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SYLLABLE BOUNDARY DEMARCATION IN HUALAPAI AND HAVASUPAI

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Abstract: This investigation focuses on syllable boundary demarcation in Hualapai and Havasupai, Native American Indian languages spoken in Northern Arizona. In an attempt to understand better the nature of the syllable, allophonic variation with respect to syllable position is examined. Cross-linguistic evidence suggests that sounds may take on similar characteristics according to their position in the syllable. Maddieson (1985) found phonetic vowel shortening before geminates in languages as diverse as Kannada, Hausa, Finnish and Italian. Phonetic vowel shortening in closed syllables was also found in Havasupai. A relationship between lexical stress and allophonic variation inside the syllable was found in Hualapai and Havasupai. Vowel lowering in closed syllables was also found in Hualapai and Havasupai.

Modern linguistic research has given much attention to the systematic study of the syllable (Fudge 1969; Halle and Vergnaud 1980; Ladefoged 1982; Maddieson 1985; Treiman 1988). In fact, syllable theories have been proposed from a number of linguistic fields such as phonology, phonetics, language universals and child language acquisition. Reporting from child language acquisition studies, Wijnen (1988) states that there seems to be a "priority" of development of the syllable-sized units over the development of phonemes.

It is widely agreed by linguists that segments of sound come together in such a way as to form units. These units are called syllables. Syllables seem to be basic to the structure of human language. They occur universally in every language. In fact, most native speakers seem to have the ability to break up words in their own language into syllable type segments.[1]

Given the above, it almost seems ironic that language investigators from all fields of linguistic research working on syllables have not yet been able to arrive at a universally agreed upon definition of the syllable. Commenting on the syllable, Ladefoged (1982) states that no phonetic definition of the syllable has yet been agreed upon. In an attempt toward a phonetic description and explanation of the syllable, researchers try to locate syllable boundaries. Important in determining syllable boundaries is the identification of the initial and/or final segment(s) of the syllable or bordering sounds (if any are present) of the syllable nucleus. The nucleus is generally identified by a sonority peak which is typically a vowel (Stockman and Stockman 1981) but can also be a syllabic consonant.

This investigation analyzes allophonic variation that occurs at the boundaries of the syllable. It was found that allophones of phonemes can serve as cues for syllable boundaries. Through an examination of allophonic variation in the Hualapai and Havasupai syllable, it was discovered that allophonic variation can also cue the initial or terminal boundary of a syllable, but unlike in other languages reviewed in this paper, knowledge of stress plays an important role in Hualapai and Havasupai syllable boundary demarcation. Allophones that occur syllable initially in prestress position of a word may vary from syllable initial allophones that occur in poststress position.

Articulatory Evidence and Phonetic Syllable Boundaries [2]

One significant discovery which helped linguists locate syllable boundaries was the fact that different allophones of the same phoneme may occur exclusively in syllable initial or syllable final position. A phoneme positioned syllable initially would be produced differently than if it had occurred syllable finally. Since there is general agreement on locating the syllable nucleus, linguists can reasonably assume that phones preceding the nucleus could include allophones that may mark the initial border of the syllable. Furthermore, sounds following the nucleus could also include allophones that exclusively occur syllable finally.

In a study on nasal consonants in Japanese and English, Fujimura and Lovins (1977c) found a difference in velum height correlating to position in the syllable.[3] Systematically throughout both languages, the height of the velum was greater in the production of syllable initial nasals than it was for syllable final nasals. This difference in velum height can be considered a feature which signals the beginning of a new syllable if the velum is relatively higher, or the end of the syllable if the velum is relatively lower. Velum height, in other words, can mark syllable boundaries (at least in Japanese and English) for nasals.

Other phonetic characteristics of consonants corresponding to their position in the syllable led to the better understanding of syllable boundaries. Fujimura and Lovins (1978) report on phonetic characteristics that accompany English voiceless plosives depending on where they occur within the syllable. Phonetic characteristics such as aspiration (as is the case for voiceless stops) may signal a new syllable.

Differences in aspiration are associated with English voiceless stop consonants /p,t,k/ and the initial, medial/final parts of the syllable. For example, the amount of aspiration for the English /p/ varies according to its position in the syllable. In syllable initial position, the /p/ is aspirated. If the /p/ follows an /s/, the glottis nearly closes by the time of articulation release and the plosive /p/ becomes less aspirated or unaspirated.

The amount of aspiration, then, can play a role in determining syllable boundaries for syllables containing voiceless plosives. An aspirated stop signals the beginning of a new syllable. A lack of aspiration would signal that the plosive is in a syllable medial or final position.

In a study on syllabification with *sp* , *st* and *sk* sound clusters occurring word medially, it was found that the sibilant and the stop could be separated, or interpreted as belonging to two different syllables if the stop was aspirated.[4] This could be formalized as: -s $ Ph-, where P stands for plosive, h stands for aspiration, $ signifies syllable boundary and (-) refers to the rest of the syllable the phone belongs to. Examples of -s $ Ph- were found in words with prefixes that ended with an -s and the following morpheme began with a voiceless plosive. In these words, the initial syllable was interpreted as ending with the sibilant and the next syllable beginning with the voiceless plosive. Examples that are given are: mis $ calculate and dis $ courteous.

In words where the stop was not aspirated, the syllable break was made before the sibilant. This can be formalized as: $ sP-. Examples of words of this type are: sub $ stantial and un $ steady. In these tokens, the *t* in the st-clusters is not as aspirated as voiceless stops which occur syllable initially. It seems, therefore, that the feature aspiration, when applied to voiceless plosives can signal a starting boundary for a syllable word initially or as in tokens like mis $ calculate, word medially.

More evidence from allophonic variation which can signal syllable boundaries comes from studies concerning the English /l/. In structures such as CVC it was found that the syllable initial /l/ differs phonetically from the /l/ occurring in syllable final position. The syllable initial /l/ has been called "light" and the syllable final /l/ has been labeled "dark"(Fujimura and Lovins 1978:109). According to the light-dark /l/ dichotomy, the light /l/ occurs syllable initially and the dark /l/ occurs syllable finally. The light /l/, then, can be viewed as a cue for a new syllable to begin, marking the initial boundary of the up-coming syllable. Moreover, the occurrence of a dark /l/ is considered to mark the termination or final boundary of the syllable.

Articulatory evidence supporting the light-dark allophonic distinction of the /l/ was also found (Fujimura and Lovens 1978:109). Using metal pellets placed on the tongue, the two /l/'s were distinguished with respect to the position of the tongue blade.

Two problems arise with regard to the distinction of the two allophones of /l/. One drawback of the light-dark /l/ distinction for syllable boundary markings is the fact that in many dialects of English, the syllable initial and syllable final /l/'s are not always light and dark, respectively. The other problem concerning the allophonic variation of the /l/ to denote syllable boundaries is noted when considering language universals. "The bimodal separation between initial and final /l/'s (rather than by different vowel contexts, for example) is difficult to account for by any universal facts of speech dynamics" (Fujimura and Lovins 1978:109).

As demonstrated above, allophonic variation can play an important role in determining syllable boundaries. Allophonic variation as a cue for a syllable boundary works when one allophone of a phoneme occurs exclusively in one position of the syllable. Unfortunately, not all phonemes have phonetic variants which occur in exclusive syllable positions. And even when different allophones of the same phoneme do tend to have their respective positions in the syllable, that does not necessarily mean that the allophones remain constant from language to language or even dialect to dialect as is the case with the English /l/.

Vowel Duration and Syllable Structure

Are there any universal phonetic cues that may help in the recognition of syllable constituency? Does a vowel, for example, take on certain characteristics or behave in a certain way in a specific environment? The following reviews phonetic behavior of the nucleus of the syllable from a cross-linguistic viewpoint.

Attempting to show that vowel shortening is associated with syllable structure, Maddieson (1985:207) notes that in many languages there seems to be "a vowel duration difference that relates to the syllabification of the next consonant". Citing evidence from languages as diverse as Italian, Kannada, Hausa, Finnish, and Rembarrnga, Maddieson states the vowels tend to be shorter when occurring before a geminate than before a single consonant (p. 208).

Concerning syllable boundaries, Maddieson assumes that geminates are two identical, adjacent consonants separated by a syllable boundary. Formally, this can be shown as the following: - V G $ G, where V stands for vowel, G for geminate, $ for syllable boundary. Important to note is that some vowels are inherently shorter than other vowels. Theoretically, the inherently shorter vowels are even shorter before a geminate consonant.

Evidence from a variety of language families suggests that vowels tend to shorten before geminate consonants. This type of vowel shortening also holds true in fast/slow speech rates and "under prosodic conditions"(Maddieson 1985: 210). If what Maddieson "assumes" (that syllable boundaries fall between a geminate consonant cluster) is true, then the vowel shortening which occurs before a geminate can be considered as a cue for an up-coming syllable boundary. The geminate following the shortened vowel can be interpreted as the end boundary of the preceding syllable and the starting point of the following syllable.

Duration studies on the syllable, however, do not always yield conclusive results. Also attempting to define syllable boundaries by examining segment duration, Lisker (1978:134) focuses on how the segments of the syllable interact. Lisker's premiss is based on the notion that "coarticulatory linkages are markedly weaker between segments said to belong to different syllables".

In an experiment reported in Lisker (1978), the average duration of individual words with a CVCV syllable structure was measured. The measurement began with the onset of the initial burst and concluded with the termination of the medial closure, i.e. the closure of the second/final consonant. The CVCV sequences consisted of a velar stop + a stressed low back vowel /a/ + a bilabial stop. The measured interval or average duration from the onset to the closure of the medial consonant for the one speaker tested was approximately 300 msec. The "target" or "intrinsic" duration of the CVCV segment, then , was considered to be 300 msec.

It was concluded that the durational difference between /p/ and /b/, the medial consonants, C2 in the C1V1C2V2 sequences, determines the length of the preceding vowel. The duration of the vowel was greater when the bilabial plosive was voiced than when the bilabial plosive was devoiced. Furthermore, the duration of C1 did not appear to be affected by C2. Since there seems to be no "coarticulatory linkage" between C1 and C2, it could be suggested that C1 and C2 belong to different syllables. As Lisker points out, this could be one conclusion from the data if it were not "for the inconvenient fact that C2 does determine V1, and no one would consider placing a boundary between C1 and V1" (p.140). Therefore, based on the data from temporal relations in CVCV sequences, the occurrence of coarticulatory linkages between segments to determine syllable boundaries is not conclusive. Syllable boundaries cannot be accurately outlined according to durational evidence, at least for the above experiment.

Syllable Boundaries: A Synthesis

The above sums up the phonetic contributions to syllable structure presented in this investigation so far. The next section of this paper applies the allophonic approach to syllable structure to Hualapai and Havasupai with an emphasis on syllable boundary demarcation.

The syllable nucleus is generally understood as the sonority peak which typically though not exclusively consists of a vowel segment. But what about the phones that surround the nucleus? What is their relationship to the syllable nucleus? Allophonic and durational evidence were reviewed with respect to syllable boundaries. The evidence suggests that phones take on certain characteristics when positioned syllable-initially and other characteristics when positioned syllable-finally. These features or characteristics may be considered as signals or cues for syllable boundaries.

Important to note is that the reviewed evidence supporting syllable boundary demarcation is not total or systematically complete. In each case, only a small set of sounds are examined. There are problems or exceptions even within the small set of sounds under investigation. But, as demonstrated above, sounds do tend to vary depending on whether they occur at the beginning or end of the syllable. These differences are presently used to help define the syllable and its boundaries.

Evidence from Hualapai and Havasupai

Investigating bordering sounds in languages as diverse as Japanese and English only begins to make any universal claim on the nature of sounds bordering the syllable. More work must be done on a variety of languages and language families to learn more about syllable boundaries which will lead us to universal tendencies. From the Northern Upland Yuman languages Hualapai and Havasupai, evidence is offered to shed more light on the allophonic aspect of sounds that border the syllable. A more complete understanding of the behavior of the sounds bordering the syllable can lead to better isolating the syllable, a definition, and a clearer explanation of the structure or phonotactics of the syllable.

First, two important points concerning Hualapai and Havasupai should be considered. According to scholars working on Yuman languages, these two languages are structurally and lexically very similar. Kozlowski (1976) considers both languages as the same and states that "analyses of one hold true for the other" (p.140). This fact is important to this investigation because it allows data from both languages and analyses of both languages to be considered.

From the literature, however, there is evidence that there may be some differences between the two languages. Redden (1966:149) comments on the verb paradigm in Hualapai. There seems to be two different systems in use as of 1966. One system is used by older speakers and the other by younger speakers. It is noted that the older speakers use the suffix {-Ø} for first person, the suffix {-ŋ} for second person and the suffix {-k} for third person. The younger speakers use the suffix {-k} for first and third person and the suffix {-Ø} for second person. The prefix {ma-} is used by all speakers for second person.

Figure 1: Verb Forms Used by Older and Younger Speakers

	Older Speakers	Younger Speakers
1st person sing.	ñač a-V́-Ø	ñač V́-k
2nd person sing.	mač ma-V́-ŋ	mač ma-V́-Ø
3rd person sing.	θač Ø-V́-k	θač V́-k

The pronouns ñač, mač, and θač refer to first, second, and third person respectively.

This finding is questioned in Hinton (1980:328). It was found that the younger speakers of Havasupai use the suffix {-ŋ} for second person and the suffix {-Ø} for first person; the precise opposite of what Redden found in Hualapai. It is important to note the possibility that the two languages may not be precisely the same.

The second important point refers to data used in this investigation. Information on allophonic variation comes from Kozlowski (1976), Redden (1966), Winter (1966), Langdon (1975; 1976), and Hinton (1980). Other sources are Hinton (1984) Havasupai Songs and Watahomigie, Bender, and Yamamoto (1982) Hualapai Reference Grammar.

Havasupai Liquid Phonemes:

The two liquid phonemes in Havasupai are /r/ and /l/. Depending on where they occur in the syllable and word, their allophonic manifestations differ. Syllable-initially, /r/ can be manifested as a voiced stop [d] or a tense voiceless stop [t]. If /r/ occurs word-initially (and therefore syllable-initially), its allophone is the voiced stop [d]. If the /r/ occurs syllable-initially but word medially, the allophone is a tense voiceless stop [t]. An essential note to the environment is that the sound must not only occur syllable-initially but also before the primary stressed vowel in the word to manifest as a tense voiceless stop. More information on the nature of the stressed syllable of the Yuman word is discussed in the following section of this paper. Important for the analysis below is the fact that the occurrence of a phoneme with respect to the stressed vowel is a significant factor in descriptions of environment. Allophones of a phoneme can be manifested in different ways depending on their position in the syllable with respect to the stressed vowel.

The following examples demonstrate the descriptive statement in the above. The symbol [|] represents a syllable break.

Figure 2. Distribution of the Havasupai /r/.

English Gloss	Phonemic Representation	Phonetic Representation
1. five	1a. /θiráp/	1b. [θi | táp] (tense voiceless stop with retracted articulation)
2. lightening	2a. /ráv/	2b. [dáv]
3. toys	3a. /ráya/	3b. [dáya]
4. singing	4a. /swára/	4b. [swá | ɾa]
5. ear	5a. /smárk/	5b. [smáɾk]
6. hat	6a. /púr/	6b. [puṭ] (stop, possibly
tense		retracted articulation)

Demonstrated in 1b, the allophone of the /r/ in syllable-initial position is the tense voiceless alveolar stop [t]. This allophone occurs word-medially in prestress position. Occurring word-initially (and therefore in prestress position), the allophone of /r/ in 2b and 3b is a voiced alveolar stop. Also syllable-initial but in a poststress position rather than a prestress position, the /r/ becomes a phonetic flap. This can be seen in 4b. In poststress, syllable- final position, the phonetic manifestation of the phoneme /r/ is a voiceless stop with tense retracted articulation, demonstrated in 6b. .

Figure 3. Position of the Havasupai /r/ with respect to word stress

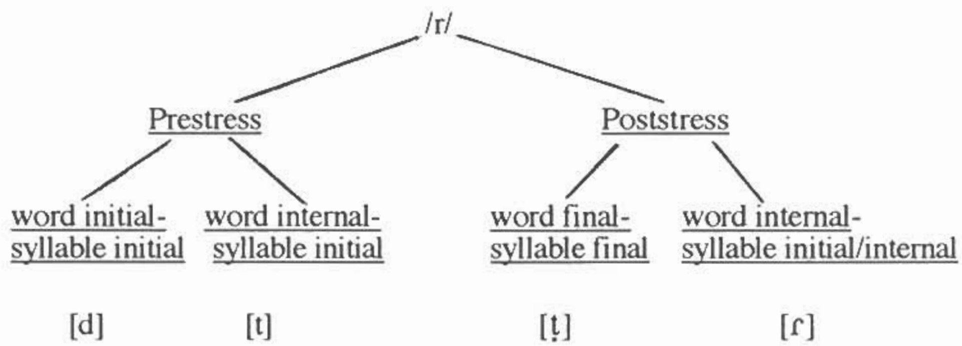
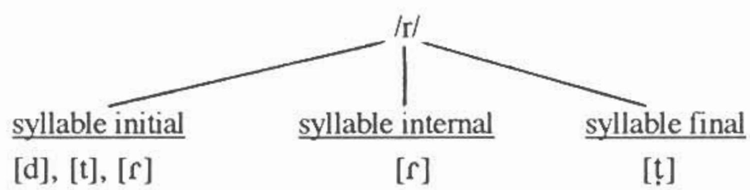


Figure 4. Position of the Havasupai /r/ with respect to syllable position



The /l/ in Havasupai is a "clear alveolar lateral". In post stress position, the lateral is "prestopped". See Figure 5 below.

Figure 5. Havasupai /l/

English Gloss	Phonemic Representation	Phonetic Representation
1. in the house	1a. /wál/	1b. [wádl]
2. alfalfa	2a. /iwíla/	2b. [i	wí	dla]

The alveolar lateral is prestopped when it occurs in poststress position. In 1b, the lateral is syllable and word final. The prestopped allophone also occurs in syllable-initial position after the stressed vowel.

Lenition and Syllable Boundaries

Lenition can be manifested as spirantization for stops. The uvular phoneme /q/ is offered as an example. See figure 6, 1a-b for examples of /q/ as an onset to a primary-stressed syllable and examples 2a-b for spirantization of the phoneme /q/ in the syllable-final position of the primary-stressed syllable. An example of lenition for the fricative /v/ is given in figure 7 below. In a syllable-final consonant cluster, the phoneme /v/ may weaken to a phonetic [w].

Figure 6. /q/-[q] and [w]

English Gloss	Phonemic Representation	Phonetic Representation
1. deer	1a. /qwáq/	1b. [qwax] ~ [qwaq]
2. they were beaten	2a. /čipéqča/	2b. [či I pex I ča]

Figure 7. /v/-[v] and [w]

1. sickness	1a. /kwe ráva/	1b. [kwe I tá I va]
2. he is sick	2a. /kwe rávk/	2b. [kwe I dáwk]

The Vowel as Syllable Final Element

When vowels occur as the last element of the syllable, i.e. in an open syllable, they tend to be "phonetically longer in duration" (Kozlowski 1976 p.143). Vowels in open syllables also tend to be higher than the same vowel in a closed syllable.

Figure 8. Vowels in Open and Closed Syllables

English Gloss	Phonemic Representation	Phonetic Representation
1. drink	1a. /θí/	1b. [θí:]
2. head	2a. /hú/	2b. [hú:]
3. eat	3a. /má/	3b. [má:]
4. when it is dark	4a. /ñatqépčo/	4b. [ñat | qép | čo:]
5. at night	5a. /ñatqépo/	5b. [ñat | qí: | po:]
6. rain	6a. /kwekmáčič/	6b. [kwek | má: | čič]
7. it is raining	7a. /kwemáčkyu/	7b. [kwi: | máč | kyu:]
8. injure	8a. /mirmír/	8b. [mɩɾ | mɩ́ɾ]
9. injure	9a. /míriñ/	9b. [mí: | rɩñ]

The phonetic representations in 1b, 2b, and 3b show the vowel in an open syllable. These vowels are phonetically longer in duration than vowels in closed syllables. No allophonic data are given to demonstrate a phonemically long vowel in an open syllable. It is assumed that phonemically long vowels in open syllables also tend to be longer in open syllables than the same occurrence in a closed syllable.

To demonstrate vowel height in open and closed syllables, the data in 4-9 are offered. Data in 5a-b show a stressed vowel in an open syllable. The phonemic vowel is mid and front but the phonetic vowel is a higher front vowel. There is so much allophonic variation that an allophone of the mid front vowel encroaches on an allophone of the high front vowel. The same phonemic vowel in a closed syllable is given in 4a with its phonetic manifestation in 4b. An example of a nonstressed vowel in a closed and open syllable is given in 6a-b and in 7a-b, respectively. The phonemic mid front vowel /e/ in 6a occurs in a closed syllable. The allophone in the /e/ in a closed syllable, shown in 6b, is also a mid vowel. The data in 7a-b demonstrate the mid vowel in an open syllable. Again, the allophone of /e/ in an open syllable overlaps with an allophone of the high front vowel /i/, as shown in 7b.

The data offered in 8a-b show the allophone of the high front vowel /i/. In a closed syllable, the allophone is [ɩ], slightly lower than the allophone [i] which occurs in an open syllable, as seen in 9b.

The length distinction for the low vowel /a/ "is often neutralized by the syllable structure" (Kozlowski 1976:146). The long /a:/ loses its length distinction in a closed syllable (here the plural form) found in 3b.

Figure 9. The /a:/ in Closed and Open Syllables

English Gloss	Phonemic Representation	Phonetic Representation
1. he picks peaches	1a. (not given)	1b. [θpál yá:ka]
2. peach picker	2a. (not given)	2b. [θpál kiyá:va]
3. peach pickers	3a. (not given)	3b. [θpál kičyam ləv]

Prevocalic Glottal Stop

When the phonological shape of a morpheme begins with a vowel rather than a consonant, a phonetic glottal stop occurs before the vowel (Kozlowski 1972:11). The glottal stop, then, marks the syllable initial boundary for morphemes beginning with a vowel. Therefore, the phonetic shape for the Havasupai word *ul* "ride" is [ˀul]. Similarly, the phonetic forms for the Havasupai words *ol* and *ar* ("cook" and "trade" respectively) are [ˀol] and [ˀaɽ].

The Stucture of the Yuman Word

The fact that allophones of some phonemes are determined by position relative to the stressed syllable in the word is evidence supporting the stressed syllable as an important element in the word. In fact, the stressed syllable of the Yuman word coincides with the morphological root, which typically has the shape of CVC but can also be CV, VC, or V. The root can be considered "the indispensable phonological and semantic core of the word, the only part that carries inherent stress" (Langdon 1976:221). The root or basic part of the word can have other shapes. Redden 1966 sites eighteen different root shapes. Among the different shapes are CVCC, CCVC, CCV, CVCVC, and CVCCVC.

Certain phonological processes only occur with elements in the root. For example, assimilation of a short vowel to surrounding sounds occurs only root-internally. Langdon (1975) offers language facts from the Yuman language Yuma to illustrate this point. The short vowel /a/ is raised to a mid or high vowel depending on neighboring sounds. When preceded by a palatalized or labialized consonant, /a/ is raised to the mid vowel [e]. When surrounded by palatalized consonants, /a/ becomes [i]. The assimilation of a short vowel to neighboring consonants is a "tendency of great generality in Yuman languages" (Langdon 1975:220) and a process restricted to elements of the root barring any boundaries. See below for examples.

Figure 10. Assimilation of /a/ to [e] and to [i]

English Gloss	Underlying Form	Surface Form
1. to create	1a. -čáw	1b. ačéw
2. to go	2a. -wȧ-č (plural stem)	2b. awėč (plural stem)
3. to go	3a. -wȧ: (nonplural)	3b. awȧ: (nonplural stem)
4. to carry a long object	4a. a:-v-kyȧw	4b. a:vkyėw
5. to be a young female	5a. x-čány	5b. xačíny
6. to conquer	6a. k-č-ȧm	6b. kačȧm

For the sake of clarity, the above figure specifies plural and nonplural stems only for examples 2 and 3. The stems were specified for these two examples to avoid confusion since the same verb "to go" is translated to two different Yuma forms.To demonstrate root-internal assimilation, it is not necessary to specify stem number. The forms used in 1a-b, 4a-b, and 5a-b are the nonplural stems. The form occurring in 6a-b is the plural stem. For more discussion and examples on root-internal processes and boundaries see Langdon (1975).

Examples 1a-b and 4a-b demonstrate the /a/ raising to [e] after a palatal consonant. Example 2a-b shows the raising process occurring after the labial consonant /w/. This assimilation process takes place only with short vowels, as evidenced by example 3a-b. Example 5a-b shows /a/ becoming [i] due to the preceding and following palatal consonants. A boundary occurs between the short /a/ and the palatal /c/ in example 6a-b. Assimilation to the preceding consonant does not take place if a boundary occurs between the conditioning consonant and the vowel, as seen in 6a-b.

Diachronically, phonological processes may also be explained with respect to the root. Described in Langdon (1975:224), the proto-Yuman *p > v a)"when following the stressed vowel and b) when preceding the stressed vowel, if not part of the root." The Yuman languages in which this rule applies are Hualapai, Havasupai, Yavapai, Paipai, Mojave, Maricopa, and Yuma. Yuman languages where this rule does not apply include Diegueno, Cocopa, and Kiliwa. Examples of the diachronic rule follow.

Figure 11. Proto-Yuman *p > v

Languages	to hurt	man's daughter	to walk	father's father
1.Hualapai	rá:v	včé	vóka	napó:ʔ
2.Havasupai	rá:vka	vikyéʔ	vó:ka	napóʔ
3. Yuma	ʔačaráv	vačí:	avʔá:	napáw
4. Diegueno	wəráp	pəčá:y	-----	-nəpá:w
5. Cocopa	ráp	pasá:	puʔáw	nyipá
6. Kiliwa	gáp	pičí	kaʔá:w	páw

The first part of the rule, which refers to root-internal elements, can be seen in the examples for the verb 'to hurt'. The *p > v when following the stressed vowel. The second part of the rule refers to root-external elements. Examples of this rule, *p>v when preceding the stressed vowel if it is not part of the root, can be seen in the forms for 'man's daughter' and 'to walk'. The forms for 'father's father' demonstrate the *p* in prestress root-internal position.

Synchronic processes are also explained in terms of the stressed constituent of the word. In Hinton (1980:328), two phonological processes are described for Havasupai, G-assimilation and Cluster Simplification. In G-assimilation, the "*g* may take on manner (and/or place) features of the following consonant, especially if *the g and the following consonant are followed by a third [-syllabic] segment.*" This process takes place "after a post-stress stem-boundary".

Cluster Simplification is a process where by the middle consonant of a post-stress cluster of three consonants is deleted. "This is especially true in a +CCC cluster, i.e. when all three consonants come after the stem boundary. A third rule, Glottal Deletion, occurs in the data below. This rule simply states that a "ʔ may be deleted anywhere, most often next to a [-sonorant] segment. Examples of these rules follow.

Figure 12. G-Assimilation, Cluster Simplification, and Glottal Deletion

Underlying Form	G-Assimilation	Cluster Simplification	Gloss
1. ʔ+ǰgyát+g- ʔ- wi	(ʔ)ǰgyátʔʔwi	(ʔ)ǰgyátʔwi	'I chop'
2. ʔ+yaám+g-ʔ-yu	(ʔ)yaámʔʔyu	(ʔ)yaámʔyu	'I go'
3. m+ǰgyát+g-m-wi	mǰgyátŋmwi	mjgyátŋwi	'you chop'
4. Ø-ǰgyát+g-Ø-wi	does not apply	does not apply	's/he chops'

Conclusion and Discussion of Allophonic Variation and Syllable Boundaries

The studies of allophonic variation in English and Japanese reveal the fact that the same sound can take on different characteristics depending on where it occurs in the syllable. Phonetic facts from Hualapai and Havasupai suggest that syllable boundary demarcation may be more complex. Sounds in Hualapai and Havasupai take on different characteristics depending on where they occur in the syllable/word and where they occur in relation to the primary stressed syllable in the word. The liquid phoneme /r/ exemplifies this point.

The /r/ is realized as a tense voiceless stop [t] when it occurs syllable initially and word-medially in prestress position. Occurring word initially (and therefore syllable initially) the /r/ is a voiced stop [d]. Positioned syllable initially after the primary stressed vowel (therefore in word medial position) the allophone of the /r/ becomes a flap [ɾ]. As a word final and syllable final element, the allophone of /r/ is a tense voiceless stop produced with retracted articulation [ṭ]. See figure 2 examples 1-6 above.

Possible syllable initial allophones of the /r/ are [t], [d], and [ɾ]. Any of these manifestations of the /r/ could signal an up-coming syllable and/or word. In languages such as English and Japanese, it may be enough to posit that a specific allophone of a phoneme is enough to signal a syllable boundary. In Hualapai and Havasupai the case is more complex. Knowledge of the appropriate syllable initial allophone must be combined with a knowledge of the primary stressed syllable. For example, the flap [ɾ] allophone of /r/ occurs syllable initially but may also occur after the nucleus of the syllable, not as a syllable final marker but as an element within the syllable's coda. (See figure 2, 5a-b above.) Whether positioned syllable initially or coda internally, the flap allophone occurs after the primary stressed syllable.

Other allophones of the /r/ can serve as syllable and/or word boundary markers. The allophone [t] occurs syllable initially in a prestress position. The prestress position must be word medially. Therefore the /t/ can be seen as a syllable-initial boundary marker that signals an up-coming word-medial syllable which carries primary stress. The voiced allophone [d] of the phoneme /r/ can also serve as a syllable-initial boundary marker. It also occurs in prestress position, but occurs word-initially rather than medially. As a word-final and syllable-final boundary marker, the allophone [ṭ] produced with tense retracted articulation occurs. This allophone can serve as a cue for the end of the word or syllable.

An ambiguity arises with the flap allophone of /r/ which only occurs in poststress position. It can occur either syllable initially or coda internally. Important to this manifestation of the /r/ is that it occurs after the primary stress. Therefore, it can serve as a poststress marker that may or may not be related to syllable boundaries. It is important because it helps demonstrate that knowledge of stress in Hualapai and Havasupai is related to allophone position, a factor not involved in other languages reported on in this investigation.

The phonetic manifestations of /r/, specifically [t], [d], and [ɾ] appear to be [-sonorant] and phonetically more closely related to plosives than to liquids. There may be distributional evidence that supports grouping the /r/ with the other liquid /l/ and not with the plosives. Unlike stops, the /r/ and /l/ cannot occur after an /s/ in an initial s+C cluster. Furthermore, in the Hualapai Reference Grammar, it was reported that Hualapai stops have a lenis~fortis distinction. This is not reported for the /r/ or /l/.

The liquid /l/ also demonstrates that knowledge of the primary stressed syllable is important to the allophony in Hualapai and Havasupai. The allophone of / l/ is a "clear alveolar lateral" in prestress position. In poststress positions, the /l/ takes on the characteristic of a stop and becomes a [dl]. The "prestopped" allophone occurs in syllable initial or syllable final position. (See figure 5 examples 1a-b and 2a-b.) Allophones of the /l/ phoneme do not seem to serve as cues for syllable boundaries, but rather refer to position in the word with respect to the stress.

Facts from lenition are also pertinent to syllable boundary demarcation.The phonemes /v/ and /q/ serve as examples. Evidenced by lenition facts, the /v/ is manifested as [v] in poststress syllable initial positions but is realized as [w] in poststress syllable internal position. The allophone [v], then, can serve as a cue to mark the initial boundary of a syllable. The realization of [w] would not cue an up-coming syllable. As seen in figure 6 examples 1a-b and 2a-b, the uvular stop /q/ is realized as a velar fricative [x] in syllable- final position. Occurring as the onset to the stressed syllable, i.e. in prestress syllable initial position, the /q/ is realized as a voiceless uvular stop [q]. Therefore, when the allophone [q] occurs, it can serve as a cue to mark an up-coming syllable.

In Hualapai and Havasupai the vowel or nucleus of the syllable is manifested differently depending on the syllable structure. As demonstrated in figure 8 examples 1-9, vowels in open syllables tend to be phonetically longer and higher than the same vowel in closed syllables. Phonetic vowel height and length, then, can serve as cues for syllable boundaries. An allophone of a vowel articulated higher in the oral cavity and longer in duration can mark the end of the syllable. Moreover, an allophone of a vowel produced lower in the oral cavity and shorter in duration does not cue a syllable boundary.

Syllable structure and vowel allophony are closely related. The vowel /a/ is also conditioned by syllable structure. In open syllables, the phonemically long /a:/ is realized by the allophone [a:]. In closed syllables, the phonemically long /a:/ is shortened to a phonetic [a]. (See figure 9 examples 1-3.) The long-short distinction for the vowel /a/ is not kept in closed syllables. Length distinctions are maintained in both closed and open syllables for the non-low vowels /e-e:/, /o-o:/, i-i:/ and /u-u:/. When the long allophone of the /a:/ occurs, it signals the end of the syllable. No other final element may occur after the phonetic long [a:] within the same syllable. Therefore, the [a:] serves as a cue that marks the syllable boundary.

This investigation focuses on the role of allophonic variation with respect to syllable demarcation in Hualapai. Information in this study is also applied to the wider question; Are there any universals in the behavior/functions of sounds bordering the syllable? Work on velum height for nasals in Japanese and English suggests further work in this area can prove fruitful. More work in this area needs to be done for Hualapai and Havasupai.

Also reported on in this study is the behavior of vowels with respect to syllable position. It was found that in many languages, vowels tend to be shorter when positioned before a geminate than before single consonants.Facts from Havasupai suggest phonetic vowel shortening in closed syllables. Also found in Havasupai is the tendency for vowels to be slightly lowered in closed syllables.

In English, aspiration occurs with syllable-initial voiceless stops. The stop series in Hualapai suggests a fortis, aspirated stop class and a lenis, unaspirated stop class. Further work must be done on the Hualapai stop series. It is as yet unknown, for example, as to whether syllable-initial fortis stops are more aspirated than fortis stops occurring elsewhere in the syllable. Moreover, are lenis stops more aspirated syllable-initially than syllable-internally or finally? Also, in a language where stress plays a role in determining the form of allophones, how does stress relate to aspiration and the stop series?

Finally, the relationship between stress and syllable boundary demarcation must be further investigated. Facts from Hualapai and Havasupai suggest that syllable initial allophones of a phoneme in prestress position may differ from syllable initial phonemes in poststress poition.

NOTES

1. The universality of syllable structure is questioned in A Theory of Phonological Weight by L. Hyman, Fortis Publications 1985. In section 3.3, Hyman considers data from Gokana. Based on "arguments frequently advanced for syllable structure", it is claimed that Gokana "has no syllable structure".

2. The term "phonetic syllable" is applied to a language specific unit whose borders are signalled by "extrinsic allophones". For more discussion on the phonetic syllable see: Davidsen-Nielsen, N. 1974. Syllabification in English words with medial sp, st, sk. Journal of Phonetics.2. 15-45.

3. This study was cited in Fujimura and Lovins (1978). Syllables as concatenative phonetic units, in A. Bell and J. Hooper (ed.s) Syllables and Segments, Amsterdam: North-Holland Publishing Company. pp.107-120.

4. This note refers to the study cited in 2 above.

REFERENCES

Boucher, V. 1988. A parameter of syllabification for VstopV and relative-timing invariance. Journal of Phonetics 16. 299-326.

Davidsen-Nielsen, N. 1974. Syllabification in English words with medial *sp* , *st* , *sk* . Journal of Phonetics 2. 15-45.

Fudge, E. 1969. Syllables. Journal of Linguistics 5. 253-286.

Fujimura, O., and Lovins, J. 1978. Syllables as concatenative phonetic units, in Syllables and Segments .Ed. A. Bell and J. Hoope. pp.107-120 Amsterdam: North-Hollπand Publishing Company.

Halle, M. and Vergnaud, J. 1980. Three-dimensional phonology. Journal of Linguistic Research 1. 83-105.

Halpern, A. 1946. Yuma II: Morphophonemics. IJAL10.147-151.

Hinton, L. 1980. When sounds go wild: Phonological change and syntactic re-analysis in Havasupai. Language 56.2. 320-344.

Kozlowski, E. 1976. Remarks on Havasupai Phonology. IJAL 42.2. 140-149.

Ladefoged, P. 1982. A Course in Phonetics (2nd ed.). New York: Harcourt Brace Jovanovich.

Lisker, L. 1978. Segment duration, voicing, and the syllable, in Syllables and Segments. Ed. A. Bell and J. Hooper.pp. 133-140 Amsterdam: North-Holland Publishing Company.

Langdon, M. 1975. Boundaries and Lenition in Yuman Languages. IJAL 41.3. 218-233.

Langdon, M. 1976. Metathesis in Yuman languages. Language 52. 4. 867-883.

Maddieson, I. 1985. Phonetic cues to syllabification, in Phonetic Linguistics: Essays in honor of Peter Ladefoged. Ed. V.Fromkin, pp. 203-221 New York: Academic Press.

Redden, J. 1966. Walapai I: Phonology. IJAL 32.1. 1-16.

Redden, J. 1966. Walapai II: Morphology. IJAL 32.2. 141-163.

Stockman, I. and Stepheson, L. 1981. Children's articulation of medial consonant clusters: implications for syllabification. Language and Speech 24. 2. 185-205.

Wijnen, F. 1988. Spontaneous word fragments in children: evidence for the syllable as a unit in speech production. Journal of Phonetics 16. 187-202.

Watahomigie, L., Bender, J., and Yamamoto, A. 1982. Hualapai Reference Grammar. Los Angeles: American Indian Studies Center, UCLA.