Contextual metrical invisibility in Mohawk and Passamaquoddy

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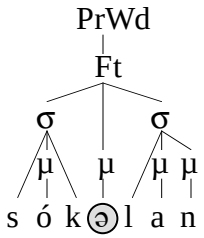
This talk investigates a stress phenomenon which I refer to as "contextual metrical invisibility" in two Native American languages, Mohawk and Passamaquoddy. In each of these languages, there is a class of vowels which are, in certain contexts but not in others, invisible to syllable-sensitive processes such as stress assignment. The conclusion we will come to is that such vowels, which I will refer to as "weak vowels," are not in fact dominated by a syllable node in the prosodic structure, due to an avoidance of syllables headed by weak vowels. To illustrate the idea, consider the Passamaquoddy word in (2a). In Passamaquoddy, the penultimate syllable of a word is generally stressed, yet in (2a), it is the *antepenultimate* vowel which surfaces with stress. If the structure of this word is as shown in (2b), however, it is still true that the penultimate *syllable* is stressed, due to the fact that the word-medial vowel is not dominated by a syllable node. It is this idea, that weak vowels like the Passamaquoddy ə are avoided as syllable heads in the prosodic structure, which we will pursue in the remainder of this talk.

(1) IDEA: Weak vowels are avoided as syllable heads in the prosodic structure.

(2) a. sókəlan 'it pours (rain).' [Passamaquoddy]

b.



Of note:
- ə is a weak vowel.
- ə is not dominated by a σ.
- Stress falls on the *penultimate* σ *antepenultimate* vowel

1. Mohawk

We will start by looking at the stress patterns in a different Native American language, namely Mohawk, a Northern Iroquoian language spoken in parts of New York, Québec, and Ontario.

1.1 Basic stress pattern of Mohawk

In (3), I list three generalizations about Mohawk prosody which I take to be correct. In particular, notice that each generalization is taken to be sensitive to syllables.

(3) Mohawk: Prosodic generalizations
- a. Stress falls on the penultimate syllable (not quantity-sensitive).
- b. A stressed syllable must be heavy (CV:, CVC).
- c. A word must consist of two syllables.

Starting with (3a), we note that Mohawk words have only a single stress, which surfaces on the penultimate syllable. This pattern is shown by the examples in (4) and (5). The generalization in (3b) states that a stressed syllable must be heavy. We see this in the examples in (5), where the stressed syllable is open and the vowel is lengthened. This

"tonic lengthening," or lengthening of the stressed vowel, is the only source of vowel length in Mohawk. Notice that in (4), the stressed vowel does not lengthen, indicating that closed syllables count as heavy with respect to tonic lengthening.

(4) Closed penult is stressed.

a.	wakharatatuhátye	/wak-haratat-u-hatye/	'I go along lifting up'
b.	rákwas	/hra-kw-as/	'He picks it'
c.	kóʔkwats	/k-oʔkwat-s/	'I dig'
d.	tékyaʔks	/te-k-yaʔk-s/	'I break it in two'

(5) Open penult is stressed, the stressed vowel is lengthened (TONIC LENGTHENING)

a.	wakashé:tu	/wak-ashet-u/	'I have counted it'
b.	khyá:tus	/k-hyatu-s/	'I write'
c.	kharát:tats	/k-haratat-s/	'I am lifting it up a little (with a lever)'

Stress placement itself does not appear to be quantity-sensitive. The examples given in (4) and (5) were chosen to illustrate that stress falls on the penultimate syllable regardless of whether the final syllable is open, closed, or even closed by two or three consonants.

Another aspect of Mohawk phonology which is sensitive to syllables is the minimal word requirement mentioned in (3c). Wherever a word would otherwise have surfaced with fewer than two syllables, a prothetic *i* is inserted, as we see in (6).

(6) Prothetic *i* inserted to ensure a bisyllabic minimal word.

a.	*í*kyʌs	/k-yʌ-s/	'I put it'	*kyʌ́s, *kyʌ́:s
b.	*í*:keks	/k-ek-s/	'I eat'	
c.	*í*kyaʔks	/k-yaʔk-s/	'I cut it'	

1.2 Metrical invisibility: Epenthetic e

In words with an epenthetic vowel, the stress patterns appear to change in certain contexts. Mohawk has two epenthetic vowels which exhibit contextual metrical invisibility, and we will begin by looking at the epenthetic *e*, inserted in the contexts listed in (7).

(7) Mohawk: Contexts in which epenthetic *e* is inserted:

a. Between a consonant and a single sonorant (C*e*n, C*e*r, C*e*w)
b. Between a consonant and a word-final glottal stop.
c. After a consonant when followed by a consonant cluster (except *h*C and *s*C).

In the first context, *e* is inserted to break up underlying consonant-sonorant sequences, as is shown in (8). In each of these examples, stress surfaces not on the penultimate vowel but earlier in the word, on the antepenultimate or even on the preantepenultimate vowel. Stress surfaces on the second vowel from the end, *not counting the epenthetic vowels*. In other words, for the purposes of stress assignment, the epenthetic *e* is invisible. The same is true for epenthetic *e* which interrupts word-final consonant-glottal stop sequences, as shown in (9).

(8) Metrically invisible *e* inserted in underlying consonant-sonorant sequence (7a).

a.	↗ ʌ́ k *e* r ʌʔ	/ʌ- k-r -ʌ-ʔ/	'I will put it into a container'
a.	ʌ́k*e*rʌʔ	/ʌ-k-r-ʌ-ʔ/	'I will put it into a container'
b.	ték*e*riks	/te-k-rik-s/	'I put them together'
c.	tʌkahsút*e*rʌʔ	/t-ʌ-k-ahsutr-ʌʔ/	'I will splice it'
d.	wák*e*ras	/w-akra-s/	'it smells'
e.	waʔtkatát*e*nak*e*ʔ	/waʔ-t-k-atat-nak-ʔ/	'I scratched myself'

(9) Metrically invisible *e* inserted in word final underlying Cʔ sequence (7b).

a.	↗ ʌká:ra t *e* ʔ	/ʌ-k-ara t-ʔ /	'I lay myself down'
a.	ʌká:rat*e*ʔ	/ʌ-k-arat-ʔ/	'I lay myself down'
b.	rokú:tot*e*ʔ	/ro-kut-ot-ʔ/	'he has a bump on his nose'
c.	waʔtkatát*e*nak*e*ʔ	/waʔ-t-k-atat-nak-ʔ/	'I scratched myself'
d.	tʌ́k*e*rik*e*ʔ	/t-ʌ-k-rik-ʔ/	'I'll put together side by side'
e.	ón*e*raht*e*ʔ	/o-nraht-ʔ/	'leaf'
f.	tʌ́:k*e*hkw*e*ʔ	/t-ʌ-k-hkw-ʔ/	'I'll lift it'

The epenthetic *e* which is inserted in order to permit proper syllabification of underlying sequences of three or more consonants, however, does not act invisible. Examples of this situation are shown in (10). Notice that in this context, the epenthetic vowel is metrically *visible*, and counts just as an underlying vowel would, leading to normal penultimate stress.

(10) Metrically visible *e* inserted in underlying clusters of three or more consonants (7c).

a.	wa k *é* ny aks	/wa k-ny ak-s/	'I get married'
a.	wak*é*nyaks	/wak-nyak-s/	'I get married'
b.	s*é*rhos	/s-rho-s/	'you coat it with something'
c.	tekahsut*é*rhaʔ	/te-k-ahsutr-haʔ/	'I splice it'
d.	skáhk*e*ts	/s-k-ahkt-s/	'I got back'
e.	sasáhk*e*t	/sa-s-ahkt/	'go back!'

It turns out that where an epenthetic *e* is invisible for stress assignment, it is also invisible with respect to other syllable-sensitive effects, such as the minimal word requirement and tonic lengthening. Recall from (6) that a prothetic *i* appears where necessary to ensure a word of at least two syllables. However, in (11) we find a prothetic *i* despite the fact that two or even three other surfacing vowels are present. This effect can be seen wherever all but one surfacing vowel is metrically invisible. Importantly, where an epenthetic *e counts* for stress placement, it counts for the minimal word requirement as well. We can see this by comparing (11a) with (10b). In (10b), where the epenthetic *e* is metrically visible, no prothetic *i* is inserted.

(11) Metrically invisible *e* is invisible for minimal word requirement

a.	*í* s *e* r i ht	/hs-ri-ht-ø/	'cook!'
	↗ ↗		
a.	*í*s*e*riht	/hs-ri-ht-ø/	'cook!'
b.	*í*t*e*nehr*e*ʔ	/t-n-ehr-ʔ/	'you and I want'
c.	*í*t*e*wehr*e*ʔ	/t-w(a)-ehr-ʔ/	'you and I want to'
cf. (10b)	s*é*rhos	/s-rho-s/	'you coat it with something'
	*í*s*erhos		

The same correlation holds between visibility for stress and ability to syllabify neighboring consonants. Recall that because stressed syllables must be heavy, vowels lengthen in stressed open syllables, as we saw before in (5). As we can see in (12), however, where a metrically invisible epenthetic *e* follows the stressed syllable, the stressed vowel fails to lengthen. This failure to lengthen indicates that the stressed syllable is already heavy by virtue of being closed. In these cases, then, the consonant preceding the metrically invisible *e* is a coda to the stressed syllable, indicating that the *e* is also invisible for the purposes of syllabifying neighboring consonants.

(12) Stressed vowels fail to lengthen before metrically invisible *e*—taken to indicate that the stressed syllable is already heavy (closed).

a.	té*k*. *e* riks	/te-k-rik-s/	'I put them together'
a.	té*k*eriks	/te-k-rik-s/	'I put them together'
b.	tʌkahsúterʌʔ	/t-ʌ-k-ahsutr-ʌʔ/	'I will splice it'
c.	wákeras	/w-akra-s/	'it smells'
d.	waʔtkatátenakeʔ	/waʔ-t-k-atat-nak-ʔ/	'I scratched myself'
e.	tʌ́kerikeʔ	/t-ʌ-k-rik-ʔ/	'I'll put together side by side'
f.	óneraht*e*ʔ	/o-nraht-ʔ/	'leaf'
cf. (5a)	wakas hé: tu	/wak-ashet-u/	'I have counted it'

What have seen is that with respect to stress placement, tonic lengthening, and the minimal word requirement, the epenthetic *e* in Mohawk only counts as a "syllable" when it is inserted for syllabification.

*1.3. "Weak vowels" and *WEAKPEAK*

Before turning to the analysis I will present, I wish to point out that the Mohawk data described here has been discussed in the phonology literature several times before. Karin Michelson—to whom the majority of the data is due, Ellen Broselow, Glynne Piggott, and Brian Potter each have suggested that the varying visibility of the Mohawk epenthetic *e* should be described in terms of a variable ordering between rules of epenthesis and rules of stress assignment in some way related to the nature and motivation for epenthesis. Other researchers, including Hajime Ikawa, John Alderete, and Karin Pizer, have proposed analyses which rely not on rule-ordering, but on the interaction of constraints on epenthesis and stress. For reasons of time, I cannot comment on these alternatives individually, but we will see that none carry over well to the data from Passamaquoddy, as we will see later.

My analysis of Mohawk takes the invisibility of certain vowels to syllable-sensitive processes as an indication that such vowels are not in fact part of a syllable. I formalize

this as a constraint on the prosodic representation which discourages the use of a "weak vowel" such as the Mohawk epenthetic *e* as a syllable nucleus. The constraint, called *WEAKPEAK, is given in (14).

(13) Mohawk epenthetic *e* is a "weak vowel."

(14) *WEAKPEAK A weak vowel is prohibited from being a syllable peak.

I take *WEAKPEAK to be one of a set of several constraints on the prosodic structure, all ranked with respect to one another within a system where satisfaction of a higher ranked constraint may force violations of conflicting but lower-ranked constraints. Specifically, I will formalize these interactions in the terminology of Optimality Theory developed in Prince & Smolensky (1993) and much subsequent literature. I will also assume that prosodic structure is organized in a hierarchy of prosodic categories, shown in (15), essentially following Selkirk (1984). Stress is taken to be an interpretive reflex, appearing on syllables which head a foot in the prosodic structure.

(15) PROSODIC HIERARCHY (Selkirk 1984, and subsequent literature)

Prosodic Word (PrWd)
|
Foot (Ft)
|
Syllable (σ)
|
Mora (μ)
|
Melodic/segmental material

Something we know about the *WEAKPEAK constraint is that it is not always satisfied. In particular, where epenthetic *e* breaks up an underlying cluster of consonants, the epenthetic *e* is metrically visible, indicating that it heads a syllable and violates *WEAKPEAK. What this tells us is that constraints which ensure proper syllabification take priority over *WEAKPEAK. The syllabification constraints which I take to be active are given in (16).

(16) Syllabification constraints (MOHAWK)
a. PARSE-C An underlying consonant must be prosodified in the output.
b. PROPERSYLL No complex onsets or codas—except *Cs* can be a coda, and *hC* can be an onset. (*Mohawk*)

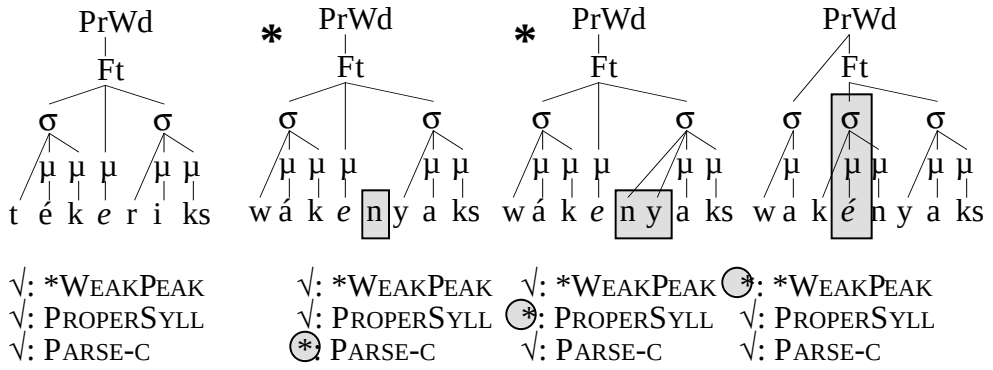
The first of the syllabification constraints, PARSE-C, requires that all underlying consonants be incorporated into the prosodic structure in the output. The other syllabification constraint, PROPERSYLL, requires syllables to be from the inventory of allowable syllables in Mohawk.

To see how the three constraints introduced so far interact, consider the two words illustrated in (17). The word in (17a) contains an epenthetic *e*, a weak vowel subject to the *WEAKPEAK constraint, but here no problem arises. The consonants flanking *e* can be incorporated into the surrounding syllables, so all of the constraints discussed so far—including *WEAKPEAK—can be satisfied by this prosodic structure in which *e* is not dominated by a syllable.

In (17b), however, there is a conflict between *WEAKPEAK and the syllabification constraints, due to the fact that a consonant cluster follows the weak vowel. There are three relevant possibilities in this situation. In order to satisfy *WEAKPEAK, one of the

syllabification constraints would have to be violated, either by deleting one of the consonants—in violation of PARSE-C—or by forming a complex onset with the consonants *ny*—in violation of PROPERSYLL. It turns out that in this situation, *WEAKPEAK gives way, resulting in a metrically visible epenthetic vowel. This means that the syllabification constraints take priority over *WEAKPEAK, as I indicate by ranking them in (18).

(17) a. tékeriks b. wakényaks



(18) PARSE-C, PROPERSYLL >> *WEAKPEAK

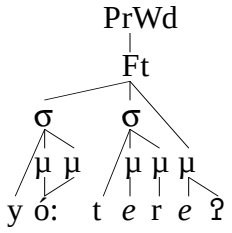
One correct prediction this analysis makes is that where a consonant is trapped between two weak vowels, only one will be metrically invisible. This is because the trapped consonant must be adjacent to a syllable in order to be incorporated into the prosodic structure. To see this, consider the data in (19).

(19) Consonant trapped between two epenthetic *e*'s forces one violation of *WEAKPEAK.

a.	yó:t *e* [r] *e̲* ʔ	/yo-t-r-ʔ/	'it's in the dish/glass'
a.	yó:t*ere̲*ʔ	/yo-t-r-ʔ/	'it's in the dish/glass'
b.	tewakahsú:t*ere̲*ʔ	/te-wak-ahsutr-ʔ/	'I have spliced it'

Looking at (19a), notice that in order to be prosodified, the *r* trapped between the two epenthetic *e*'s must become either an onset or a coda. This means that it is not possible for both epenthethic vowels to satisfy *WEAKPEAK, since one must head a syllable in order to prosodify the *r*. The same is true in (19b). The surface prosodification of (19a) is shown in (20), where the first epenthetic *e* heads a syllable taking the trapped *r* as its coda.

(20)



For simplicity, I will assume that the insertion of epenthetic *e* is motivated by the constraint in (21), *BADSEQ, which acts as a surface filter for prohibited consonant

sequences. Assuming that there is a constraint which discourages epenthesis, namely DEP in (22), it must be outranked by *BADSEQ to allow epenthesis in these cases. Lastly, we know that epenthetic *e* is inserted in order to syllabify underlying consonants into proper syllables, which gives us evidence for the ranking in (24).

(21) *BADSEQ No prohibited consonant sequences (CʔC#, C*r*, ...)

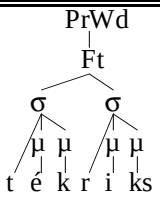
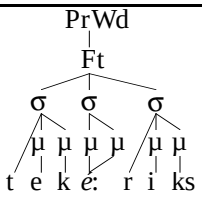
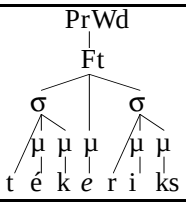
(22) DEP No epenthetic vowels in the output.

(23) *BADSEQ >> DEP

(24) PROPERSYLL, PARSE-C >> DEP

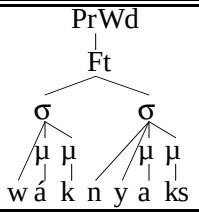
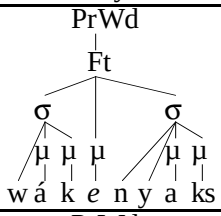
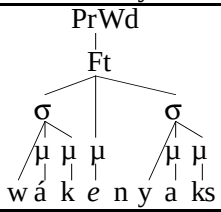
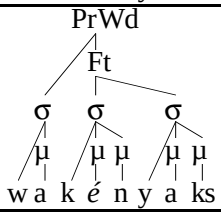
The tableau in (25) illustrates how these constraints interact to yield the correct output. I have not shown candidates which violate the syllabification constraints. Candidate (25a), the simplest syllabification of the underlying form, contains an illicit *kr* sequence, violating the high-ranked *BADSEQ. The remaining candidates satisfy the high-ranked constraints by inserting an epenthetic vowel, in violation of DEP. This leaves the crucial decision to *WEAKPEAK. Candidate (25b) violates *WEAKPEAK, because the epenthetic vowel is syllabified. Candidate (25c), satisfies *WEAKPEAK, thereby winning.

(25)

/ te-k-rik-s /	*BAD SEQ	PROPER SYLL	PARSE-C	*WEAK PEAK	DEP
a. 	*!	√	√	√	√
b. 	√	√	√	*!	*
c. ☞ 	√	√	√	√	*

The tableau in (26) is just a reillustration of the case from (17), where *e* is inserted for syllabification. Recall that no candidate can satisfy both PROPERSYLL and PARSE-C without violating both DEP and *WEAKPEAK. The winning candidate, (26d), has an inserted *e* which is syllabified in order to prosodify all underlying consonants.

(26)

/ wak-nyak-s /	PROPER SYLL	PARSE-C	*WEAK PEAK	DEP
a. 	*!	√	√	√
b. 	*!	√	√	*
c. 	√	*!	√	*
d. ☞ 	√	√	*	*

Epenthetic *e* is also inserted between a consonant and a word-final glottal stop, but we will postpone discussion of epenthesis in this context until section 1.5. The main points of this section are summarized in (27): epenthetic *e* is a weak vowel, inserted to avoid illicit surface sequences, and there is pressure to realize all underlying consonants as part of well-formed syllables.

(27) Main points of this section:
- a. Epenthetic *e* is a "weak vowel" which avoids being a syllable nucleus.
- b. Epenthetic *e* is inserted to break up illicit surface clusters.
- c. Underlying consonants must surface in well-formed syllables.

1.4. Technical formalization of the analysis

At this point, the basic ideas have been outlined, so we will now quickly run through the technical aspects of the analysis. First, it is important that consonants in Mohawk may *only* be prosodified as part of a syllable, since this is what explains why pressure to prosodify all underlying consonants can force syllables into the prosodic representation, even at the expense of *WEAKPEAK.

(28) Consonants in Mohawk may only be prosodified as part of a syllable.
- a. Consonants can only be immediately dominated by a mora or a syllable.
- b. Only a mora dominated by a syllable may dominate a consonant.

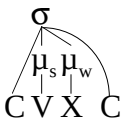
As I note in (28), this will be true if (*a*) a consonant cannot be immediately dominated in prosodic structure by anything hierarchically above a syllable, and (*b*) a consonant dominated by a mora is necessarily also dominated by a syllable. I assume both conditions hold in Mohawk, for the following reasons.

First, I take property (28a) to hold of prosodic structure generally, because I assume that prosodic structure conforms to "weak layering." I state in (29) a somewhat stricter version of a proposal made by Itô & Mester (1992). It dictates that, to the greatest extent possible, each node in a prosodic structure is dominated by a node from the immediately higher category in the prosodic hierarchy. In certain circumstances, one prosodic level may be skipped—allowing, for example, an onset to be immediately dominated by a syllable node, or a syllable to be immediately dominated by a Prosodic Word—but never are *two* prosodic levels skipped, at least word-internally. This entails (28a): no consonant can be prosodified except through immediate domination by a mora or a syllable.

(29) WEAK LAYERING: A prosodic node of category *i* is immediately dominated by a node of category *i*+1, preferably, or *i*+2 (at least word-internally). (Based on Itô & Mester 1992, cf. Selkirk 1984)

Property (28b) follows from the assumption that there is a language-particular threshold which constrains the sonority of segments a mora may dominate, adopting the proposals of Zec (1995). We suppose that there is an asymmetry between the two moras of a heavy syllable, as in (30), where the first mora—the "strong mora"—heads the syllable. The other mora within a syllable is a "weak mora." Specifically, I assume the definitions in (31). We know that coda consonants can be moraic in Mohawk, but that consonants cannot be syllable nuclei. This observation translates into the two constraints on strong and weak moras given in (32). The constraint on strong moras requires that a strong mora dominate a segment at least as sonorous as a vowel, while the constraint on weak moras allows any segment to be dominated by a weak mora.

(30) Structure of a maximal syllable (Zec 1995).



(31) a. Strong mora: A mora not preceded within a syllable by another strong mora.
b. Weak mora: A mora within the same syllable as a strong mora.

(32) a. μ_s constraint: A μ_s may only dominate segments at least as sonorous as vowels. (Mohawk)
b. μ_w constraint: A μ_w may only dominate segments of any sonority. (Mohawk)

Interpreted properly, this yields (28b). A consonant may not be immediately dominated by a strong mora, given the syllabicity constraint. Thus, a mora dominating a consonant must be a weak mora. However, a weak mora is only defined in opposition to a strong mora, meaning that a weak mora cannot exist outside of a syllable. Thus, any consonant dominated by a mora must also be dominated by a syllable.

We will not dwell on issues of the exact analysis of penultimate stress placement and tonic lengthening, since they are not essential to the main point. For concreteness, I will nevertheless outline the analysis I am assuming. I take the penultimate stress to reflect a single word-final syllabic trochee, which can be induced by the standard constraints given in (33), ranked as in (34).

(33) Constraints involved in deriving a single word-final syllabic trochee.

PARSE-SYLL	Syllables must be parsed into feet.
FTBIN	Feet must contain two syllables.
FTFORM(L)	Feet are left-headed (trochaic).
ALIGN-FT-R	ALIGN (Foot, R; PrWd, R).

(Prince & Smolensky 1993, McCarthy & Prince 1993)

(34) ALIGN-FT-R >> FTBIN >> PARSE-SYLL
FTFORM(L) doesn't interact.

The tonic lengthening of an open stressed syllable is taken to be a response to a constraint requiring stressed syllables to be heavy, *STRESSEDLIGHT, which outranks a constraint that otherwise prohibits vowel lengthening, DEP-μ.

(35) Constraints for tonic lengthening; all stressed syllables are heavy, no extra moras.

*STRESSEDLIGHT	Stressed syllables are bimoraic.
DEP-μ	A mora in the output structure must be projected by an underlying segment. ("Don't lengthen vowels")

(36) *STRESSEDLIGHT >> DEP-μ

The tableau in (37) shows how these constraints and rankings interact in a word without epenthetic vowels.

(37)

/CVCVCVCV/	ALIGN-FT-R	FTBIN	PARSE-SYLL	*STRESSED LIGHT	DEP-μ
a. ☞ σσ(σ́:σ)	√	√	σσ	√	*
b. σσ(σ́σ)	√	√	σσ	*!	√
c. (σ́σσσ)	√	*!	σ	*	√
d. (σ́σ)(σ́σ)	σσ!	√	σ	**	√

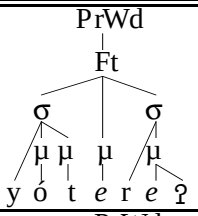
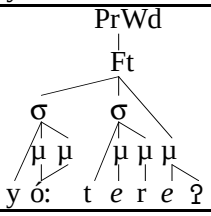
To account for the preference for syllabifying the leftmost of two weak vowels in sequence, I assume that there is a low-ranked alignment constraint, ALIGNSYLL, as defined in (39). The tableau in (40) shows how ALIGNSYLL chooses the correct candidate.

(38) In a sequence of two epenthetic *e*'s, the leftmost one heads a syllable.

a.	yó:t*er̲e*ʔ	/yo-t-r-ʔ/	'it's in the dish/glass'
b.	tewakahsú:t*er̲e*ʔ	/te-wak-ahsutr-ʔ/	'I have spliced it'

(39) ALIGNSYLL The left edge of every syllable is aligned to the left edge of a PrWd (ALIGN(σ, L; PrWd, L))

(40)

/ yo-t-r-ʔ /	PROPER SYLL	PARSE-C	*WEAK PEAK	DEP	ALIGN SYLL
a. 	√	√	*	**	μμμ!
b. ☞ 	√	√	*	**	μμ

A summary of the partial rankings discussed so far is given in (41).

Summary of partial rankings for Mohawk so far:

(41) *BADSEQ, PROPERSYLL, PARSE-SEG >> DEP, *WEAKPEAK
ALIGN-FT-R >> FTBIN >> PARSE-SYLL
*STRESSEDLIGHT >> DEP-μ
FTFORM(L) doesn't interact
ALIGNSYLL ranked low

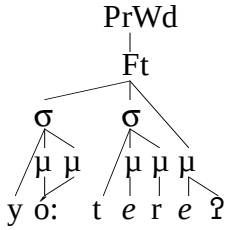
1.5. The glottal stop in Mohawk

There is an interesting issue which arises with respect to the glottal stop in Mohawk, which we turn to now. Recall that one of the contexts in which we find the metrically invisible epenthetic *e* is between a consonant and a word-final glottal stop. Because metrical invisibility is taken to indicate the lack of a syllable node, it must be the case that a word-final glottal stop does not need a syllable to be incorporated into the prosodic structure.

The suggestion I make is that the glottal stop in Mohawk is dependent on the neighboring vowel, which I will implement by proposing that the glottal stop in Mohawk must "share a mora" with vowels. An example of the structure I refer to is shown in (43).

(42) Implementing the dependence of glottal stop on neighboring vowel:
Glottal stop (Mohawk) must share a mora with a vowel.
(No other consonants may be in such a configuration.)
(Violations of this are taken to be violations of *BADSEQ.)

(43)



I will not argue specifically for this particular structure here, but I will point out a couple of reasons to suppose that such a representation is plausible. The glottal stop has several properties which set it apart from other consonants. Piggott (1995) points out that in cases like those in (44), where an epenthetic *e* breaks up an underlying triconsonantal cluster, a final consonant which is anything but a glottal stop forces the *e* to be metrically visible, as in (44a), presumably in order to prosodify the final consonant as a coda. In (44b), where the final consonant is a glottal stop, the *e* remains metrically invisible. This means that the behavior of word-final glottal stops cannot be simply due to a general extrametricality of final consonants, since only glottal stops appear to be "extrametrical."

(44) Word-finally, glottal stop allows metrical invisibility, unlike other consonants.

a.	sasáhk*e*t	/sa-s-ahkt/	'go back!'
b.	ón*e*raht*e*ʔ	/o-nraht-ʔ/	'leaf'

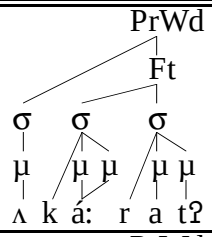
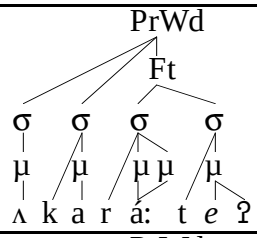
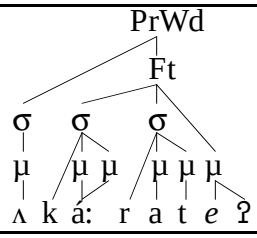
Word-medial glottal stops behave essentially the same way. Examples (45a) and (10a) each have an underlyingly tri-consonantal cluster. However, only the epenthetic *e* which breaks up the cluster in (10a) is metrically visible. In (45a), despite the fact that the epenthetic *e* is followed by a consonant sequence which would not be a well-formed onset, the *e* remains metrically invisible. These effects are at least consistent with the interpretation illustrated in (42), and we will assume this interpretation from here on.

(45) Word-medially, glottal stop allows metrical invisibility, unlike other consonants.

a.	rák*e*ʔni	/rak-ʔni/	'father (voc.)'
b.	k*e*yáʔt*e*ʔkʌs	/k-yaʔt-ʔkʌs/	'I am fat'
cf. (10a)	wak*é*nyaks	/wak-nyak-s/	'I get married'

The tableau in (46) completes the set, showing the remaining case of epenthetic *e*, appearing between a consonant and a word-final glottal stop. Tableau (46) parallels tableau (25).

(46)

/ ʌ-k-arat-ʔ /	*BAD SEQ	PROPER SYLL	PARSE-C	*WEAK PEAK	DEP
a. 	*!	√	√	√	√
b. 	√	√	√	*!	*!
c. ☞ 	√	√	√	√	*

1.6. The joiner vowel and weak edges

We now turn to the remaining epenthetic vowel in Mohawk, the "joiner vowel." Like the epenthetic *e*, the joiner vowel is invisible for stress placement if all underlying consonants can be syllabified without it, but there is a difference with respect to tonic lengthening. This discussion of the joiner vowel does not directly add to our general understanding of weak vowels, but it is worth considering both for Mohawk-internal completeness and because it could be construed as a counterexample to parts of the preceding discussion.

The joiner vowel appears at certain morphological boundaries where consonants from different morphemes would otherwise be adjacent. In (47), I give some examples which show the joiner vowel appearing before the stressed syllable. More interesting are the cases in (48), where the joiner vowel interacts with stress placement much like epenthetic *e*.

(47) Epenthetic *a*, separating consonants at morpheme boundaries (pretonic examples)

a. wak*e* $\boxed{\text{r } a \text{ ʔ}}$ núhneʔ /wak- $\boxed{\text{r-ʔ}}$ n(a)-u-hneʔ/ 'I went and put it in'

a.	wak*era*ʔnúhneʔ	/wak-r-ʔn(a)-u-hneʔ/	'I went and put it in'
b.	karist*a*kʌ́:ra	/ka-rist-kʌra-ø/	'tin'
c.	yerist*a*karanyè:thaʔ	/ye-rist-karanye-ʔt-haʔ/	'file'
d.	ruhskw*a*h*é*hrhaʔ	/hru-(a)hskw-hr-haʔ/	'steel-workers (they put the bridge up)'

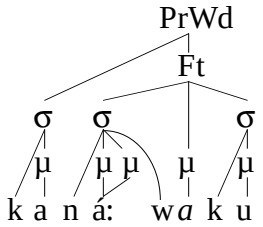
(48) Epenthetic *a*, metrically invisible in (a-b) but without blocking tonic lengthening.

a.	kan á: w *a* k u	/ka-na w-k u-ø/	'in the swamp'
a.	kaná:w*a*ku	/ka-naw-ku-ø/	'in the swamp'
b.	tekaʔshá:r*a*riks	/te-k-aʔshar-rik-s/	'I put the knives side by side'
c.	wakiʔtuhkw*á*rhos	/wak-iʔtuhkw-rho-s/	'I have a fever'
d.	k*erá*kwas	/k-r-kw-as/	'I take it out of something'
e.	tekahruw*á*nyu	/te-kahruw-nyu-ø/	'many objects put in your path'
cf. (8b)	té k.*e*.r iks	/te- k-r ik-s/	'I put them together'

Like epenthetic *e*, the joiner vowel is metrically invisible except when it breaks up a sequence of three or more consonants. Unlike epenthetic *e*, however, even when it is metrically invisible, the joiner vowel does not prevent tonic lengthening. Recall that in examples like (8b), a stressed vowel fails to lengthen before an epenthetic *e*. However, in (48a) and (48b), we see that a stressed vowel does lengthen before a metrically invisible joiner vowel. We explained cases like (8b) by saying that the stressed syllable is closed by the consonant preceding the metrically invisible vowel, due to the fact that the metrically invisible vowel does not head a syllable. So, what's going on in (48a)?

Assuming syllables are maximally bimoraic, it turns out that there is only one possible structure for such examples that is consistent with the discussion so far. This structure is shown in (49). Because the joiner vowel is not dominated by a syllable, the preceding consonant must be prosodified by the stressed syllable. The long vowel heading the stressed syllable accounts for both moras, so the consonant between the stressed vowel and the joiner vowel must be a nonmoraic consonant appendix of the stressed syllable.

(49)



Let us suppose that the morphological boundary at which the joiner vowel appears is the boundary of the lexical stem, and let us further suppose that consonants at the right edge of a lexical stem, like the *w* in (49), cannot be dominated by a mora. If this is true, the observed patterns follow. Because the boundary consonant cannot be moraic, it can only be an appendix which does not contribute weight, so the vowel must still lengthen in order to make the stressed syllable heavy.

To capture this generalization, I adopt a slight variant of a constraint introduced by Spaelti (1994). The constraint, WEAKEDGE, minimizes structure along the right edge of a prosodic representation, such as the prosodic structure which dominates segments of the lexical stem. I give the technical definitions in (50) and (51), but rather than work through them in detail, I will simply illustrate the intuition with an example.

(50) WEAKEDGE (LexStem): The right periphery of a lexical stem should be empty. (based on Spaelti 1994).

(51) PRSTRUC(*x*) is the subset of the prosodic structure which dominate segments of the morphological domain *x*.

The RIGHT PERIPHERY of *x* is a set of nodes *n* from PrStruc(*x*) which satisfy one of the following conditions:

(*i*) *n* dominates all other nodes in PrStruc(*x*), *or*

(*ii*) there is some *m* in the Right Periphery of *x* such that the following holds of PrStruc(*x*): *m* immediately dominates *n* and there is no *n'* which follows n (in linear order) such that *m* immediately dominates *n'*.

Consider the two candidate prosodifications in (52). In the shaded box are the nodes contained in the "right periphery" of the lexical stem. The function of WEAKEDGE is to choose the candidate with the minimal amount of structure in the shaded box. Because the box in (52b) contains a mora node as well as all of the elements found in the box in (52a), (52a) is better with respect to WEAKEDGE. The effect ofWEAKEDGE, then, is to force stem-final consonants in these environments to be nonmoraic.

(52) a. b.

Assuming that there is a *APPENDIX constraint to prevent syllables from freely taking appendices, it must be ranked below WEAKEDGE, as in (54).

(53) *APPENDIX Appendix consonants are not allowed. (Sherer 1994)

(54) WEAKEDGE >> *APPENDIX
(Note: CVCC syllables must be ruled out by *BADSEQ or PROPERSYLL)

Having addressed the issues raised by the joiner vowel, we now close our discussion of Mohawk and turn to another language with weak vowels, namely Passamaquoddy.

2. Passamaquoddy

Passamaquoddy is an Algonquian language spoken in parts of Maine and New Brunswick. What makes Passamaquoddy particularly interesting for our investigation of weak vowels and metrical invisibility is that it shows weak vowels which are not epenthetic, but underlying. This tells us that whatever "weakness" is, it cannot follow from properties of epenthesis. This fact undermines the several previous analyses of Mohawk mentioned earlier, all of which attempt to draw a principled connection between the metrical invisibility of the weak vowels and their epenthetic status. The Passamaquoddy data and much of their interpretation are taken from Phil LeSourd's 1988 dissertation, published as LeSourd (1993). To begin the discussion, we will look at the stress patterns, and then we will review the evidence that the weak vowels in Passamaquoddy are underlying.

2.1. The stress patterns of Passamaquoddy

The examples in (55) illustrate the basic stress pattern of Passamaquoddy. We see that initial syllables are stressed, as are even syllables counting from right to left.

(55) First syllable, and even syllables counting from right to left, are stressed.

a.	wás-is	'child'
b.	l-éwésto	'he speaks'
c.	wík-ewésto	'he likes to talk'
d.	séhtáy-ewésto	'he speaks while walking backwards'

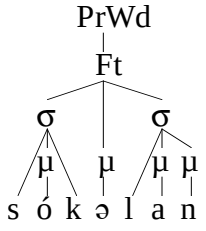
The regular stress pattern just described is disrupted in words containing *ə*, as we see by looking at the examples in (56). In (56a), the word-medial *ə* is metrically invisible, causing the stress to surface on the antepenultimate vowel where it would normally have surfaced on the penultimate vowel. Compare this to (56b), which receives stress normally, indicating that the word-medial *ə* is metrically visible. The word in (56c) contains a large sequence of schwas, and it shows an alternating pattern of metrical visibility.

(56) Contextual metrical invisibility of *ə*: invisible, visible, and alternating.

a.	sók-ə̲lan	'it pours (rain)'	*sók-ə́lan
b.	písk-ə́lan	'it rains so hard that it is dark or hard to see'	
c.	ásə̲w-əcə̲k-ə́po	'it (an.) is flopped over to one side'	

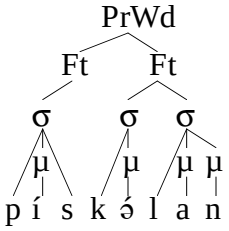
If we suppose that the Passamaquoddy *ə* is a weak vowel subject to *WEAKPEAK, just like the Mohawk epenthetic *e*, the behavior of *ə* in (56a) and in (56b) follows just as before. While *sok* and *lan* are well-formed syllables, *pisk* is not. Thus, in (56a), *ə* need not head a syllable to ensure that all underlying consonants can be prosodified into well-formed syllables, as shown in (57a). In (56b), however, the fact that *pisk* is not a well-formed syllable forces *ə* to head a syllable, as in (57b). That is, *WEAKPEAK must be violated in order to prosodify the *k* preceding *ə*, and so the *ə* is metrically visible.

(57) a.



√: *WEAKPEAK
√: PROPERSYLL

b.



*: *WEAKPEAK
√: PROPERSYLL

This implies, like in Mohawk, that *WEAKPEAK is outranked by the syllabification constraints, which I give in (58).

(58) Syllabification constraints (PASSAMAQUODDY)

a.	PARSE-C	An underlying consonant must be parsed in the output.
b.	PROPERSYLL	No clusters are allowed in syllable margins—except in cases where *s* is the external member of a cluster (*s*CVC or

CVC*s*) and cases where *h* is the internal member of a cluster (CV*h*C or C*h*VC). (*Passamaquoddy*)

(59) PARSE-C, PROPERSYLL >> *WEAKPEAK

Again, the exact analysis of how the stress pattern comes about is not highly relevant here, so we will go through it with very little discussion. I take the stress pattern to be a reflection of syllabic trochees aligned with the right edge, where a monosyllabic foot is allowed at the left edge in words with an odd number of syllables. This pattern can be derived using the standard constraints in (60), ranked as in (61). The tableau in (62) illustrates how these constraints interact, but we will not go through this in any further detail.

(60) Constraints involved in iterative trochees, exhaustively parsed, aligned left

PARSE-SYLL	Syllables must be parsed into feet.
FTMAX	Feet can contain no more than two syllables.
FTMIN	Feet can contain no fewer than two syllables.
FTFORM(L)	Feet are left-headed.
ALIGN-FT-L	ALIGN (Foot, L; PrWd, L).

(Prince & Smolensky 1993, McCarthy & Prince 1993, Everett 1994)

(61) PARSE-SYLL, FTMAX >> FTMIN, ALIGN-FT-L

(62)

/CVCVCVCVCV/	PARSE-SYLL	FTMAX	FTMIN	ALIGN-FT-L
a. ☞ (σ́)(σ́σ)(σ́σ)	√	√	*	σ;σσσ
b. (σ́σσ)(σ́σ)	√	*!	√	σσσ
c. σ(σ́σ)(σ́σ)	*!	√	√	σ;σσσ
d. (σ́σ)(σ́σ)(σ́)	√	√	*	σσ;σσσσ!

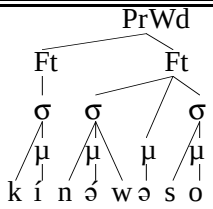
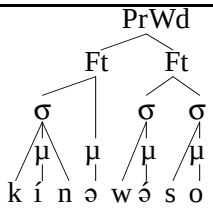
I assume that in cases, like those listed in (63), where there is a sequence of weak vowels, the crucial decision between candidates can be made by the low-ranking ALIGNSYLL constraint given in (64). The tableau in (65) illustrates how such a decision is made.

(63) Where more than one candidate can satisfy *WEAKPEAK and syllabification.

a	kínə̲w-ə́so	'he is a certain one'
b.	h-pásk-əcə̲k-ə́n-a	'you (sg.) break him, it (an., squishy) with your hand'
c.	ásə̲w-əcə̲k-ə́po	'it (an.) is flopped over to one side'
d.	ht-ə́tə̲l-ət-ə̲m-ə́n-əl	'he is eating them (in.)'

(64) ALIGNSYLL The right edge of every syllable is aligned to the right edge of a PrWd (ALIGN(σ, R; PrWd, R))

(65)

/ kinəwəso /	PROPER SYLL	PARSE-C	*WEAK PEAK	ALIGN SYLL
a. 	√	√	*	μμ;μμμ!
b. ☞ 	√	√	*	μ;μμμ

We leave the discussion of the Passamaquoddy stress system there, and we now turn to the question of underlying weak vowels in Passamaquoddy.

2.2. Weak vowels are underlying in Passamaquoddy

Let me reiterate that if it is true that weak vowels can be underlying, this tells us something important and interesting, namely that their metrical invisibility cannot and should not be derived from some property of epenthesis. This issue is important enough that we will take a moment to review some arguments, adapted from LeSourd (1993), for the underlying status of *ə* in Passamaquoddy.

The first argument is a simple one. Consider the examples in (66), each of which contains the putatively *ə*-initial morpheme *əpi-*. However, if we consider the clusters which are broken up by *ə* in (66), we see that these clusters occur elsewhere without any vowel intervening. Examples are given in (67). If *ə* is epenthetic in (66), why is it not inserted in (67)?

(66) Where the *ə* in /-əpi-/ 'sit' is metrically invisible:

a.	wə́l-ə̲po	'he sits nicely, comfortably; he is well off'
b.	nís-ek-ə̲pí-si-t	'ghost'
c.	tót-ə̲po	'he sits a long way off, he is far along'

(67) Clusters, broken up in (66), occurring elsewhere:

a.	ktə́kəmə́l̲p̲ən	'we (exc.) hit you (sg. or pl.)'	cf.	(66a) wə́l̲ə̲po
b.	tə́l̲p̲áyo	'he is scared'		
c.	ktəmak̲p̲əket	'it is a weak liquid'	cf.	(66b) nísek̲ə̲písit
d.	k̲p̲ə́cále	'he is hoarse'		
e.	wìk̲p̲	'black ash'		
f.	piskit̲p̲ohkət	'it is a dark night'	cf.	(66c) tót̲ə̲po
g.	t̲p̲əlokemo	'he gossips'		

The second argument is more complicated, making use of the insertion of a vowel, the "connective *i*," which is inserted at certain morpheme junctures, between consonants.

The first step is to look at a consonant-final root which conditions the insertion of a connective *i*. One such root is *kis-* in (68). Notice that connective *i* is inserted only when it is followed by a consonant-initial root.

(68) Root /kis-/ ‘finished, past’ conditions insertion of connective *i* before C-initial finals
a. kís-ewésto ‘he talked’
b. kís*í*-ko ‘he is full grown’

Now, consider example (69), where we the connective-inserting root is followed by a putatively *ə*-initial stem. Notice that no connective *i* is inserted. This means that the stem in (69) patterns with the vowel-initial stems, not with consonant-initial stems. This suggests that the metrically invisible *ə* in (69) is in fact part of the underlying representation.

(69) Lack of *i* insertion indicates that /-əpi-/ ‘sit’ is underlyingly vowel-initial.
kís-əpo ‘it (an.) is finished’

The dependence of the insertion of connective *i* on the underlying forms is further supported by the examples in (70) and (71). It is an independent fact of Passamaquoddy that certain instances of *a* delete in certain contexts. One morpheme which contains a syncopating *a* is the morpheme *-ahte-* meaning ‘be located.’ This *a* surfaces in (70), and is deleted in (71).

(70) Initial *a* of final /-ahte-/ ‘be located’ surfacing:
a. sákh-áhte ‘it protrudes into view’
b. íhtəl-áhte ‘it is always there’

(71) Initial *a* of final /-ahte-/ ‘be located’ failing to surface:
a. émék-te ‘it is down below’ < / emehk-ahte-w /
b. nís-ék-te ‘it has two layers’ < / nis-ek-ahte-w /

Interestingly, combining a connective inserting root with this morpheme in a syncope context yields the form in (72), where the connective *i* is *not* inserted, even though it results in a consonant cluster on the surface. This indicates that the connective *i* is conditioned not by the surface form, but by some aspect of the underlying form. That is, no *i* is inserted in (72) because the second morpheme is *underlyingly* vowel initial even though the underlying vowel does not surface.

(72) *i* insertion is sensitive to underlying form:
kís-te ‘it is finished’ < / kis-ahte-w /

These two arguments taken together give us good reason to believe that *ə* in Passamaquoddy is not epenthetic.

2.3. Syncope of weak vowels as an alternative to nonsyllabicity

Underlying weak vowels have an important property which epenthetic weak vowels lack. Both types of weak vowel are subject to *WEAKPEAK, but underlying vowels have two distinct ways to satisfy this constraint. One way is familiar, namely being prosodified without a syllable node. However, underlying weak vowels can also satisfy *WEAKPEAK by being deleted. It turns out that the Passamaquoddy *ə* takes full advantage of both options.

(73) A language may avoid violations of *WEAKPEAK by
  a. Parsing the weak vowel, but not into a syllable.
  b. Not parsing the weak vowel at all.

In Passamaquoddy, metrically invisible weak vowels are often deleted when they would have preceded an obstruent, although they always surface before sonorants. The examples in (74) show such a *ə* where it is metrically visible, therefore surfacing. The examples in (75) show the same *ə* in a position where it would have been metrically invisible if it had surfaced, but, because it would have preceded an obstruent, it does not appear. Recall that in examples like (56a), even metrically invisible *ə* surfaces when it precedes a sonorant.

(74) *ə* surfacing before an obstruent, where metrically visible
  a. áps-əkíhqən ‘it is small’
  b. n-kə́pəcàl ‘I am hoarse’

(75) *ə* deleted before an obstruent, where metrically invisible
  a. kín-kíhqən ‘it is big’
  b. kpə́cále ‘he is hoarse’

cf. (56a) sók-ə̲lan ‘it pours (rain)’ (always surfacing before a sonorant)

I propose that these facts be interpreted as follows. Suppose sonorants in Passamaquoddy enter the computation associated with a mora, and obstruents do not. Further suppose that there is a penalty for adding moras to the representation, as well as a penalty for not using moras which are introduced in the input. Lastly, suppose that weak vowels do not enter the computation with a mora.

(76) a. Sonorants and full vowels project a mora at the input level
  b. Obstruents and weak vowels do not project a mora at the input level

Now, we have the following situation. Where a metrically invisible *ə* precedes a sonorant, the sonorant licenses a mora but is necessarily an onset to the following syllable. Because onsets cannot be moraic, the mora *licensed* by the sonorant cannot be *linked* to the sonorant. As illustrated in (77a), however, that mora could be linked to the preceding weak vowel, which prosodifies the weak vowel and allows it to surface. On the other hand, where a weak vowel is followed by an obstruent, no such mora is available, as in (77b). Assuming it is worse to add a mora to the representation than it is to just delete the weak vowel, which is the effect of the ranking in (79), then syncope results.

(77) a. b.

(78) PARSE-V An underlying vowel must be parsed in the output.

(79) DEP-μ, *WEAKPEAK >> PARSE-V

One interesting advantage of this interpretation of the syncope facts is that it provides a natural way to represent a significant class of exceptional forms. It turns out that in certain words, *ə* "resists syncope," even when followed by an obstruent. One such example is the stem *əpi* 'sit' which has appeared in several earlier examples. In (80) we can see that this *ə* surfaces even when it is both metrically invisible and preceding an obstruent.

(80) Certain (lexically marked) instances of *ə* resist syncope before an obstruent.

a.	pét-ék-ə̲po	'it (an.) comes to be located here.'
b.	wə́l-ə̲po	'he sits nicely, comfortably; he is well off'
c.	nís-ek-ə̲pí-si-t	'ghost'
d.	tót-ə̲po	'he sits a long way off, he is far along'

This behavior follows if we suppose that "syncope-resistant" *ə* is underlyingly associated with a mora, unlike other "syncope-prone" weak vowels, since syncope only occurs when no mora is available underlyingly to allow the weak vowel to surface.

(81) "Syncope-resistant" *ə* is a weak vowel which projects a mora.
(Normal "syncope-prone" *ə* does not project a mora.)

3 Concluding remarks

I will conclude this talk here, first reiterating the basic idea. We have seen that a fairly straightforward analysis of the prosody of both Mohawk and Passamaquoddy has been made possible by supposing that certain vowels are dispreferred as syllable nuclei, and that where such vowels are prosodified without being dominated by a syllable, they are invisible to syllable-sensitive processes.

An important point to note is that the metrical invisibility of weak vowels does *not* simply follow from an aspect of epenthesis, since Passamaquoddy showed us that even underlying vowels can be weak vowels. This is a crucial point of divergence between this proposal and previous analyses of Mohawk, all of which attempt to derive the patterns from fundamental properties of epenthesis. Any such account is then left without a way to accommodate the *underlying* weak vowels in Passamaquoddy.

(82) What we've seen...
- a. Certain vowels have the property that they are dispreferred as syllable nuclei.
- b. Such vowels may be incorporated into prosodic structure anyway, but
  - can't provide a constituent for neighboring consonants
  - are invisible to syllable-sensitive processes (stress, etc.)
- c. The crucial property does not follow from the nature of epenthesis.
  (unlike prior analyses of Mohawk in Michelson 1989, Potter 1994, Piggott 1995, Ikawa 1995, Alderete 1995, Pizer 1997)

The question of what makes a vowel "weak" has been left open, but I will close with some speculations on this point. In Passamaquoddy, *ə* can behave in one of three different ways. We have seen that *ə* can be a weak syncope-resistant vowel, or a weak syncope-prone vowel. In addition, *ə* can also be *inherently visible*, acting just like any other full vowel. In the previous section, we saw reasons to suppose that syncope-resistant weak vowels are underlyingly associated with a mora, whereas syncope-prone weak vowels are not. An obvious extension of this idea is to suppose that *full vowels* are underlyingly associated with a *syllable*. An added advantage of such a view is that it also allows for a more natural explanation of the otherwise fairly stipulative *WEAKPEAK

constraint. If full vowels enter the computation already associated with a syllable, *WEAKPEAK is really just a constraint against addition of structure.

Regardless of the correctness of these speculations, however, I hope to have given reason to believe that there is such a thing as a weak vowel, whose properties warrant further investigation.

(83) Speculations about the nature of vowel "weakness"
- a. Passamaquoddy has three distinct types of *ə*:
  - i. Syncope-resistant weak vowel
  - ii. Syncope-prone weak vowel
  - iii. Full vowel (inherently visible).
- b. These might be distinguished in terms of underlying prosodic associations (Inkelas 1994 provides possible support for this view)
  - i. Full vowels = underlyingly associated with a syllable
  - ii. Syncope-resistant = underlyingly associated with a mora
  - iii. Syncope-prone = underlyingly unassociated
- c. Allows us to interpret *WEAKPEAK as simply *STRUC (Zoll 1993).

Data sources for examples

Key: L = LeSourd 1993
M8 = Michelson 1988
M9 = Michelson 1989
P = Piggott 1995
S = Sherwood 1986

(2) L:22
(4) M8:53, M8:55, M8:63, M8:59
(5) M9:44, M8:53, M8:53
(6) M9:45, Potter 1994:350, M8:163
(8) M9:41, M8:133, M8:142, M9:46, M9:140
(9) P:292, M9:43, M8:140, M9:41, P:292, M8:137
(10) M9:42, M9:42, P:292, M8:135, P:307
(11) M8:137, P:294, M8:140
(19) M9:65, M8:143
(45) P:308, P:308
(47) M8:62, M8:33, M8:48, M8:37
(48) M9:48, M9:39, M9:39, M9:48, M9:48
(55) L:75, L:75, L:75, L:75
(56) L:22, L:22, L:92
(63) L:90, L:92, L:92, L:52
(66) L:87, L:90, L:286
(67) L:389, L:59, S:75, L:168, L:59, S:74, S:73
(68) L:369, L:370
(70) L:340, L:340
(71) L:341, L:341
(72) L:370
(69) L:370
(74) L:169, L:168
(75) L:169, L:168
(80) L:81, L:87, L:90, L:286

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