel changes for contrastive reasons.

**CHANGES WITH MULTIPLE EFFECTS.** When a single contrast shift accounts for more than one subsequent development, we gain an insight into these developments, since they can now be seen as related effects of the same underlying cause rather than separate, unrelated innovations. The following list exemplifies the kinds of relationships that have emerged.

**Promotion of [long] in PA (§3.4).** In this article, the feature [long] has been used in an abstract contrastive sense to represent phonemic length (§2.1). The promotion of [long] above [low] in PA was posited to explain the partial merger of short \*/ε, i/, but the length-based grouping of the front vowels had continued ramifications in the daughter languages, allowing not only the complete \*/i, ε/ merger in Ojibwe-Potawatomi and Cree-Montagnais-Naskapi but also the \*/ε, i:/ merger in northwestern Cree dialects and Blackfoot. After \*/ε/ shifted to non-[coronal] \*/ə/ in PEA, the ranking of [long] above [low] grouped \*/a, ə/ as sisters, thus accounting for their merger in Abenaki, Mahican, Maliseet-Passamaquoddy, and Mi'gmaq (and correctly predicting the absence of \*/a, a:/ mergers).

**Promotion of [long] in Potawatomi (§4.2).** The promotion of [long] to a rank between [labial] and [coronal] was posited to explain the merger of short \*/i, a/, but the intermediate rank of [long] also explains why short \*/o/ merged with long \*/o:/ rather than with another short vowel. The difference in the patterning of short \*/i, a/ and short \*/o/ would not necessarily have an obvious explanation otherwise.

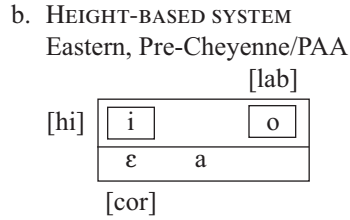
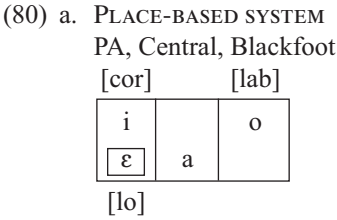
**Restructuring of the PEA vowel system according to [high] (§5.1).** The formation of a new natural class of [high] vowels was posited to explain why only these PEA vowels lost the length contrast. The resulting complementary class of non-[high] vowels then became active in subsequent changes, such as the shift of \*/ε:/ to /a:/ in Massachusetts and the \*/a, ə/ merger in Maliseet-Passamaquoddy and Mi'gmaq.

**Place asymmetry in the PEA vowel system (§5.1).** When the new [high] contrast was added to the PA hierarchy in PEA, the result was an asymmetry in which the high vowels contrasted for [labial] while the nonhigh vowels contrasted for [coronal]. Pressure to balance this asymmetry explains the independent development of new nonhigh [labial] vowels in both Unami Delaware and Mi'gmaq. The asymmetrical specification of \*/ε:/ but not \*/i:/ as [coronal] also explains why Massachusetts palatalization was triggered by \*/ε:/ but not by \*/i:/.

**Promotion of [long] in Massachusetts (§5.5).** Posited to explain the merger of \*/ě/ with \*/ə/, the promotion of [long] also grouped \*/ε:/ and \*/a:/ as sisters, thus accounting

for the subsequent shift of \*/ε:/ to /a:/ after the nasalization of original \*/a:/. In Western Abenaki, where the promotion of [long] did not occur, the borrowed backing of \*/ε:/ was not controlled by length and instead resulted in a merger with short \*/a/.

PARALLEL INDEPENDENT DEVELOPMENTS. Abstracting away from various details, the contrastive structures proposed for the Algonquian vowel inventories fall into one of the two arrangements in 80. Under the PA arrangement in 80a, which was maintained in the Central languages and Blackfoot, the highest-ranked contrasts involve place, with /i, ε/ forming a [coronal] pair. Under the restructured arrangement in 80b, which was innovated in PEA, Pre-Cheyenne, and PAA, the highest-ranked contrast instead involves height, with the resulting /i, o/ and /ε, a/ pairs distinguished by [labial] and [coronal], respectively.



The height-based shift in 80b was posited to account for the patterning of the high vowels as a natural class in PEA, Pre-Cheyenne, and PAA. The other contrastive effects of the shift—the grouping of \*/ε/ with \*/a/ rather than \*/i/ and the specification of [coronal] on \*/ε/ but not \*/i/—are purely coincidental. Nevertheless, subsequent developments in both the place-based and height-based vowel systems consistently pattern exactly as these coincidental changes predict. The predictive accuracy of these changes is most striking with respect to developments that have occurred in both systems, but with slightly different conditioning in each. There are two such developments: (i) mergers and shifts involving \*/ε/, and (ii) innovative cases of palatalization.

**Mergers involving \*/ε/.** In both vowel systems, there are several cases in which the reflex of PA \*/ε/ is merged or shifted. On the one hand, in languages with the place-based arrangement of contrasts, \*/ε/ consistently merges with \*/i/.<sup>26</sup>

- (81) PLACED-BASED SYSTEM: \*/ε/ > \*/i/
- a. Partial neutralization of short \*/ε, i/ in PA
  - b. Merger of short \*/ε, i/ in weak environments in Miami-Illinois
  - c. Complete merger of short \*/ε, i/ in Ojibwe-Potawatomi, CMN, and Blackfoot
  - d. Complete merger of long \*/ε:, i:/ in northern Cree dialects and Blackfoot

In languages with the height-based arrangement of contrasts, on the other hand, \*/ε/ consistently merges with, shifts to, or otherwise interacts with \*/a/ rather than \*/i/.

- (82) HEIGHT-BASED SYSTEM: \*/ε/ > \*/a/
- a. Partial merger of \*/ə/ (the reflex of \*/ε/) with \*/a/ in Mahican and Abenaki
  - b. Merger of \*/a/ with \*/ə/ in Mi'gmaq and Maliseet-Passamaquoddy
  - c. Shift of \*/ε:/ to /a:/ in Massachusetts and Mahican
  - d. Merger of \*/ε/ with /a/ in Western Abenaki

<sup>26</sup> The lone exception to this generalization is Northern East Cree, in which \*/ε:/ merged with \*/a:/, possibly due to contact with Inuktitut (§4.3).

- e. Vowel harmony involving /*ɛ*/ > /*ɔ*/ (the reflex of \*/*a*/) in Arapaho-Atsina
- f. Shift of \*/*ɛ*/ to \*/*a*/ in Cheyenne

We might imagine that this difference follows from phonetic facts—it could be the case, for example, that \*/*ɛ*/ in the height-based system is lower or more back than \*/*ɛ*/ in the place-based system, thus explaining its propensity to merge with \*/*a*. This explanation is unlikely, however, since it is in fact the place-based Central languages that often have a very low realization of \*/*ɛ*/ (as [æ]). It therefore seems more likely that the different behavior of the two systems follows from their phonological structure, since the contrastive sister of \*/*ɛ*/ is \*/*i*/ in the place-based system and \*/*a*/ in the height-based system. The overwhelming consistency of the resulting mergers provides a strong confirmation of the height-based shift posited for PEA, Pre-Cheyenne, and PAA, even though this shift was motivated on entirely independent grounds.

**Innovative cases of palatalization.** The second correspondence involves fewer examples but is perhaps even more striking due to its improbability. Various Algonquian languages have developed new palatalization processes. On the one hand, in languages with the place-based arrangement of contrasts, such processes always include \*/*i*/ as a trigger.

- (83) PLACE-BASED SYSTEM: palatalization triggered by \*/*i*/ (sometimes also \*/*ɛ*/)
  - a. PA coronal palatalization triggered by \*/*i*, *i*/
  - b. Montagnais-Naskapi velar palatalization triggered by \*/*i*, *i*, *ɛ*/
  - c. Betsiamites Innu coronal palatalization triggered by /*i*/
  - d. Blackfoot assibilation triggered by \*/*i*, *i*/

In languages with the height-based arrangement of contrasts, on the other hand, palatalization is triggered by \*/*ɛ*/ but not \*/*i*. <sup>27</sup>

- (84) HEIGHT-BASED SYSTEM: palatalization triggered by \*/*ɛ*/ but not /*i*/
  - a. Massachusetts velar palatalization triggered by \*/*ɛ*, *ɛ̃*/
  - b. Pre-Cheyenne yodation (\*/*k*/ > /*kj*/) triggered by \*/*ɛ*, *ɛ*/

These conditioning patterns fall out from the contrastive properties of the two systems. In the place-based system, \*/*i*, *ɛ*/ are both contrastively [coronal] and are thus both potential palatalization triggers (with \*/*ɛ*/ often excluded due to its [low] specification). In the height-based system, by contrast, \*/*ɛ*/ is contrastively [coronal] but \*/*i*/ is not, thus predicting the exclusion of \*/*i*/ as a palatalization trigger. Given the typological rarity of palatalization triggered by mid but not high vowels—in Kochetov's (2011:1672) survey of sixty-four languages, for instance, no such examples were found—it would otherwise be a strange coincidence for two such processes to develop independently under the height-based system. We have thus formulated not only a synchronic analysis of these typologically unusual processes, but also a diachronic analysis in which their peculiar conditioning falls out from the same contrast shift that accounts for the occurrence of high-vowel mergers and repeated \*/*ɛ*, *a*/ interactions in related languages as well as the consistently different patterning of similar processes in the other branch of

<sup>27</sup> The Arapaho-Atsina consonant shifts also include apparent examples of palatalization, but these shifts occurred after the vowel system had been restructured into a fully symmetrical arrangement (at least in Arapaho; the ordering of the shifts in Atsina is indeterminate (Goddard 1974a:111)). This restructuring significantly altered the contrastive properties of the vowel system (§6.2), differentiating it from both the canonical height-based system in 80b and the canonical place-based system in 80a. Subsequent changes such as the consonant shifts are thus not relevant to the current discussion, since they do not bear on the two systems in question.

the family. Recognizing patterns of contrast in historical phonology provides a unified explanation of this large set of developments.

**7.3. EVALUATING THE MODEL.** The model of the role of contrast in sound change proposed in this article consists of the four hypotheses in 85, repeated from above. The model was tested against the set of vowel changes in the Algonquian languages, a detailed database of sound change that had not previously been extracted from the philological literature. Such a test could be carried out using any language family, since the proposed model provides a straightforward technique for importing the findings of traditional philology into a phonological framework.

- (85) a. Contrastivist hypothesis: Only contrastive features are phonologically active.  
 b. Sisterhood merger hypothesis: Structural mergers apply to ‘contrastive sisters’.  
 c. Contrast shift hypothesis: Contrastive hierarchies can change over time.  
 d. Segmental reanalysis hypothesis: A segment may be reanalyzed as having a different contrastive status.

We were able to formulate an analysis of the Algonquian data by applying these hypotheses in essentially a mechanical fashion, but is the resulting analysis explanatory? The potential weak point of the model is the contrast shift hypothesis, which allows us to manipulate the contrastive hierarchy in order to satisfy the contrastivist hypothesis and the sisterhood merger hypothesis. It was thus suggested that contrast shift be subjected to the constraints in 86, with the satisfaction of these constraints determining the degree to which an analysis may be considered explanatory.

- (86) a. Contrast shifts should be minimal.  
 b. Contrast shifts obey the forces of drift, markedness, and symmetry.

Our Algonquian case study generally satisfies the minimality constraint in 86a. Most of the posited contrast changes (listed in 79 above) are minimal, involving the reranking of an existing feature by a single step or the addition or reanalysis of a single feature. The most obviously nonminimal contrast shift was the promotion of [low] from the bottom to the top of the hierarchy in Pre-Cheyenne and PAA, which must be understood as a dramatic reanalysis rather than a gradual stepwise change. In light of the startling innovations that occurred in these divergent languages, however, the assumption of a dramatic reanalysis is clearly appropriate in this case. In general, then, the analysis appears to obey the minimality constraint to an appropriate degree.

The constraint in 86b is less straightforward to evaluate, but nevertheless appears to be confirmed to some extent. The operation of drift can be observed in the ranking of the length contrast, which was promoted a step above its Proto-Algic level in PA (§3.4), by a subsequent step in several daughter languages (Ojibwe-Potawatomi, Montagnais-Naskapi, Massachusetts, Blackfoot), and by a further step in Betsiamites Innu, thus reaching the top of the contrastive hierarchy. If we accept that drift is in play, all of these promotions can be regarded as consequences of the initial promotion in PA.

The markedness of the contrastive hierarchy also appears to play a role in the posited contrast shifts. If we follow Jakobson and Halle (1956:41) in assuming that vocalic contrastive hierarchies begin with a height contrast by default, we can explain the otherwise surprising fact that the two innovative Algonquian branches—PEA in the east and Pre-Cheyenne/PAA in the west—both underwent essentially the same contrast shift: the insertion of a height contrast at the top of the hierarchy. If Jakobson and Halle are correct, such a shift can be understood as serving to reduce the markedness of the place-

based hierarchy inherited from PA, thus making it unsurprising that such shifts would have developed independently in the innovative branches of Algonquian.

Several of the Algonquian developments also illustrate the influence of symmetry. Some symmetry-related developments can be explained without requiring a hierarchical model of contrast—for example, the addition of a full complement of short vowels in Delaware (§5.3) would presumably be natural under various models. In other cases, however, the very meaning of symmetry with respect to a given inventory can only be determined in light of its contrastive feature specifications. To see how this is the case, consider the five-vowel inventory /i ε ə a u/. If the back vowels are distinguished by [dorsal], as in 87a, the height contrast will apply symmetrically to both the front and the back vowels. But if the back vowels are instead distinguished by [labial], as in 87b, the height contrast will apply to the front vowels but not to the back (round) vowels, an asymmetry that leaves an unfilled phonemic slot in the vowel system.

(87) a.	[cor]	[dors]	b.	[cor]	[lab]
	i	u		i	u
	ə			ε	ə
	ε	a		a	□

The inventory in 87 is similar to that of PEA, in which the back vowels were specified asymmetrically as in 87b. The subsequent development of /ɔ/ in Unami and /o/ in Mi'gmaq was unsurprising, since the new vowels filled the empty phonemic slot—but, crucially, this slot was ‘empty’ only because of the contrastive structure of the inventory. If the PEA vowels were instead specified as in 87a, the Unami and Mi'gmaq developments would be unexpected, since the vowel system would already have been symmetrical from the perspective of feature economy. We must therefore recognize a link between contrast and symmetry, since we can only determine what counts as symmetrical once we understand the contrastive relationships in the inventory.

**8. CONCLUSION.** This article has argued that the recognition of contrast-related patterns can bring new insight into phonological change. Beginning with the assumption that only contrastive features can be phonologically active, further considerations led us to conclude that contrastive features must be hierarchically specified and that such hierarchies can undergo diachronic change in a constrained fashion, subject to familiar considerations such as minimality, drift, markedness, and symmetry. The resulting model was tested against the set of major vowel-related changes in the Algonquian languages and was found to produce revealing results, allowing us to identify common sources for sets of seemingly independent developments. The most striking correspondences arose with respect to mergers involving \*/ε/ and the triggering of innovative palatalization processes, which exhibit previously unrecognized patterns that any approach, regardless of its theoretical orientation, should be expected to explain. In its application to the Algonquian data, the model proposed in this article has provided a coherent and constrained framework for analyzing the phonological structure of an entire language family and revealing unified diachronic and crosslinguistic patterns in developments that might otherwise appear to be random. The hierarchically constrained model of mergers and shifts also provides an explicit formalization of the notion of subsystems that Labov (1994) has shown to be central to sound change, thus creating a new connection between theoretical and variationist perspectives on phonology.

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