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FROM SEGMENTS TO DISTINCTIVE FEATURES: PRELIMINARIES TO AN ANALYSIS OF THE MALAY SOUND SYSTEM

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In one of his early writings, M. Halle (1959) proposed that speech events be represented as sequences of segments and boundaries, segments being characterized by articulatory as well as acoustic properties, and boundaries by their effects on segments; that the properties by which segments are characterized should belong to a specific narrowly restricted set of such properties called the distinctive features, all of which are binary.

Without doubt, the term 'specific' does not mean only the set of Jakobsonian features as presented in Jakobson and Halle (1956), and later expanded in Halle (1959), and Jakobson et al. (1963); and by 'narrowly restricted' Halle does not mean to imply that distinctive features as presented in his works are the universal phonetic features by means of which languages may be represented, but rather a testable proposal for a universal set of phonological features. For it is often that the demand for simplicity in the phonological description of a specific language will lead to a reinterpretation of the definition of certain features or a reclassification of segments in terms of the given features depending on how the segments fuction in the language. In Malay, for example, it seems more natural to assign a non-consonantal feature to the segment, *h* (i.e., as a glide) rather than a consonantal feature (as a consonant), for the following reasons: perceptively, *h* has somewhat glide quality, which is partly pharyngealized, and functionally, it behaves in the system as a non-consonant in the sense that the rules which apply to all [-consonantal] segments apply also to *h*, just as they apply to the glides, *w* and *y*. An example of such rules in Malay is Vowel Nasalization which penetrates all non-consonantal segments, namely *y*, *w*, and *h*[1].

In what follows, an attempt is made to set up a system of classificatory phonetic features to account for the Malay sound segments based on the model presented by Chomsky and Halle (1968). The language described here is that of Johor Malay (hereafter, JM) as spoken predominantly in the districts of Muar-Batu Pahat which, unlike the more formal form of Malay, has no foreign sounds[2] in its phoneme inventory.

The phoneme inventory of JM consists of eighteen consonants and six vowels which, traditionally, are classified as follows:

CHART 1. JM Phonemic Inventory

Consonats:						
	Bilabial	Alveolar	Palato-Alveolar	Palatal	Velar	Glottal
Stop	pb	td			kg	

Affricate			c				
Fricative		s					
Lateral		l					
Nasal	m	n				ŋ	
Glide				y		w	h

Vowels:

	Front		Back
High	i	ə	u
Mid	e	a	o
Low			

All phones are produced with egressive pulmonic air.[4] There are three linear distinctions for stops, the bilabials *p, b,* the alveolars *t, d,* and the velars k, g; there are only two fricatives, that is the alveolar *s* and the valar , while the nasals have the masimal four linear distinctions in the bilabial *m,* the palatal ɲ and the velar ŋ. The affrictes c and j are palato-alveolars which retain the voiced distinction. both are not found in word or stem-final position, except in loan words.

The three glides are normally classified in the inventory as the palatal *y,* the velar *w* and the glottal or laryngeal *h.* Although *y* and *w* could be interpreted as non-syllabic allophones of the vowels *i* and *u,* respectively, since there is no contrast between *y* and *i* or between *w* and *u,* the twod glides, along with the laryngeal *h* are, traditionally, interpreted as conso two for the simple-minded reason that they play the same role as do the non-suspect consonants, such as

CHART 2. Consonantal Distribution*

	initial		medial		final	
p	pari	'ray fish'	kapor(r)	'chalk'	sikap	'attitude'
b	bagi	'to divide'	kaba(r)	'blur'	-	
t	tari	'to dance'	katun	'cartoon'	sikat	'comb'
d	dari	'from'	sədap	'delicious'	-	
k	kari	'curry'	təkap	'to press'	rosa?	'spoil'
g	gari	'handcuff'	təgap	'strong'	-	
l	lari	'to run'	tulaŋ	'bone'	tabal	'to install
r	ratu	'queen'	saraŋ	'charcoal'	tika(r)	'mat'
c	cari	'to find'	aca(r)	'pickle'	-	
	jari	'finger'	aja(r)	'to teach	-	
m	makan	'to eat'	taman	'garden'	tikam	'to stab'
n	nakal	'naughty'	senaŋ	'easy'	təkan	'to press'
	amo?	'mosquito'	ba a?	'many'	-	
ŋ	ŋilu (of sound)	'irritaring'	taŋan	'hand'	sənaŋ	'easy'
s	satu	'one'	masa	'to cook'	kapas	'cotton'
y	yaŋ	'which'	mayat	'corpse'	panday	'clever'
w	waŋ	'money'	mawa(r)	'rose'	pulaw	'island'
h	haŋat	'hot'	mahal	'expensive'	tabah	'steadfast'

*All examples are given in phonetic forms.

CHART 3. Distribution of Malay Vowels
In Open and Closed Final Syllables*

	VCV	VCCV	CVCV	CVCCV
i	ini	inti	diri	tiŋgi
	irə	-	bilə	timpə
	itu	iŋgu	pilu	miŋgu
e	-	-	-	-
	e ə	-	betə	rendə
	ʁ	elmu	-	-
a	api	asli	tali	nanti
	adə	alpə	bare	tandə
	adu	ampu	balu	bantu
ə	-	ərti	pəri	səndi
	əsə	-	karə	bandə
	əlu	əŋku	səru	təntu
o	-	-	roti	koŋsi
	o ə	oŋkə	rodə	bombə
				boŋsu
u	uli	undi	guli	tumpi
	urə	untə	mulə	tundə
	ulu	uŋku	kuku	sumbu

	VCVC	VCCVC	CVCVC	CVCCVC
i	ise?	in el	pileh	tindeh
	ikat	indah	pitam	pindah
	ikot	indo?	hidop	timbol
e	ese?	eŋsel	lere?	pende?
	ena?	eŋka(r)	sela?	tempaŋ
	elo?	eŋsot	belo?	beŋko?
a	asen	ambel	raket	paŋgel
	asam	antan	sawan	bantal
	apoŋ	aŋkoh	taroh	antoŋ
ə	areh	əmpeŋ	səre?	səmpet
	ərat	əmpaŋ	sərah	təmpah
	-	əmpo?	bəro?	təmpoh
o	oleh	ondel	toleh	toŋgeŋ
	olah	amba?	boraŋ	toŋgaŋ
	olo?	oŋgo?	boros	lomboŋ
u	uke(r)	uŋket	buket	rundeŋ
	urat	undaŋ	surat	tumpah
	usoŋ	uŋso(r)	turon	lunto(r)

*The dash (-) indicates the absence of examples with the particular vowel combinations in the articular vowel combinations in the particular structures.

the stops, in filling the nonsyllabic slots of a syllable. However, interpreting these glides in terms of distinctive features, as we shall attempt to do in the following pages, they fail to qualify as consonantal sounds. This is because in the production of consonantal sounds, the obstruction occurring in the mid-sagittal

region of the vocal tract must be at least as narrow as that found in the fricative sounds[5], and the glides in Malay (JM) are produced without such an obstruction. The distribution of the JM consonants, including the three glides, is shown in Chart 2 . Chart 3 shows the distribution of the vowels in open and closed final syllables. The six-vowel system has a contrastive pattern of two front vowels against two back vowels, and three vertical distinctions of high, mid and low.

The preceding paragraphs show, briefly, the traditional manner of interpreting the sound segments of JM. However, the segments may also be interpreted in terms of a set of properties called distinctive features. Such analytical procedure has been elaborated by Jakobson et al. (1963), with the purpose of establishing "the ultimate discrete components of language, their specific structure, their inventory in the languages of the world, their identification on the accoustical and perceptual levels and their articulatory prerequisties."[6]

For the rest of this paper, the phoneme is thus regarded as a complex bundle of characteristics or distinctive features. Some of these characteristics are shared by vowel and consonant alike as the study of an acoustic spectrogram reveals. Sometimes a speech characteristic carries over a stretch of two or more phonemes as when the periodic wave is shared by adjacent voiced segments. Vowels are characterized on the spectrogram as a series of more or less horizontal lines representing the harmonics of the basic pitch of the sound. Several of these harmonics, recognizable as much darker than the others, are called formants. The formants correspond to the resonating effect of the resonance chambers of the vocal tract and serve to differentiate among the vowels. This way, a correlation between acoustic characteristics and binary distinctive features can thus be made. For example, phonemes whose first and second formants are close together and fairly centrally located on the spectrograph are characterized in Jakobson et al.(1963) as *Compact* while those whose formants are separated and non-central are termed *Diffuse*. Every phoneme, therefore, is characterized as having a set of attributes which identifies its similarity to other phonemes and distinguishes it from every other phoneme. The set of attributes, each of which functions in a binary descriptive capacity, comprises the distinctive feature matrix of that phoneme.

As mentioned earlier, the distinctive features employed in the present study are derived from Chomsky and Halle's feature system, as presented in *The Sound Pattern of English* (SPE). However, in order to present a more adequate and meaningful description of the sound segments of JM, it was found necessary to replace some of the SPE'S features. For example, the feature *Vocalic* is replaced by the feature *Syllabic* in order to distinguish vowels from all consonants and glides. This is possible due to the fact that each of the JM vowels can occur as a syllable, whereas the consonants and the glides are not Syllabic. Thus, a syllable in JM may be a combination of the following phoneme classes: a vowel (V), a consonant plus a vowel (CV), a consonant plus two vowels (CVV) or (CVVC). In the form of a rule, the Malay syllable is stated as follows:

$$[\ +\text{syll}\ ] \qquad (C)V(V)(C)$$

Following Maran (1971), the feature *Voice* has also been discarded. Instead, the glottal features, *Spread* and *Constricted,* are used in its place. According to this specification, a sound is voiced if the vocal cords are in a slit configuration. That is, they can neither be open (spread) nor closed (constricted). The vibration by the Bernoulli effect[7] will take place only if the pulmonic air is allowed to flow up between the vocal cords. Voicelessness, on the other hand, may occur if the vocal cords are in a constricted configuration or a spread configuration, or it may be due to an oral stoppage of the air stream during which the supraglottal pressure becomes equal to or greater than the subglottal pressure, thereby obstructing the flow of air through the vocal cords.

In a spread configuration, the vocal cords are pulled apart, allowing a gushing flow of air to escape through the oral tract. There may be additional supraglottal occlusions which are superimposed upon the configuration. In JM, the fricative *s* and the affricate *c* have the feature [+spread], while the glides and the vowels are all [-spread]. In the case of a constricted configuration, the vocal cords are completely closed so that no air passes through the glottis, and vibration by the Bernoulli effect does not take place. In JM, therefore all (voiceless) stops are [+constricted], while the glides, the vowels, and the (voiced) stops are all [-constricted]. The feature *Lateral,* as proposed in Chomsky and Halle (1968:317), is also to be discarded. While this feature may be necessary for raw phonetics, and is in any case quite descriptive, the evidence offered for its relevance as a phonological feature by Chomsky and Halle is hardly convincing. In the first place, this feature is restricted, or applicable only to coronal consonantal sounds, and in JM, the lateral or liquid *l* can easily be distinguished from all other coronal consonants by the features *Anterior* and *Continuant*. The absence of the trilled *r* in JM also makes the feature *Lateral* superfluous. Following Chomsky and Halle (1968:304), the features *Anterior* and *Coronal* are defined as follows:

> Anterior sounds are produced with an obstruction that is located in front of the palato-alveolar [that is, alveopalatal] region of the mouth; non-anterior sounds are produced without such an obstruction. The palato-alveolar region is that where the ordinary English [s] is produced. Coronal sounds are produced with the blade of the tongue raised from its neutral position; noncoronal sounds are produced with the blade of the tongue in the neutral position.

Thus in JM, labial and dental consonants are [+anterior], while all other consonants are [-anterior]. Coronal consonants include dentals, alveolars, and palato-alveolars, while all other consonants are [-coronal].

Other features necessary to a description of the sound segments of JM are as follows:

Consonantal: This feature distinguishes the true consonants and the liquids, which are [+consonantal], from the glides and the vowels, which are [-consonantal]. Segments having the feature [+consonantal] are produced with a narrow constriction or occlusion at some point (the mid-sagittal region) in the vocal tract. The constriction, caused by the closing of the articulator to the target region, must at least be as narrow as that found in the fricative sounds. Hence, all glides in JM, like the vowels, do not qualify as being consonantal.

Sonorant: From the point of view of the acoustical correlates, this feature distinguishes segments which are characterized acoustically by a definite, clear cut formant structure from those without formant structure or whose formants are identifiable only as a glide from one level to another. In terms of the articulatory correlates, sonorant sounds are produced with a vocal tract cavity configuration that makes spontaneous voicing possible. In order that spontaneous voicing be possible, constrictions in the vocal tract must not be narrower than those found in the glides. Thus in JM, vowels, liquids, glides, and nasals are [+sonorant], while true consonants which include the stops, the fricatives, and the affricates are [-sonorant].

Nasal: JM nasals are produced when the velum is lowered allowing air to pass through the nasal cavity. When raised, the velum shuts off the nasal cavity from the oral tract and non-nasal sounds are produced. Except for the fact that in nasals, the air passage is directed through the nasal tract, the supraglottal gestures, particularly for *m, n* and ŋ are quite the same as for the stops or the obstruents *b, d,* and *g,* respectively. The remaining JM nasal, , is produced with the blade of the tongue, which is the articulator, t ouching the target point at the palatal region. It must be noted that in the production of the nasal sounds, the vocal bands are generally in the slit configuration, that is, they can neither be open (spread) nor completely closed (constricted).

The next three features, *High, Back,* and *Low* characterize the placement of the body of the tongue, which is the most crucial articulator located supraglottally. These three features may be used to characterize consonants that are non-anterior, namely, the palatals, the velars, and the glottals, as shown by the specification of segments in Chart 4. The absence of consonants with non-high and non-back features is simply due to the fact that the body of the tongue can form a constriction only if it is high or back.

The above features, involving the placement of the body of the tongue are, however, more appropriate for the characterization of the vowel system. The feature, *High,* refers to the configuration where the dorsum is placed alongside the roof but without touching it, or as explained in Chomsky and Halle (1968), the body of the tongue in its neutral position is raised - if the tongue is raised above its neutral position, high sounds are produced; if on the other hand the body of the tongue is lowered below the level that it occupies in the neutral position, low sounds are then produced. In JM, the feature *Low* is only applicable to the vowel *a,* while all other vowels and all consonants are non-low. The feature *Back,* on the other hand, has a wider application in that it applies to both vowel and consonant. Back sounds are produced by retracting the articulator, that is, the body of the tongue, from the neutral position. Apart from the vowels *u* and *o,* which have the feature [+ back] the velar rasal ŋ and the glides *w* and *h,* are also [+back]. Another feature which applies to JM vowels of lips caused usually by constriction of the orbicularis oris muscle. Thus both *u* and *o* in JM are [+ raound].

Continuant: This feature distinguishes segments produced by constriction of the vocal tract from those produced by occlusion of the vocal tract. In the

production of the continuant sounds, the primary constriction in the vocal tract. In the production of the continuant sounds, the primary constriction in the vocal tract is not completely closed so that the airflow past the constriction is not blocked. In JM, the glides *y, w, h,* the sibilant or fricative *s,* and the liquid *l,* are all continuant sounds, while vowels are redundantly [+continuant]. All stops, affricates, and nasals are [-continuant].

The only source feature[8] used in the present description of JM sound segments is *Strident.* Strident sounds are produced by the air stream pressing at right angles across a sharp edge or over a rough surface producing a periodic noise. Acoustically, this noise appears as a random distribution of black areas on a spectrogram. The strident feature is restricted to consonantal sounds. Non-strident sounds are those which lack one or more of the above factors.

Chart 4 shows the way in which the inherent distinctive features have been applied to the sound segments of JM. Only features that are marked in an unshaded area are required to distinguish the segments from each other, while those features marked in the shaded area are redundant for the specific segments. The minimum feature specifications to distinguish the segments are also shown in a tree following Chart 4.

As specified in Halle (1959) and Chomsky and Halle (1968), the specification of features in the lexicon must be such that all redundant information is omitted. Generally, there are two ways in which features can be redundant:

a) Some features in a column of features are predictable from others. All nasals, for example, are [+consonantal, +sonorant], and all syllabic segments are predictably [+sonorant, +continuant]. All such predictable features are omitted from the laxicon. They will be filled in by the Morpheme Structure Rules (MSR), but only in case their specification is necessary to the operation of the phonological rules.

CHART 4. Full Segment Specification With Redundancies Blocked (in shaded area)

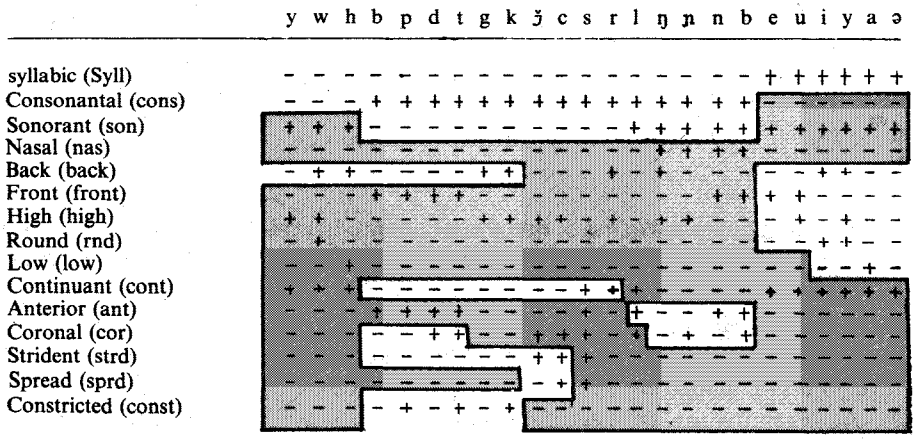
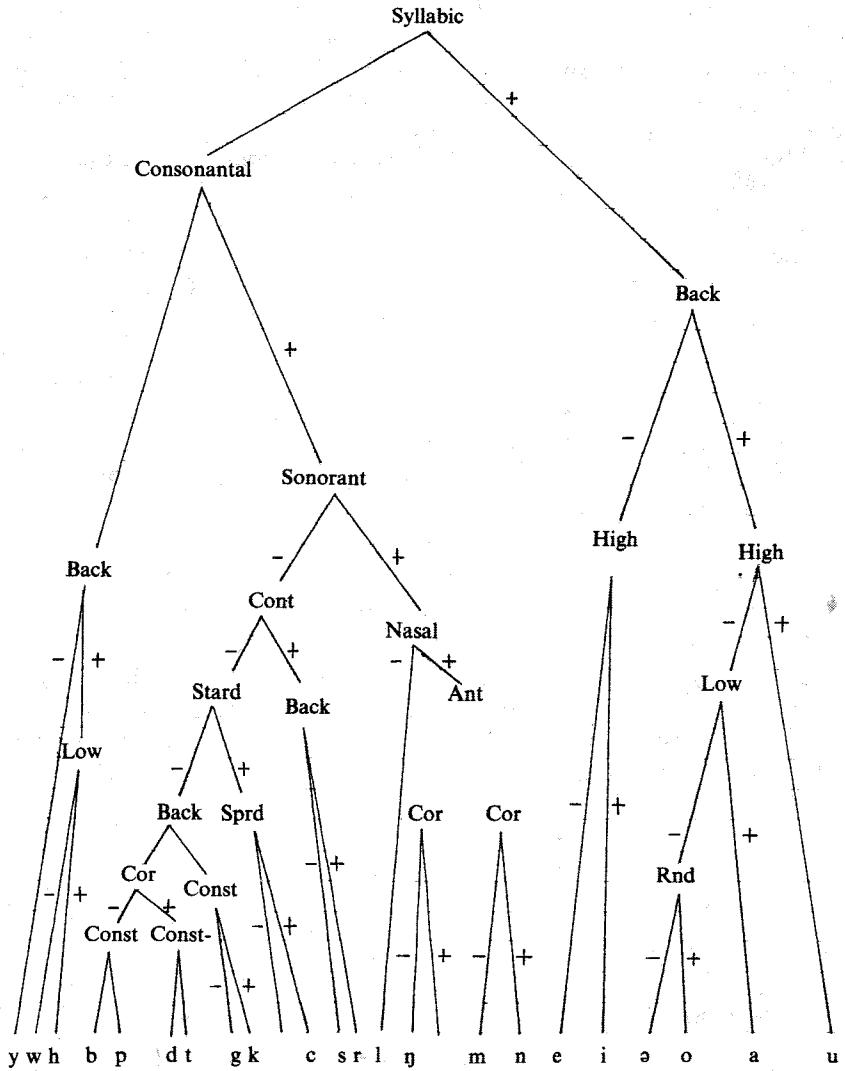


CHART 5 Binary specification of JM Sound Segments



b) Some features in a row of features are predictable from others. These are redundancies which arise form sequential constraints in the language. In JM for example, if an initial segment is [+consonantal], then the following segment must be [+ syllabic]; and if a final segment is [+nasal] it must also be [+ anterior] or [+ back]. These predictable features are also omitted from the lexicon and supplied by Morpheme Structure Rules.

An examination of Chart 4 enables us to state the following segment redundancies:

1.	[+syll]	→	[-cons]
2.	[-cons]	→	[+son, -nasal, +cont]
3.	[+nasal]	→	[+cons, +son, -cont]
4.	[-son]	→	[+cons, - nasal]
5.	-syll, -cons	→	[+son, -nasal]
6.	[+ant]	→	[-high, -back]
7.	[+cor]	→	[-back]
8.	+nasal, +ant	→	[-back, -high]
9.	-cons, + son	→	[-stard, -sprd, -const]
10.	[+strd]	→	[+cons, -son, -nasal, -const]
11.	[+high]	→	[-low]
12.	[+low]	→	[-high]
13.	+cons, sprd	→	[- const]
14.	+syll, -back	→	[-rnd]

In addition to the above redundancy rules which supply features which are predictable from others in the same column, we may also have the following Morpheme Structure Rules which capture the major sequential constraints in JM.

15. [+segment] → [+ syll]/#[+cons]

The above rule states that any initial consonant must be followed by a syllabic segment, i.e., a vowel which, of course, implies that there is no initial consonant cluster in JM. Another rule which is a mirror-image of the above rule, in terms of environment, states that any final consonant must be preceded by a syllabic segment, which means that there is also no final consonant cluster in JM. The rule may be stated as follows:

16. [+segment] → [+syll]/ — [+cons]#