Construction and Hierarchy of Syllable Features in Monosyllabic Tone Languages

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A syllable in a monosyllabic tone language is postulated as having the following syllable constituents, i. e. matrices of features that do not specify individual segmentals. P is a matrix that conditions the three major types of syllables: open, closed, and syllabic consonantal, which are specified by the binary features {±vocalic, ±open}. T is tone, with various binary tone features. Z is voicing. G is the optional configuration of the air passage behind and below the oral cavity, including {±aspirated, ±breathy, ±nasal, ±glottal}. R controls the selection of G-features. T, G, and Z modify the qualities of the segmentals S. The syllable structure so defined is schematized as

$$PR\frac{TGZ}{S}$$

Sub-types of syllables like 〔pa, b'a, ban, maʔ(n), ma, mban, mat, bat,' baʔ(t), 'ba〕 are specified by mechanisms such as {±delayed, ±suspended} in the application of G. Not only syllable structure but also sound change and derivation are all explainable in terms of the nine binary features, vocalic, open, voiced, aspirated, breathy, nasal, glottal, delayed and suspended, and in terms of tone features.

1. Introduction

The syllable in monosyllabic tone languages, the syllable-juncture type, stands out more as a natural linguistic unit than in most other languages. A reason for being so is that the secondary articulation in a syllable is

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basically limited in the domain of that syllable and the syllable juncture is basically distinctive. Tone sandhi, different from categorial tone change (i. e. tone change according to its own tone category disregarding the categories of other tones in its environment), and other kinds of harmony between syllables do occur, but they do not obscure the overall picture of the syllable in these languages. It is a discrete entity, an individual. When a constituting part in a syllable changes, it is considered that it is the syllable that changes, by native speakers and by philologists. As such, a syllabic view rather than a phonemic view of sound change appears to be more suitable for these languages.

This paper endeavors to quest for an adequate explanation, an archetypal structure of syllables, that not only applies to the sound change in Sinitic but also can be projected into other monosyllabic tone languages in East and Southeast Asia. The study is, in effect, a sequel of three research findings, namely, Chang Yü-hung 1973 and 1986 and Jeffrey Tung 1986.

The first research stresses that the "clear" and "muddy" contrast in Chinese philology will become more meaningful both descriptively and historically if it is viewed as a contrast in voice register rather than in initial voicing. It posits "breathy phonation", like tone, as a syllable feature in Sinitic and some other languages. The second study, one on Taiwanese Hokkien (Taiwanese hereafter) riming schemes, considers the glottal stop as a phonetic realization of "glottality". The argument then follows that glottality and nasality, behaving similarly to tone in riming, though in slightly different ways, are treated as suprasegmentals. The concept that breathy phonation, glottality, and nasality, as well as tone, that are superimposed on the syllable as a linguistic unit, is further followed by the idea on mechanism operating the suprasegmentals in Tung's paper, which posits a mechanism of "delayed nasalization" and a rule of "consonant nasalization" to explain the nonoccurrence of, for instance, *man* and *mat*, in Taiwanese. Highlights of these studies will be reiterated where pertinent in the discussions to follow.

Secondary articulations such as breathy phonation, glottality, nasality and tone, whose operations affect the syllable as a unit, have therefore been considered as suprasegmentals and treated as *syllable features*. With the notion of syllable features in the picture, there follows a desire or curiosity to look for more of them, for a better understanding of the syllable and its change. Voicing and aspiration are added as syllable features, rather than segmental features. Furthermore, two types of non-constituent features are posited. Though Tung's mechanism of "delayed nasalization" is adopted and also adapted for other suprasegmentals, the delaying mechanism alone is not sufficient to specify all the phenomena of suprasegmentals that work on syllables. Another mechanism, "suspension", thus answers to the call. (For the applications of the mechanisms, see Section 3.3 and thereafter.) It is also necessary to explain how the suprasegmentals, as well as the segmental constituents, are chosen in the process of syllable construction. Therefore, two controlling features are posited to manage the selections, one for each purpose. The control on the segmental constituents results in different conventional types of syllabic constructions. And the control on the suprasegmentals yields syllables with different secondary articulations.

The syllable features are therefore of three kinds, as we can now see. They are the *controls*, the *suprasegmentals*, and the *mechanisms*. Since the controls are the "masterminds" of the types of syllables to be constructed, there apparently is a hierarchy in the syllable structure, with the controls on the top of the hierarchy. Inevitably, this paper holds a hierarchical view of syllable features. It is analogous to the PS grammar in syntax. In other words, syllable features are of different levels. In the specifications of a syllable, the controls take precedence of the other kinds of features, and the supresegmentals take precedence of the mechanisms. Furthermore, the features under the banner of the controls and those under the suprasegmentals are also stratified, all the way down to basic specification features.

Breaking a syllable in a monosyllabic language down to individual

features and then reassembling them in a hierarchical manner, it is possible to look at it with more understanding. However, one cannot feel satisfied stopping at this point. To test the validity of the analysis, sound change and lexical derivation are examined in the light of syllable features. Except for most cases of onset change and all cases of vowel shift and semivowel drifting, which are not effected by the posited syllable features, all the phonological changes of syllables are explainable as the changes of the operations.

This study, however, is a projection of the results obtained from the studies of a limited number of languages, mostly Sinitic. There are likely other features that need to be added so as to more adequately analyze monosyllables in Asian tone languages.

In the following sections, the paper will first review the syllable structure as commonly understood and revise it step by step as new information is added. The revision will finally arrive at a syllable structure with all relevant suprasegmentals included and categorized. It then, in section 3, will offer a hierarchical view of the structure in the light of the controls. The last section (Section 4) deals with syllable change with the mechanisms as "motivating" features in the course of sound change.

2. Syllable structure and constitution features—revisions within the system

2. 1. Traditional segmental constituents

Traditionally in Chinese linguistics, a syllable is divided into three parts, a tone (T), an initial consonant (I), and the remaining part of the syllable (F). In the following representations, the suprasegmental T is placed above a line, which is to be understood as the stretch of the syllable, whereas the segmentals I and F are placed under the line.

$$(1)\quad \frac{T}{IF}$$

where the value of I can be zero. It also can be a consonant cluster de-

pending on languages. The leftovers (F) are later subdivided into a syllable nucleus (V), a medial (M), and an ending (E), that is,

(2) F → (M)V(E)

where except for the nuclear vowel, everything else is optional. Thus:

$$(3)\quad \frac{T}{(I)(M)V(E)}$$

In modern Sinitic there seems to be no dialect that has an emic or contrastive syllable peak with an offglide (O) occurring before the ending. In other words, emically offglides only occur in open syllables in modern Chinese. They have been treated as a type of ending:

(4) E → {O, C}

The standard Chinese model does not suit all monosyllabic languages, however. Some languages do have emic offglides occurring before endings. The structural schema must then be revised to incorporate these languages, that is,

$$(5)\quad \frac{T}{(I)(M)V(O)(C)}$$

Examples can be cited from Vitenamese, as in (6)-(10) below, where the V's are lined up in the central column.[1]

(6)	T/IMVOE	Nguyễn	(family name, 阮)
(7)		huyế't	'blood' (血)
(8)	T/IMVE	huýt	'to whistle'
(9)		quận	'county' (縣)
(10)	T/IVOE	cuọn	'to roll up' (卷／捲)

Nucleus Contrasts
in Vietnamese Closed Syllables

1 Based on Nguyễn-Dình-Hòa, comp., 1966, *Vietnamese-English Dictionary*, Charles E. Tuttle Co.

Modern linguistics further distinguishes nasal endings and stop endings, that is,

(11) $C \rightarrow \{N, D\}$

These two types of endings are treated in the traditional Chinese philology as in complementary distribution conditioned by tone categories. They are indeed so in all attested monosyllabic tone languages. However, owing to the occurrances of the coarticulation of the glottal stop and the nasal ending, it is necessary to treat nasal endings as contrastive to homorganic stop endings:

(12) $$\frac{T}{(I)(M)V(O)(N)(D)}$$

2.2. Suprasegmentals and the case of glottality

Studies in Taiwanese point to the direction that nasality, no matter vocalic or consonantal, will be more adequately treated if it is also viewd as a suprasegmental operation like tone. In the study of riming, the author (1986) attributed the permissable riming between nasalized and non-nasalized syllables to the suprasegmentality of vocalic nasality. However, it is Tung who first treated nasal syllable initials, nasal syllable finals and nasalized syllable peaks as all resulting from the application of "consonant nasalization" and/or "delayed nasality". He posited B, L, G as the underlying consonants for both initial and final stops and nasals. When nasality is not present, the syllabic types will be like *a, ap, at, ak, ba, da, ga,* and when it is at work, they will be like *anh, am, an, ang, ma, na, nga.* It is not known, however, what he will say about syllabic nasals, i. e., what their non-nasalized counterparts will be, but so far the treatment of non-syllabic consonants is exquisite. Incorporating Tung's interpretation, the structural schema is revised as (13):

(13) $$\frac{T(N)}{(I)(M)V(O)(D)}$$

Tung's treatment completely goes against Hashimoto's (1979), which treats stop endings as the *denasalization* of nasal endings. Like Hashimoto, the author also treated stop endings as the *glottalization* of nasal endings: *-mq* > *-p*, *-mgh* > *-b*, *-nq* > *-t*, *-ngh* > *-d*, *-ngq* > *-k*, *-nggh* > *-g*, where *q* and *gh* represent glottalization in the upper and lower tone registers respectively (1980:11). Later (1986), the glottal stop ending in Taiwanese, as referred to above, was given the suprasegmental status, which again in a way agrees to Hashimoto's assumption that the stop endings are "part of the 'tonal' features of these two staccato tones" [D1 and D2] (Hashimoto ibid: 282).

In this paper, however, the glottal stop is considered as the segmental realization of glottality alone. In other words, glottality is suggested as another independent suprasegmental syllable feature on the basis that it either is parallel to or behaves like tone, orality, and nasality, and that it is in many ways different from other stop endings. Like tones, the glottal stop ending is lost in songs. Structurally, moreover, it corresponds to nasality. There is a series of syllabic types that are nasalized in the syllable peak and in the endings at three points in the air passage and the oral cavity, namely, *anh, ang, an, am.* There is also a series that consists of syllabics with a stop ending, such as *aq, ak, at, ap.* The two series correspond with one another point by point, i.e. "interior", velar, dental, and labial. Nevertheless, while syllables with the glottal stop ending are permitted to rime with those without, i.e. (Glottal R Oral) or (Glottal R Nasal), syllables with any other stop ending only rime with those with a homorganic stop ending, that is, with the same ending. The latter, furthermore, are not lost intervocalically and are retained in songs, unlike the glottal stop ending. Of all the syllables in Taiwanese, open syllables and syllables with a glottal stop can either be nasalized or "denasalized" (cf. 116-119 below). This feature, in addition to further supporting the pecularity of the glottal stop as a stop ending, indicates that the glottal stop has more of a similar nature

to orality. [2]

Yet another reason that Taiwanese glottal stop is not a common stop is seen in coarticulation. No other stops than the glottal stop can co-occur with nasality; moreover, the glottal stop does not co-occur with a segmental nasal that is a C-ending, as in (5) above. (For syllabic nasals see Section 2.3 below.) The following figure helps to give a clearer picture in this respect:

		Interior	Velar	Dental	Labial
(14)	Oral	a			
(15)	Nasal	anh	ang	an	am
			ung		um
(16)	Glottal	aq	ak	at	ap
(17)	Nasal-Glottal	anhq	—	—	—
			ungq		umq

Nasality and Glottality in Taiwanese

Not all languages have preglottalized endings in checked syllables. For instance, in Hakka the glottis is left open at the moment of occlusion (Hashimoto 1973: 87). This seems to pose a difficulty in projecting the Taiwanese case to monosyllabic tone languages in general. Nevertheless, an unreleased final stop in American English is also immediately preceded by a glottal stop[3]. Whether this is a universal tendency in phonology or not,

2 Commenting on the observations on the glottal stop in my study of Taiwanese riming, Professor Nicholas Bodman writes in a Christmas greeting, "I'm not surprised that Taiwanese -q is disregarded in rhyming. It may be different with Ch'aochou or other dialects where the -q is 'stronger'." However, I do not think that a strong glottal stop would affect the hypothesis of a supra-segmental glottality.

Beverly Hong-Fincher warned me of the "abuse" of the terminology *orality*. Yet, so far there seems no better word available.

3 Adrian Akmajian, Richard A. Demers and Robert M. Harnish, *Linguistics: An Introduction to Language and Communication*, 2nd ed. (MIT Press, 1984), p. 125.

it is an identical phenomenon as found in most Sinitic dialects. Besides, positing a could-be abstract concept of glottality as the counterpart of nasality is helpful in historical linguistics on at least three counts. Firstly, vocalic nasalization and the glottal stop are often parallel phonetic phenomena in sound change[4]. The nasalization is sometimes said to be the "compensation" for the loss of a nasal syllable ending. Analogously, the glottal stop will be the "compensation" for the loss of a stop syllable ending. Then, were it true that a checked syllable did not bear a feature that is at least underlyingly glottal, it would bear a feature that is neither glottal nor nasal, i.e. oral, and the "compensation" would not be a glottal stop but just nothing, i.e. oral. Secondly, substituting a residue theory for the compensation theory, it is clearly seen that when a nasalized syllable drops its ending, what remains is a nasalized syllable without an ending. By the same token, when a glottalized syllable drops its ending, what remains is a glottalized open syllable. This remaining glottalization happens to be realized as a glottal stop rather than vocalic glottalization in Taiwanese and many other Sinitic languages. Putting it more succinctly, vocalic nasalization and the glottal stop are the remains of syllables that lost their endings. Finally, besides the gain over the compensation theory, the residue theory also explains better than the retreat theory (Chen 1973). If the glottal stop were merely the ultimate retreat of the point of articulation, i.e. p → t → k → q, one would expect that the mere retreat of the nasal ending from the lips to the glottis would ultimately yield the glottal stop as well, i.e. m → n → ng → q. However, this is not the case. In fact, it is nasality that takes precedence of the occlusion that yields vocalic nasalization. As such, it would be more consistent to consider the glottal stop as the remains after the contact is lost in the oral cavity, that is, glottality takes precedence of occlusion.

4 Professor Matisoff kindly informed me that in Tibeto-Burman glottality and nasality also work as a pair.

The hypothesis, of course, does not neglect or ignore the historical fact of the retreat or the articulatory fact of the glottal stop as a stop. The facts are there, but it is glottality that motivates the closure of the glottis. When glottality becomes idle, the retreat is still there, but there will be no occlusion, and the result is a clearly open syllable.

In Taiwanese lexical derivation by feature change, other than tone change, only the shift between nasality and glottality (101-123 below) are attested. There is no mutual replacement of nasality and orality in lexical derivation. If checked syllables were to be interpreted as simply the non-nasalized counterparts of syllables with a nasal ending without involving glottality, then one would expect derivational doublets of open nasal (79) and open oral(77)in addition to doublets of nasal closed(83)and stop closed (84). The non-occurrence of such derivational doublets is an argument against treating checked syllables as merely devoid of nasality in their endings[5].

This treatment that is based on sources of evidence, both synchronical and diachronical, is satisfactorily workable to treat the glottal stop as a realization of glottality. It thus moves glottality to the suprasegmental sphere in the schema. With both nasality (N) and glottality (Q) gone, what is left of the ending? Nothing but the configurations at a certain point of articulation in the oral cavity. Whether the syllable ending is a nasal consonant or a stop, or both, depends on the presence of nasality or glottality or both. As such, the C-constituent in (5) is restored for the purpose:

$$(18)\quad \frac{T(N)(Q)}{(I)(M)V(O)(C)}$$

According to the interpretation of glottal stop as the phonetic realization of the underlying suprasegmental glottality, the C-constituent does not

5 The discussion excludes "stylistic nasalization" in Hokkien and Teochew which creates doublets but does not result in semantic change.

include a feature that designates the glottis as an emic point of articulation. There is, in effect, no such need, for the glottal stop is now, like glottal constriction, a phonetic variant of the result of the operation of (glottality).

Since the foregoing discussions on syllables are exclusively based on Taiwanese and Vietnamese, voice register as a syllable constituent is so far ignored. However, as voice register is certainly contrastive in ancient Chinese, in some modern Chinese dialects, and in many Southeast Asian Languages, it should also be incorporated. Voice quality is postulated in the author's 1973 paper as a syllable feature in historical Chinese. According to this notion of breathy phonation as a suprasegmental operation, a syllable in an Asian monosyllabic tone language can have as many as four types of suprasegmental syllable constituents and five segmental ones:

(19) $$\frac{T(N)(Q)(B)}{(I)(M)V(O)(C)}$$

Pittman 1970 (pp. 4-5) enumerates the realizations of register contrast that are conditioned by tongue-root position. Most of them are arranged in the table bleow.

		UPPER REGISTER	LOMER REGISTER
(20)	Pitch	high	low
(21)	Articulation	tense	lax
(22)	Onset	fortis	lenis
(23)	Length	short	long
(24)	Voice quality	laryngealized	clear
(25)	Voice quality	clear	breathy

Note that "clear" in (25) is in the upper register, and in (24) it is in the lower register. When the tongue-root is neither advanced nor retracted, the voice quality is clear. On the other hand, it is "muddy" or breathy when the tongue-root is advanced and "suffocative" when retracted. No matter

whether "clear" belongs to the upper register or the lower register, the contrast is between more advanced tongue-root and less advanced or between less retracted tongue-root and more retracted.[6] There seems to be no three-way contrast of retracted-relaxed-advanced in the voice register configurations.

Nevertheless, Edmondson 1987 shows a three-way contrast in Maonan syllables with nasal initials.[7] In order to take care of both the new information and the non-register languages where laryngealization is emic, it is necessary to change the single two-way contrast, upper register vs, lower register, to double two-way contrasts and postulate the feature matrice {±glottal, ±breathy}. The upper register realizations in (20)-(24) are the properties of 〔+glottal〕, and the lower register realizations in (20)-(23) can be the properties of 〔+breathy〕.

Another reason why the two types of register contrasts have to be separated is that they cause different kinds of sound change. While the register contrast of either type can give rise to the distinctive phonological effects in (20)-(23), the presence of glottality in a syllable does exert effects that are different from the effects of breathy phonation (24, 25, 72-75). The differences are reflected in sound change (cf. especially 92-94).

Chang Yü-hung 1986 further postulates the feature "orality" as contrasing both nasality and glottality. However, since orality is unmarked and redundant, deducible from the absence of both nasality and glottality as well as breathy phonation, it is not necessary to incorporate it into the schema.

If one reflects on voicing (Z) in a syllable in the languages in question, one will be reminded that the syllable peak is always voiced and that the

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6 Breathiness or murmuring can be articulated either by keeping the vocal cords slightly apart (Ladefoged 1971: 8) or by advancing the tongue root (Stewart 1967). Here I am just making a simplified presentation.

7 Professor Edmondson also kindly informed me of a 4-way sytstem in the Bai (白) language in China.

onset and the coda are either voiced or voiceless. This is common sense, but it is a clear indication that voicing is the property of the syllable rather than a feature that specifies individual segmentals in the syllable.

(26) $\frac{T(N)(Q)(B)Z}{(I)(M)V(O)(C)}$

The most drastic revision of the traditional system in this paper is probably the treatment of aspiration as a syllable feature. Similar to voicing, aspiration is not limited to syllable initials. It can operate on syllable ending as well, such as in Malay and English. Although there is no data of final aspiration available in the tone languages that concern this paper, the notion of aspiration (A) as a suprasegmental feature is still motivated.

(27) $\frac{T(N)(Q)(B)ZA}{(I)(M)V(O)(C)}$

The operation of voicing and aspiration also are conditioned by the mechanisms of delaying and suspension which will be taken up in Section 3.

2.3. Syllabic consonants and peripheral configurations

There is no justification to treat syllabic consonants as a manifestation of the C-constituent for two reasons. First, treating a syllabic consonant as C denies the existence of a syllable peak in (M)V(O). Second, the C-endings of closed syllables are paired at each point of articulation as either nasalized or glottalized, but syllabic nasals do not have their glottalized, and denasalized, counterparts. If syllabic consonants are treated as a type of syllable nuclei (U), not only the two difficulties above can be avoided but also syllabic non-nasals, such as the syllabic lateral in Hakka and the syllabic stridents in Mandarin, can be accounted for. (For more discussions about syllabic consonants, see Section 3.2.) In the treatment suggested here, syllable nuclei can either be a vowel or a consonant:

(28) U → {±vocalic}

As a conclusion of the analysis of syllable constituents in monosyllabic tone languages, (26) includes all the constitution features that are necessary and sufficient in specifying the syllabics, if not all the syllables. Of these structural constituents, I, M, O and T are traditional. The only difference between C and the syllable ending in the conventional sense is that C is a variable, subjected to the specifications of the suprasegmentals. The syllable nucleus (U) extends to include syllabic consonants, and V is but a subcategory of U. Z (voicing) and A (aspiration) are reinterpreted as more than a manner of articulation of individual phonemes. B (breathy phonation) and N (nasality) has long been known as having features that are secondary. These and Q (glottality) are now postulated as suprasegmental syllable constituents. Implicitly, the structural schema contains orality in addition to nasality, glottality, and breathy phonation.

Of all the constituents, Z, A, N, Q, and B are without a bundle of binary features. They are themselves binary features. It is thus desired to classify them under a single syllable constituent, if possible. This, of course, is not a phonological motivation. Phonologically, N, Q, A, and B behave distinctively different from T and Z. Tone is omnipresent in tone languages except when a syllable becomes atonic, and voicing basically is also obligatory in every syllable; whereas nasality, glottality, aspiration, and breathy phonation are optional, in the structural sense. They can all be present or absent in a syllable. Moreover, aspiration, breathy phonation, and glottality are relevant to voice register, and nasality and glottality are in many occasions a pair of syllable modifiers. These four indeed are similar in many ways and can be grouped as sister constituents. As they are configurations outside the oral cavity, in the more interior part of the air passage, they can be classified under a category tentatively called "peripheral configuration" (G).[8]

8 If we envisage the oral cavity and the air passages above the glottis as a box, the nasal cavity will occupy its top and the pharynx and the glottis occupy one side of it;

The G-constituent, therefore, has four binary features under it, aspiration, breathy phonation, nasality, and glottality, with [-nasal, -glottal, -aspirated, -breathy] implying orality.

The structural schema now is revised as (29), where G is specified by the binary features of nasality, glottality, aspiration, breathy phonation, or a combination of these.

(29) $\dfrac{\text{TGZ}}{\text{(I) (M) U (O) (C)}}$

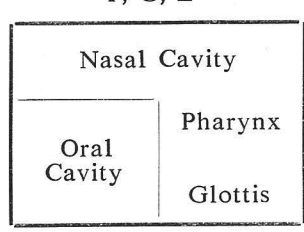
3. Hierarchy and specification features—a new outlook

3. 1. Hierarchical construction

The specifications of MUOC in Section 2 reqire features of lower hierarchies, that is, tongue position, lip-rounding, and point of articulation. On the suprasegmental level, T is specified by tone features. The combination of breathy phonation, nasality, glottality, and orality into "preipheral configuration" also indicates the stratificational nature of the syllable structure, like other linguistic constructions. Constitution features are not the highest in the hierarchy of syllable features. Taking one step farther than the static concept of construction and constituents, this paper postulates a set of controls that set off the syllable features of lower hierarchies so as to reach a

(續)

T, G, Z



I, M, U, O, C

All the suprasegmental features occupy the top and the right hand side, and all the segmental features occupy the left bottom corner.

dynamic, float-chart interpretation of the syllable. For this purpose, the paper resorts to an old conception of syllable types, that is, classifying syllables according to whether there is a closure or obstruction of the air passage. Furthermore, as there are also syllabic consonants, syllables are also classified according to whether the nucleus is vocalic or not (28 above). Therefore, in the structural hierarchy of a syllable there must be a node that decides whether the syllable is vocalic or non-vocalic, and if it is vocalic, whether the syllable is open or closed. Such watershed of syllabic types is labelled "P", which is at the very top of the hierarchy of syllable features. From P are derived different types of syllables in the traditional sense.

Modern monosyllabic tone languages are of two major types, registered and non-registered, depending on whether the register feature is at work. Syllable registers are distinguished either by breathy phonation (B) or by glottality (Q), that is, register languages contrast syllables either by the presence or the abscence of breathy phonation or by the presence or absence of laryngealization. But how are they chosen? It therefore appears that a syllable constituent higher in the hierarchy is needed to indicate whether, in a register language, it is breathy phonation or glottality, or the combination of these, that is at work. This controlling feature on demand is labeled "R". It is combined with P, and the combination is named "primary structure features" (PR).

Two types of primary structure features are therefore postulated. One specifies the nature of a syllable in the segmental aspect. The other determins whether a syllable has register contrast or not, and if it does, which kind of contrast?

The primary structure features and their derivatives take care of all the segmental syllable constituents of (26) except initials, which is the concern of this paper only when syllable register, voicing, and aspiration are involved. How the types of onsets, i.e. zero initials, single consonant initials,

and consonant cluster initials, are also controlled by the primary construction features and how they are specified are yet to be studied. This paper refrains from saying anything about them. In view of syllable features, apparently there is no necessity to subdivide the syllable final F, for (M)U(O)(C) is only a matter of the arrangement of segmental configurations. Even the division of the segmentals (S) into the onset, the peak, and the coda is redundant, unless the effects of the suprasegmentals exerted on individual segmentals are to be discussed in detail. They are then taken as a whole, and the new structure is therefore revised as (30), where from P all the subcategories of F are derived, and from R the subcategories of G are selected.

(30) $\mathrm{PR}\dfrac{\mathrm{TGZ}}{\mathrm{S}}$

Besides the interpretation of voicing and aspiration, this paper has nothing new to offer concerning the conventional segmental features, which are not the concern here anyway. This paper only elaborates on the newly postulated constitution features, i.e. voicing, aspiration, orality, nasality, glottality, breathy phonation, syllable nucleus, and primary structure.

3.2. Primary structure features (PR) and syllable nucleus (U)

The distinction between a syllable with a vocalic nucleus and one with a non-vocalic nucleus appears to be more fundamental in the scale of classification. The vocalic syllables are further divided into open syllables and closed ones. If, on the contrary, the criterion whether a syllable has an ending is made primary, there will be an awkward situation of grouping syllabic nasals with open syllables. Of course, this is a matter of interpretation. An autosegmental approach (Fu Yi-chin 1986) will treat a syllabic consonant as *either* an onset *or* an ending with an "unclassified" vowel as the syllable nucleus. The problem is how to decide whether it is an onset or an ending when it is not preceded by another consonant.

In Taiwanese, the syllabic type *um* [m] is a reflex of initial labial nasal or, in one dubious case, final labial nasal and can be preceded by a glottal fricative. The syllabic type *ung*, on the other hand, comes from a final dental, velar, or, again in one dubious case, labial nasal and can be preceded by most initial consonants.

With these difficulties in view that involve the alternatives, this paper considers the presence or absence of a vocalic nucleus as one of the most important signals to the operations of other features. A binary feature [vocalic] is therefore identified, which indicates whether in an array of matrices there is one that specifies a vowel.

(31) P → {±vocalic}

If the syllable is [-vocalic], the oral cavity is obstructed in a certain way at a certain point throughout the duration of the syllable. In other words, the oral passage is [-open].

(32) [-vocalic] → [-open]

Now if the syllable is [+vocalic], other lower-level specifications also follow. As [+vocalic] syllables can be open or closed, the next step is to make a choice between them:

(33) [+vocalic] → {±open}

If the last matrix in the array happens to specify some kind of obstruction in the oral passage, i.e. [-continuant], the syllable is treated as [-open]. It then has to be decided whether it is a nasal consonant or a stop, or a glottalized nasal ending, by the peripheral configuration features (G). That is:

(34) [+vocalic, -open] → [α nasal, -α glottal], [+nasal, +glottal]

Both the syllabic consonant and the syllable ending indicate that the

constituent F is specified by [-open], which, in turn, is to be defined according to the point of articulation in the oral cavity.

(35) [-open] → {±coronal, ±anterior}

On the other hand, if it is [+open], then it is necessarily [+vocalic], and there will be different types of [-consonantal] syllable peaks which are to be specified by vocalic distinctive features:

(36) [+vocalic] → (M)V(O)

The hierarchy of the syllable P-features are shown as follows.

(37)

Primary Structure

+vocalic		-vocalic
+open		-open
Tongue Position	Lip Shape	Point of Articulation

[+vocalic, -open]: closed syllables

[+open]: open syllables

[-vocalic]: syllabic consonants

Syllable Types

3.3. Peripheral configuration features (G)

The primary structure features (PR) include one that specifies the presence or absence of register contrast (R).

(38) R → {registered}

R not only decides whether a syllable bears the register distinction[9] but also

9 In Middle Chinese, syllables with nasal or liquid initials seemed to have lost the register contrast. See next section.

determines whether it is breathy phonation or glottality, or their combination, that will work. In other words, in a register language, [+registered] further determines whether the contrast is realized as clear-breathy or laryngealized-clear (19, 18 above), or otherwise.

(39) [+registered] → {±breathy, ±glottal}

(40) [-registered] → {±glottal}

Breathy phonation is a sure indication of register contrast, but glottality is not. That is, in a non-register language, glottality can still be a contrastive feature.[10]

Following Tung's concept of "delayed nasality", this paper posits "delayed glottality" and "suspended glottality", and maybe also "advanced glottality", to facilitate an adequate analysis. Theoretically, there are five distinctive syllable constructions with regard to glottality:

		[glottal]	[delayed]	[advanced]	[suspended]
(41)	ba	−	−	−	−
(42)	bat	+	+	−	−
(43)	baq(t)	+	−	−	−
(44)	'baq(t)	+	−	+	−
(45)	'ba	+	−	+	+

Vietnamese distinguishes (43) from (42) and (41), and many Tai languages distinguish preglottalized syllables (44, 45) from others. However, it is not known whether there is a language that makes a three-way distinction, such as (42-43-44), that is, clear-laryngealized-preglottalized. If not, [+advanced] can be discarded, that is, emically (42) [+delayed] versus (43/44) [−delayed] or (42/43) [+delayed] versus (44) [−delayed], depending on languages. In the discussions to follow, [+advanced] is ignored.

10 One exception is Mandarin, which has lost glottality completely.

Nasality can be suspended also. This accounts for the denasalization of nasal initials, such as the cases in Wenshui, a Northern Mandarin dialect, e.g. *mba* 漠 'sandy desert', *nda* 諾 'to respond', *ngga* 惡 'wicked'[11]. The nasality in these syllables are also treated as 〔−delayed, +suspended〕, like (45). Theoretically, temporary suspension is possible: *mban, ndan, nggan.* Their specifications are to be determined by P → 〔+vocalic, −open〕 (31, 32).

If a process is delayed, there is, as a matter of fact, no chance to suspend it, and if it is suspended, it cannot be delayed to begin with (↓ indicating redundancy):

(46) 〔+delayed〕 ↓ 〔−suspended〕

(47) 〔+suspended〕 ↓ 〔−delayed〕

The notion of delayed operations is also applicable to breathy phonation, but the suspension of breathy phonation in a syllable seems not realistic, for the effect of breathy phonation must be manifested in syllable peaks, and the suspension of the breathy voice quality means its absence. As for aspiration, it is always 〔−delayed, +suspended〕 in the data available.

(48) 〔+aspirated〕 ↓ 〔−delayed, +suspended〕

Arranging the features nasality, glottality, aspiration, and breathy phonation, with regard to {±delayed, ±suspended}, we have (49)-(51) in the following figure. Here the difference between *ma* (rather than *manh*) and *mba* are not specified owing to the lack of evidence of such contrast.

11 Bernhard Karlegren, trs. Y. R. Chao et al, 1940, *Etudes sur la phonologie chinoise*, Comercial Book Co., 1940, pp. 772, 720.

		[+nasal]	[+glottal]	[+aspirated]	[+breathy]
(49)	[+delayed]	ban	mat		pahh
			bat	pat'	
(50)	[−delayed, −suspended]	manh(n)	'baq(t)	p'at'	b'a (phha)
(51)	[+suspended]	ma	'ba	p'at	–
		mba(n)			
		mbat			

To sum up, the configuration of G-features specify a syllable on two hierarchical levels, or in two stages. First, the syllabic character of orality, nasality, glottality, laryngealization, relaxation, aspiration, breathiness, and whatever else that may be or can become distinctive are specified by {±nasal}, {±glottal}, {±aspirated}, and {±breathy}:

(52) G → {±nasal}, {±glottal}, {±aspirated}, {±breathy}

The next stage is that when G is [+nasal] or [+glottal], it is required to specify whether the nasality and glottality are delayed or suspended, or neither:

(53) [+nasal], [+glottal] → {±delayed, ±suspended}

When breathy phonation is at work, the question then is whether it is delayed:

(54) [+breathy] → {±delayed}

In the languages in question, there is no necessity to further specify aspiration, however. For, as it is already mentioned, aspiration is always [−delayed, +suspended].

3.4. Voicing

The Z-constituent has only a binary feature, voicing:

(55) Z → {±voiced}

Like the G-features, the operations of voicing also can be delayed or suspended, or both, that yields four types of syllables. The following examples are artificial.

		[+voiced]
(56)	[+delayed, +suspended]	pat
(57)	[+delayed, −suspended]	pan
(58)	[−delayed, +suspended]	bat
(59)	[−delayed, −suspended]	ban

Voicing seems to be a "later" feature than breathy phonation. As the reader will see in (74), the non-delayed breathy phonation will trigger the advancement of voicing. Unfortunately, nothing more is yet clear about the hierarchical relationship between the G-features and the Z-feature.

3.5. Tone features

Tones are conventionally divided into A, B, C, D, where Sinitic B and C confusingly correspond to Tai C and B, unfortunately. However, such division is only valid in historical and comparative studies. Structrual phonology is correct in phonemicizing D tones as allophones of tones of the other categories. Vietnamese orthography is an indication of this phonemicization. In the following figure (60), the operations of glottality and Sinitic tone categories are used as a reference.

In addition to the four tone categories, extra tones are innovated in languages like Taiwanese. Some of these new tones cannot in any way be classified or phonemicized as members of the four categories. As such, in the hierarchy of syllable features, historical tone categories are not considered as sub-categories of the constitution feature T. These are ignored in

this study. Instead, synchronic tonemes are considered. The author's variety of Taiwanese has as many as 14 tone categories, which can be phonemicized into 8 tones in terms of tone features and glottality. They serve as a good example for illustration (64-71).

(60)

Tone Name	Smooth	Checked	Glottal	Delayed
Ngang	A1		−	
Sắc	C1	D1	+	+
Hỏi	B1		+	−
Huyền	A2		−	
Nặng	C2	D2	+	−
Ngã	B2		+	−

Distribution of Tone Categories in Vietnamese

William Wang 1967 posits seven tone features, [contour, high, central, mid, rising, falling, convex], of which the first one, [contour], belongs to a higher level. In the specification matrices, only the remaining six seem to be sufficient. Hierarchically speaking, three of these six features are contour features, and the other three are pitch features, with [−contour] implying [+pitch] only.

(61) T → [+pitch, ±contour]

(62) [+pitch] → {±high}, {±central}, {±mid}

(63) [+contour] → {±rising}, {±falling}, {±convex}

Checked syllables tend to have shorter durations, but this cannot be viewed as a concomitant feature of glottality, for there are languages where even checked syllables are not short (67b). It can only be said that glottality, being "suffocative", has the tendency of shortening the syllables. However, as there is yet no contrast of syllabic length without the presence of other factors attested, it is not economical to add a length tone feature to the inventory. So far, shortness is but considered a possible realization

of [+glottal] (see 17 above). Of the Taiwanese tones, (69) and (70) are contrastive in length, as well as pitch, (69b) being the shortest and (70) the longest, with (69a) in between. Yet they can be distinctively specified without a [short] feature or a [long] feature.

		[−glottal]	[+glottal]	
(64)	[+high]	ㄱ (ㅏ) A1	ㄲ khobppiq 'copy'	[+high]
(65)	[−high, +central]	ㅓ (ㄴ) C2	ㅓ (ㄴ) D2	[−high, +central]
	([−high, −central])			([−high, −central])
(66)	[−high, −central]	ㅡ(ㅁ) C1	ㅓ (ㅁ) D1	[−high, +central]
	([+high, +falling])			([+high, +falling])
(67)	[+high, +rising]	ㅓ , ㄲ carrng 'yesterday'	ㅓ torp 'prolonged sound of water dripping'	[+high, +rising]
(68)	[−high, +rising]	ㅓ (ㅏ) A2	ㅏ addsaadiq 'simply; frankly'	[−high, +central]
	([−high, +central])			
(69)	[+high, +falling]	ㅋ (ㄱ) B	ㅋ topp 'staccato sound of water dripping'	[+high, +falling]
(70)	[+high, +mid, +falling]	ㄴ xell 'Hey'		
(71)	[+convex]	ㅢㄴ xorl 'Now you are in trouble!'		

Taiwanese Tones

4. Shaping and reshaping of syllables—features in motion

4.1. Modification of segmentals and specification of the syllable

From the analysis of syllable features above, one can envisage the processes of making syllables. First, there is an array of matrices specified by points of articulation (including tongue positions) and manners of articulation (including lip shapes) responding to the order from the primary structure features (PR) and ready to be modified by the tone features (T), the voicing feature (Z), and the peripheral configuration features (G). This string of matrices is divided into the onset (I), the peak, and the coda (C), which will receive different modifications from the syllable features. The combination of the peak and the coda (F) is further subcategorized into closed, open, and consonantal according to the arrangement of the matrices.

The universal modifications, of course, are tone and voicing. Tone does not need special attention here. As for the voicing feature, it, with the operations of the mechanisms of delaying and suspension, determines how extensive the string of matrices is to be voiced.

Nasality is possibly another universal modification. Hokkien is a typical language in which nasality is a major feature that crosscuts the primary classification of syllables. Syllables in this language are considered either nasalized or non-nasalized. The status of nasality in Hokkien is analogous, in a way, to that of glottality in Vietnamese. In many other languages, such as Mandarin, Vietnamese, and Siamese, nasality works emically only on limited segments in the positions of onset (I) and coda (C).

Glottality has ceased to be a syllable feature in standard Mandarin, and possibly in some other languages. The C-constituent in Mandarin is only modified by nasality. In some other varieties of Mandarin, however, glottality is applied to open syllables and is realized as a glottal stop. Examples are Old Mandarin and modern Singapore-Malaysian Mandarin. Vietnamese, Siamese, and Hokkien syllables that undergo glottalization, on the other

hand, are not limited to open syllables nor only to closed syllables.

The C-constituent in the languages in question happens to be uniformly [-continuent, -strident]. As such, when either nasality or glottality is at work, and indeed either one or the other must be at work in this respect, the result is always *-m*, *-n*, *-ng*, *-p*, *-t*, or *-k*.[12]

When both nasality and glottality are working, there is coarticulation. Whether the Vietnamese nặng tone open syllables (C2), such as *nặng* 'heavy', end in a glottal stop is not to the knowledge of the author, but Taiwanese is certainly a language with the coarticulation of a nasal consonant and the glottal stop, such as *munggh* 物 'thing' (cf. 98).

Breathy phonation is the most uncommon syllable constituent in the monosyllabic tone languages nowadays, but historically it seems to be much more prevailing. The author's 1973 paper claims that it is voice register rather than the initial voicing that is the best interpretation of the "clearness" and "muddiness" in Chinese philology and sorts out pitch (high/low), voice quality (clear/breathy), initial voicing (voiceless/voiced), and aspiration (unaspirated/aspirated) from the sub-phonemic realizations of syllable register as relevant to the development of tone registers in languages in East Asia and Southeast Asia and to the aspiration and/or voicing of the so-called "voiced aspirated" initials in Chinese. With regard to these four realizations, in a syllable where breathy phonation is at work, it will have breathy voice quality and comparatively lower pitch, and *its onset tends to be voiced and aspirated*:

12 The presentations are reminiscent of Pike's (1966). However, they are derived from a different concept and are on different levels of phonological structure.

		+breathy phonation
(72)	Breathy Voice Quality	+
(73)	Lower Pitch	+
(74)	Voiced Onset	±
(75)	Aspirated Onset	±

When none of these G-features is at work, it is orality that is at work (cf. *pa* in 76). Orality is unmarked and thus occur in every language.

The foregoing is partly a review of the previous sections. Having refreshed and elaborated the concept, this paper proceeds to illustrate by combining the six suprasegmentals and the two mechanisms in specifying the syllable. The syllable still will be divided into three parts for specifications, that is, the onset, the peak, and the coda. As such, each suprasegmental is also broken into maximally three sections so that delaying and suspension can be shown visually. Twelve syllable types are selected for the demonstration of the operation of the suprasegmentals (76). The symbols used are t for tone, z for voicing, a for aspiration, n for nasality, q for glottality, and b for breathy phonation. The absence of the symbols means the absence of the features which may mean delaying or suspension or both. Since the delaying and suspension of tone do not change the syllable a bit, they will not be shown in the examples.[13]

13 Vietnamese palatal endings and coarticulated endings are emically velar and are therefore not listed here.

(76)	**maqn**	**man**	**mhhan**	**mban**
	ttt	ttt	ttt	ttt
	zzz	zzz	zzz	zzz
	---	---	---	---
	nnn	nnn	nnn	n-n
	qqq	---	---	---
	---	---	bbb	---
	phaqt	**pat**	**pahht**	**phhat**
	ttt	ttt	ttt	ttt
	-z-	-z-	-z-	zz-
	a--	---	---	---
	---	---	---	---
	qqq	--q	--q	---
	---	---	-b-	bb-
	ma	**mat**	**pha**	**phan**
	tt	ttt	tt	ttt
	zz	zz-	-z	-zz
	--	---	a-	a--
	n-	n--	--	--n
	--	--q	--	---
	---	---	--	---

Operations of Suprasegmentals

The concept that the major types of syllables are specified by the combinations of the primary structure features (PR) and the configuration features (G) gives new light to the interpretation of syllables. Here are some actual examples to illustrate. The first, Taiwanese, has all the syllable ending series plus nasalized and glottalized open syllable. It also has syllabic nasals. The next one, Vietnamese, has the most "conservative" syllable

types. It has all the syllable ending series, but no syllabic consonants. The last one, Hinghwa, is an example of languages which are reaching the end of losing the syllable ending.

Taiwanese is one language that has all the three major types of syllables, i. e. consonantal, closed, and open, depending on the specifications of [vocalic] and [open]. All of these further undergo the operation of either [nasal] or [glottal], or both. These four features specify eight major syllable types in total (77-84). Whether these syllables bear a [glottal] feature or not is the factor for the distributions of tones (64-69 above). In the following fingure, it is worth noting that nasality prevails.

			Vocalic	Open	Nasal	Glottal
(77)	**a**	Open Oral	+	+	−	−
(78)	**aq**	Checked oral	+	+	−	+
(79)	**anh**	Open Nasal	+	+	+	−
(80)	**anhq**	Checked nasal	+	+	+	+
(81)	**ung**	Consonantal	−	−	+	−
(82)	**ungq**	Checked consonantal	−	−	+	+
(83)	**ang**	Nasal closed	+	−	+	−
(84)	**ak**	Stop closed	+	−	−	+

Major Taiwanese Syllabic Distinctions

Vietnamese, where there is a contrast of delayed and non-delayed glottality, shows a different picture. Unlike in Taiwanese, its glottality prevails and is not limited to checked syllables, which are limited to two tone categoires only. The two tone categories in (60) that include checked syllables are distinguished by the delaying of glottality beside pitch and contour. Combining the delaying mechanism with other relevant features, six major syllabic distinctions are specified (85-90).

		Example	Open	Nasal	Glottal	Delayed
(85)	**a**	tá 'senior officer'	+	−	−	
(86)	**aq**	tạ 'dumbbell'	+	−	+	−
(87)	**am**	tám 'eight'	−	+	−	
(88)	**aqm**	tạm 暫 'termorary'	−	+	+	−
(89)	**ap**	táp 'gust of wind'	−	−	+	+
(90)	**aqp**	tạp 雜 'miscellaneous'	−	−	+	−

Major Vietnamese Syllabic Distinctions

In Hinghwa, there are two kinds of glottal stop syllable endings. The glottal stop ending in a category of D syllables (D1a and D2a) is in the majority of cases realized as the reduplication of the onset of its following syllable, if any. C1 syllables also end in a glottal stop, but this one is normally lost in non-final positions. The distinction further indicates that the presence of a glottal stop ending does not necessarily mean that the syllable is emically closed. C1 syllables are treated as not having a C-constituent in their structures. If Da syllables are treated as having the C-constituent in their structures, the C-constituent is neutral in all positions. It is either assimilated by the onset that follows it or, finally, by the lexical juncture, where the only [−continuent, +glottal] is the glottal stop. Similarly, the nasal ending also changes its point of articulation according to environment. In the final position, since the specification [−continuent, +nasal] is impossible in the glottis, nasality is realized as a velar nasal instead. As such, it is not necessary to identify the point of articulation of the C-constituent in the syllable structure. Its realizations depend on their contexts and depend on whether it is glottality or nasality that is at work. In short, the C-constituent is nothing but a configuration in the oral cavity ready to be modified. In the following examples, tones are left out.

(91)

	〔+open〕	〔−open〕
〔+nasal〕	**A1** cjanh 正〔月〕 'the first lunar month'	**A1** cjang 尖 'pointing sharp'
〔+glottal〕	**C1** cjaq 蔗 'sugar cane'	**D1a** cjaq 汁 'juice; sap'
[−nasal, −glottal]	**D1b** cja 隻 '(classifier for animals, etc.)'	

Hinghwa Vocalic Syllables

4.2. Syllabic change and lexical derivation

The development from a register language with breathy phonation as its distinctive feature (72-75) to a non-register language is a matter of settling down the phonetic value of the onset and the category of the tone as well as a matter of losing breathy voice quality. The following are the possible changes. The voicing of the onset is understood as the non-delaying of the Z-feature, and the voicelessness is the other way around. The realization 〔+voiced, −delayed, +aspirated〕 means that breathy phonation is still operating. In other words, no emic change has taken place. Examples for (92), (93), and (94), below, can be cited from Hsiang (Xiang), Hakka, and the main-stream literary Min respectively concerning stop and affricate onsets. The change in (93) also explains the aspirated fricatives reported in Fang Jin 1966.

(92) 〔±delayed, ±aspirated〕 ⟹ 〔−delayed, −aspirated〕

(93) 〔±delayed, ±aspirated〕 ⟹ 〔+delayed, +aspirated〕

(94) 〔±delayed, ±aspirated〕 ⟹ 〔+delayed, −aspirated〕

Pitches seem not to be affected by the change except in syllables with liquid or nasal onsets, which have tones in one or the other register, depending on languages and tone categories. At least in Middle Chinese, syllables

with liquid or nasal onsets do not have register distinction. The ambiguity of liquids and nasals with regard to register accounts for the irregular correspondences of tones between dialects (Chang Yü-hung 1973). As such, it is more adequate to state that before the loss of register contrast, syllables with liquid or nasal initials already are stably assigned to one or the other register according to tone categories in different dialects of Middle Chinese. In other words, in some dialects these syllables bore a feature that is [+breathy], and in others, [−breathy]. In any of these dialects, syllables with liquid or nasal initials in some tone categories bore a [+breathy] feature, and in others, [−breathy]. Those that were breathy had comparatively lower pitch then and have the second register tones later. The same thing happened to those without breathy voice quality that they aquired the first register tones.

The influence of glottality on pitch, as seen in Tai (Li 1943, 1944, 1980), must also be understood as sub-phonemic as long as the register contrast is kept. Only when there is a shift of phonemic tone specification that tone change occurs. Again, no detail is needed in this respect.

Conventionally, linguists maintain that vocalic nasalization is a compensation for the loss of the nasal ending, that the glottal stop ending is an articulatory point of retreat from the outer part of the oral cavity, and that both voacalic nasalization and the glottal stop can be completely deleted in sound change. The histories of such changes are here interpreted in the light of syllable features. (Cf. Section 2.2)

The structural changes of syllables are, as stated above, viewed as the changes of the presence and absence of syllable features. A P-change effects the rearrangement of the segmentals, which is specified by {±vocalic, ±open}, and an R-change affects the selections of the G-features, the Z-feature, and the T-features to be operated on the segmentals.

The phonological change of the preglottalized onsets in Po-ai (Li 1944, 1980) is peculiar to Tai. The syllable feature approach again offers an

explanation that goes beyond merely the change of segmental consonants. Take three examples from Li 1980:9-10 for example. There are two changes involved. One is the loss of preglottalization, and the other is the nasalization of initial voiced stop consonants. For the first change, the paper hypothetically attributes it to the operation of the delaying mechanism, and for the second one, a suspended nasality, which will not affect a segment that is not [−continuent, −strident]. T-1, T-2 etc. represent stages in history. Segmental changes such as vowel shifts are ignored.

(95)					
	T-1	[+glottal]	* 'dii	* 'bau	* 'jïak
	T-2	[+nasal, +suspended]	* 'nii	* 'mau	—
	T-3	[+delayed]	nii	maau	jiik

The changes from Middle Chinese second register syllables with a nasal initial all the way down to Hinghwa oral syllables are spectacular. They went through the changes of all the suprasegmental features except aspiration. In the following examples (96), tone change is not shown. The hypothesized forms are only given to accommodate the intermediate forms. They are by no means results of comparative studies. The extant forms are annotated by a language or dialect where they can be found. [14]

(96)		麥 'wheat'	掠 'to capture'	月 'the moon'
T-1		mhhak (Rongxian)	*nhhjak	*nghhvat
T-2	[−breathy]	mak (Cantonese)	*njag (Foochow *njaq*)	ngvat (Lungtu)
T-3	[−nasal]	beg (Hokkien)	djag (Hokkien)	gvad (Hokkien)
T-4	[+open]	begh (Hokkien)	djagh (Hokkien)	gvegh (Hokkien)

14 Only a minority of Taiwanese Hokkien dialects underwent the change in T-5.

T-5	〔−glottal〕	be (Taiwanese)	dja (Taiwanese)	gve (Taiwanese)
T-6	[+voiced, +delayed]	pe (Hinghwa)	tja (Hinghwa)	kve (Hinghwa)

G-Changes and Z-Changes

Changes result in mergers and splits. The following are more examples of the syllable feature approach to sound change, an artificial example of merger and three Hokkien examples of split. The three Hokkien examples (98–100) put together also show the merger of different syllabics into the syllabic consonant *ung*.

(97)

T-1	thham	tam	tap	thhap	
	↓	↓	↓	↓	
T-2 〔−breathy〕	→	tam	tap	←	
		↓	↓		
T-3 〔−delayed〕		tanhm	taqp		
		↓	↓		
T-4 〔+open〕		tanh	taq		
		↓	↓		
T-5 〔-nasal〕		ta	←		〔−glottal〕

Feature Change and Merger

(98)

T-1	*mud 物 'thing' →	→	→		
	↓			↓	
T-2 〔−delayed〕	*muqd			bud	〔−nasal〕
	↓				
T-3 〔+open〕	*mugh				
	↓			↓	
T-4 〔−suspended〕	*munhgh →				
	↓	↓			
T-5 〔−open〕	*munggh	minhgh →			
	↓		↓		
		↓		↓	
T-6 〔−vocalic〕	mnuggh	minhgh	milnh	bud	〔−glottal〕

(99)

T-1		*mor 毛 'hair'	
		↓	
T-2	〔−suspended〕	*mornh → →	
		↓	
T-3	〔−open〕	*morng ↓	
		↓	
		↓	
T-4	〔−vocalic〕	murng mo(r)nh	

(100)

T-1		*cij 指 'finger' →	→	→	
		↓		↓	↓
T-2				*caij	
				↓	
T-3	〔+nasal〕	*cijnh		caijnh	↓
		↓			
T-4	〔−open〕	cijng →	→		
		↓			
			↓	↓	↓
T-5	〔−vocalic〕	cuvng	cijng	caijnh	cij

Hokkien Feature Change and Split

Some of the operations on syllables apply to derivations by sound change as well. Though derivation by altering the syllable features is a subcategory of sound change, more often than not it is not known which of a group of the related words is the original. What is known is that at least one feature is substituted by another in each case.

Granted that Karlgren's reconstructions are correct, G. B. Downer's (1959) list of classical Chinese derivation includes not only doublets of different tones but also pairs of words contrastive in the presence or absence of an ending. These examples are questionable, for there are not many cases of abrupt dropping of an ending, and the rare emergence of an ending has to be conditioned. One of the conditions is the non-final position before the onset of the following syllable. Another is the pre-existance of non-suspended nasality, e. g. (98)-(100) above. Nevertheless, tonal derivation was

definitely active in Chinese in the old times. Many of the doublets are still extant as doublets.

Besides tone-change, the mutual replacement of glottality and nasality is also an important process in derivation. There is yet no clear picture of this kind of derivation in ancient Chinese, but from cognates such as Mandarin *yun* and Hokkien *ut* 熨 'to iron', from phonetic indicators of characters such as 溫〔+nasal〕and 殟〔+glottal〕, from homophones ih the Han times such as 旁〔+nasal〕and 溥〔+glottal〕, and from graphic doublets such as 瓊〔+nasal〕and 璚〔+glottal〕, it is easy to have a glimpse of its existance. This kind of derivation is still alive in Taiwanese, though not active. Of the following examples, (112) is a historical residue, and (118) can be questionable.[15] Pairs (120), (121), (122), and (123) are doublets with almost but not exactly identical meanings.

As for register-change as a factor for derivation, no instances are attested so far. Nevertheless, it is very plausible that register plays a role in derivation.[16]

	〔+nasal〕	〔+glottal〕
(101)	dom 'to slip on; to muzzle'	dop 'to encase with something that just fits'
(102)	dohm '(the whole body) falls into water'	dop 'to step into (especially water, carelessly)'

15 As Robert Cheng's paper on Taiwanese derivation is not available to me when preparing this paper, I don't remember whether he deals with the yáng syllables and ru syllables. The following examples are my independent collections. The examples of open syllables (116-119) are comparatively fewer. This is reasonable, because pairs of nasalized open syllables and glottalized ones are fewer than closed syllables.

16 In the descriptive phonetic annotations (譬況) by Ho Xiu (何休, A. D. 129-182), there are hints of voice register. For instance, 伐 is used actively as 'to invade' and passively as 'to be invaded'. The syllable is said to be "short" when the meaning is active; otherwise, it is "long". Nevertheless, it is not definite that the contrast is due to breathiness in one of the two words.

(103) dohm 'boggy and muddy; to tramp with force'	dob 'to tramp in wet and soft ground'
(104) kholm 'to slam'	khop 'to chop (as seal)'
(105) khahm 'to cover'	khap 蓋 'to turn face down and/or cover something else'
(106) 〔da(r)〕sa(r)m 'dirty'	〔daq〕sap 'dirty; obscene'
(107) sjahm 'to leak or ooze, as urine or stool'	sjab 泄 'to leak or ooze, as semen or water'
(108) 〔cid〕tjaam〔aa〕〔－〕點〔仔〕'a little bit'	〔cid〕tjap〔aa〕'a little while'
(109) kahn 'to prick with the penis'	katt 'F－k!'
(110) khen 'to hit the head with the fist, etc.'	khed 'to hit the head with the knuckle of the middle finger'
(111) kirn 'to scoop out or pour off excessive liquid'	kid 'nearly dry, as rice porridge'
(112) wan 彎 'to curve' (more in a static sense)	wat 斡 'to curve' (more in an active sense)
(113) wan 彎 'to curve'	wad 'to turn the head or body around (as on an axis)'
(114) sjahng 'to throw something large with force to the ground; to fall heavily to the ground'	sjak 'to throw something to the ground; (for men or animal) to fall down'
(115) sahng 送 'to send forth'	sak 'to push with the hands'
(116) penh 'to force apart with both hands'	peq 'to break open (fruit with shell or skin) with the fingers; to open (the mouth or eyes)'
(117) pvarnh 'to set aside and transfer, often from one container to another'	pvaq 撥 'to set aside and transfer'

(118) svanhh 散 'to be separated owing to loss of contact' svaq 煞 'to end love affair'

(119) telnh 'to hold in hand and press with the palm and the fingers' teq 'to press down'

(120) uhnbuln = utbuln 鬱悶 'feeling depressed'

(121) yokdjolng = yokdjog 約略 'roughly; about'

(122) dvor tahngtahng = dvor taktak 'very muddy'

(123) telng khongkhong = telng khokkhok 'very hard (solid)'

5. Summary

In order to treat the syllable as an individual intact linguistic unit so as to have a better understanding of it, an effort is directed to construct an archetype for syllables in monosyllabic tone languages. Just to posit the constituents such as I, M, V, O, C, T is not satisfactory, however, for (I)(M)V(O)(C) are but arrangements of the matrices that specify segmentals. These arrangements must be classified in a more meaningful manner. The segmental syllable peaks are conventionally understood as being modified by tones in different ways. However, beside tones, there are other sources of modification.

To be able to classify the different arrangements of matrices, this paper has posited a set of "primary structure features" (PR) as controls at the very top of the structural hierarchy. One of them is the P-feature, which specifies whether a syllable is consonantal or not and, if not, whether it is closed or open. The features that are at work under P are [vocalic] and [open].

The R-feature controls the choice of "peripheral configuration features" (G). If it is [+registered], either or both of [breathy] (breathy phonation) and [glottal] (glottality) will be chosen depending on languages. But no matter whether a language is registered or not, glottality and nasality normally are emic. As for tones, they are always present unless neutralized.

A new concept of voicing and aspiration is also presented. Instead of assigning them to individual segmentals in a syllable, this paper treats them as the fifth and the sixth suprasegmental features identified.

There must be another feature that controls the onsets. However, this paper does not intend to tackle the problem of the syllable structural condition in the initial consonants. It is left for future researches.

The six R-features each has its own area of influence. Tone only affects the syllable peak and the nasal ending. Breathy phonation modifies every segmental as well as pitch and voicing except perhaps the stop ending. Voicing, nasality, and glottality also work on the whole syllable with the various combinations of [delayed] and [suspended]. And aspiration operates only on the initial consonants in the monosyllabic tone languages attested.

The syllable feature approach will also falicitate historical phonological studies of the languages in question. In this frame of reference, when the operations of these syllable features change, there are sound changes that affect the syllables as a whole. New lexical items are also seen as derived from changing the specifications of the R-features.

Key to Phonological Representations

General

hh	breathy phonation
q	glottality
nh	nasality
j, v	glides

Hokkien and Hinghwa lexicon

-p, -t, -k, -q	upper register
-b, -d, -g, -gh	lower register
um, ung	syllabic nasals
r, h, l, a (following a), j (following e, i, j), v (following o, u, v),	tones

Vietnamese

Orthography

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摘　　要

單音節有聲調語言的音節，可以視爲含有下述結構成分，也就是下述超音段的徵性組合。其中P以｛±含元音，±開放｝等徵性決定音節爲開尾，爲閉尾，或爲韻化輔音音節。T含有多個聲調徵性。Z是幽響。G爲鼻喉間器官的形勢的其他徵性，包括｛±送氣，±濁流，±鼻化，±喉化｝等。R控制G所屬諸徵性的選擇。T，B，Z三者修飾屬元成素的S。如此界定的音節結構，圖示如下：

$$PR\frac{TGZ}{S}$$

這G的運作方式有｛±延後，±吊銷｝，用以進一步細分音節的類型，如〔pa̤, b'a̤, ban, ma (n), ma, mban, mạt, bạt, 'bạ(t), 'ba〕等。不只音節的構成，即語音的變化與語詞的引申，都可以這九個音節徵性（含元音，開放，帶音，送氣，濁流，鼻化，喉化，延後，吊銷）的正負值及聲調屬下的徵性來說明。