PHONOLOGY

CRITICAL CONCEPTS

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Volume III
Syllables and Multi-level Analyses

London and New York

First published 2001
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
270 Madison Ave, New York, NY 10016

Transferred to Digital Printing 2005

Routledge is an imprint of the Taylor & Francis Group

Typeset in Times by RefineCatch Limited, Bungay, Suffolk
Printed and bound in Great Britain by
TJI Digital, Padstow, Cornwall

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
A catalogue record for this book has been requested

ISBN 0–415–20344–9 (Set)
ISBN 0-415-20347-3 (Volume 3)

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VOLUME III SYLLABLES AND MULTI-LEVEL ANALYSES

GENERAL INTRODUCTION

Syllables and multi-level analyses

The notion of a syllable has been around for millennia, but it has been given different degrees of importance as a phonological unit in different phonological theories and different language descriptions. The rules proposed by Chomsky & Halle 1968, for instance, make no use of the term. In describing the syllable as a phonological unit there are two considerations: 1) what are the elements that make up a syllable and how are they related to one another—what classes of units are there? 2) Other than segmental content, how do different syllables differ? Different languages may have different possibilities in syllable structure. What are the parameters of such variation? Is there a general scheme that fits all languages? Essentially all analyses agree in recognizing a central element, a peak or nucleus, with marginal elements before and perhaps after. There is also agreement that relative sonority plays a role in determining which elements can be nucleus, which can border the nucleus, and which occur in syllable-initial and syllable-final positions.

Pike & Pike (**35**) established a model for later studies with their careful description of the syllable in Mazateco. They describe the three classes of elements—vowels, consonants, tones—that enter into a syllable of Mazateco, the number of each, and the possible sequences in which they may occur (which, from a different point of view, also states the constraints—what elements may not co-occur).

Fudge, in selection **36**, distinguishes between the phonetic syllable and the phonemic (or phonological) syllable. He shows for English the fact that sequences have a structure which is largely but not entirely based on relative sonority.

Basbøll (**37**) introduces a Sonority Syllable Model as a norm or pattern, with different phones classified according to the positions they may hold in a syllable. By means of this model the phonotactic patterns of different languages may be described and the constraints or restrictions on co-occurrence may be stated.

Selection **38**, by Blevins, is a thorough review of 20th-century literature treating the syllable. She establishes a typology of syllables and a typology of

languages according to the kind of syllable structure they have. She examines problems of a theoretical nature.

Auer (**39**) argues that the syllable is not a universal prosodic unit of importance. Rather, he says, there are syllable-languages and word-languages. German and English, for instance, are said to be word-languages, in which syllable boundaries are not always clear-cut.

In considering the non-segmental elements of syllables, we see that syllables may differ in the following ways, depending on the language in question:

tone (pitch level or pitch contour)
strength (strong vs. weak)
length (long vs. short)
weight (heavy vs. light)

Hyman (**40**) proposes that syllables can be characterized as differing in weight, heavy vs. light. He introduces the idea of extrasyllabic elements, usually consonants, in the phonological shape of a word, which do not necessarily correlate with anything in the phonetic form but which have an effect on what is in the phonetic form.

In moraic theory the unit of time is a mora. Generally, all vowels have a mora; long vowels and diphthongs have two moras, and a consonant in coda position has a mora in some languages. Feet are grouped into prosodic words, each of which has one syllable with primary stress. For Japanese (and other languages) the mora is an essential phonological unit, as Kubozono shows (**41**). His demonstration is based on data which consists of errors made by speakers of the language.

The last quarter-century has seen a rich development of multi-level analyses in phonology to account, first, for prosodic phenomena (tone, stress, length) and, then, for harmony relationships among consonants and vowels (also considered prosodies in the Firthian theory sketched by Hill, **6**). These analyses have various names, suggesting greater or lesser differences in representation: metrical phonology, skeletal analysis, CV-analysis, autosegmental phonology. Rubach (**42**) reviews five different theories about phonological representation, two skeletal and three moraic, to see which is most appropriate for two phonological rules of Slovak, Compensatory vocalization and Depalatalization. The moraic theories don't do well because Slovak consonants do not carry moras. In the X-skeletal theory all consonants are associated with X-slots so that a deletion rule acts in the melodic tier alone, leaving an X-slot, which can then be linked to a floating segment. CV-theory is at a disadvantage here because Cs and Vs are different kinds of elements.

Katamba (**43**) studies the role of units of prosodic hierarchy (mora, syllable, foot, prosodic word) in specifying phonological domains for morphological operations. He carefully distinguishes between morphological

rules that have nothing to do with phonology, and phonological rules that belong to syntactic domains. Some phonological rules can be stated in terms of features (in a multilevel approach). So what he is talking about is something akin to Prosodic or Template Morphology. This is differentiated from Lexical Phonology.

Selection **44**, by Durand, is a study of French liaison in relation to other rules of French phonology. It makes use of the notion of floating, or extrametrical, segments introduced by Clements and Keyser, that is, abstract elements which have concrete effects. The study uses a Dependency Phonology framework in which insights of metrical and autosegmental phonology can be integrated.

Linguists have tried for a long time to establish what the prosodic system of Proto-Indo-European must have been. Halle (**45**) takes up the matter, making use of recent developments in metrical structure. His conclusions support the theory of metrical structure over alternative theories of stress, but he argues for a rule-based account rather than one based on constraints.

Goldsmith (**46**) gave the name Autosegmental Phonology to his theory regarding the geometry of phonetic representations, which is intended to show how the various components of the articulatory apparatus are coordinated. Autosegmental phonology recognizes separate tiers for segments and tones, the latter called autosegments, i.e. segments in their own right. The two levels are interrelated—connected by association lines—but each is independent in its own right.

McCarthy's contribution to multi-level analysis is the template (**47**). A template is a pattern consisting of a certain number of consonants (Cs) and vowels (Vs) in a certain order. A form is a sequence of specific consonants and vowels which is mapped onto a template, yielding an output. The output has a long consonant (or a long vowel) where the template has two Cs (or two Vs) and the form has a single consonant (or a single vowel) to match it.

Haraguchi (**48**) reanalyzes the accent systems of different Japanese dialects in the framework of Autosegmental Phonology.

In **49** Van der Hulst's objective is to decide whether vowel harmony can be described better segmentally or autosegmentally. The autosegmental approach is favoured because it offers a principled solution to the controversy over abstractness.

Dell & Elmedlaoui (**50**) continue the use of McCarthy's template. When a form is mapped onto a template, the mapping preserves as much of the phonological structure of the form as possible but the authors demonstrate that transfer of melodic units—consonants—takes precedence over quantitative transfer—if the template calls for three consonants and the form has three consonants, one of which is geminate, the geminate consonant is transferred as a single consonant.

A typical change in language is the loss of a consonant with concomitant

(or compensatory) lengthening of a preceding vowel. A multilevel representation handles this well: the vowel on the segmental tier is now associated with two places on the upper tier. Mascaró (**51**) shows two kinds of compensation in a dialect of Catalan: one in which a consonant is deleted and a glide is inserted after a preceding noncontiguous vowel, another in which a glide is inserted before two consonants. These facts are better understood in relation to other phonological processes when they are formulated within a tier-organized theory of phonological representations.

Goldsmith's account of harmonic processes (**52**) is especially valuable because of its preliminary classification of phonological theories—theories of representations, of levels, and of rules, respectively—and its distinction between rules that apply at the same level, which must be harmonic, and rules that apply across levels, which may or may not be harmonic.

Disclaimer

References within each chapter are as they appeared in the original complete work.

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IMMEDIATE CONSTITUENTS OF MAZATECO SYLLABLES

Kenneth L. Pike and Eunice V. Pike

Source: *International Journal of American Linguistics* (1947): 13.78–91

1

It is well known that sentences have an internal structure which can be analyzed in terms of successive layers of immediate constituents.[1] Thus, the sentence *Poor John ran away* divides first into *Poor John* and *ran away*, then *Poor John* divides into *Poor* and *John*, while *ran away* divides into *ran* and *away*, and so on.

It is convenient to describe syllables of Mazateco[2] in a similar fashion. The structure of these syllables does not consist of a series of sounds equally related, like beads on a string, but is rather like an overlapping series of layers of bricks. The different layers in the syllable tend to have different phonetic and grammatical characteristics.

2

The majority of Mazateco syllables consist of a single chest pulse, as in hma[2] (in which the number following a syllable gives its tone; 1 is high level,

4 is low level and so on) *black*. Some syllables, however, begin with a nasal consonant followed by two consonants—the second a glottal stop—before the vowel. In these syllables a weak chest pulse for the nasal precedes a strong chest pulse for the vowel; the weak and strong chest pulses fuse into a single functioning syllable. For this type of syllable note the words nt^{1} *good* or *industrious* nčą^{1} *cold*, and nk^{3} *tall*.

The releasing^{3}—i.e. trigger—segments in the syllable comprise its marginal elements. One, two, or three consonants may enter a syllable margin, as in the following illustrations: to^{3} *fruit*; č$^{1-3}$ *a load*; hnko^{3} *one*.

The main part of syllable pulse itself—the nucleus of the syllable—is carried by the vowels. One, two, or three vowels may enter a syllable nucleus, as follows: sa$^{1-4}$ *moon*; čao$^{3\ 4}$ *dust*; koai^{4} *he will go*. Two vowels juxtaposed, as in the second of the preceding illustrations, do not make two syllables; the two vowels are pronounced together very rapidly, so that the timing seems to be about the same as that for a single vowel. The nucleus of the syllable takes about the same length of time—within the limits of perception—regardless of the number of vowels it contains, whether one or two or three.

The syllable must be divided into margin and nucleus for other reasons than their relation to the chest pulse, however:

Mazateco is tonal, with significant lexical or grammatical pitch on each of its syllables. Many words differ in meaning with concomitant differences of pitch, but such pitch contrasts are limited exclusively to the segments here called the vowels, and the vowels are limited to the nuclei. Now of the margins many of the consonants—especially the nasals—have noticeable pitch characteristics; there is a sharp functional difference, however, between the pitch on the consonants and the pitch on the vowels: The pitches on the items called consonants never form contrasts in such a way as to carry different meanings. The contrastive tone in the language is a characteristic of the nucleus of the syllable; this constitutes one of the major reasons for separating the margin from the nucleus of the syllable on the first division of the syllable into its immediate constituents.

One other minor reason may be given for the breaking of constituents between the margin and nucleus: a nucleus may contain a nasalized vowel. Now if such a vowel occurs in the nucleus, every other vowel in that nucleus is also nasalized; the nasalization covers the entire nucleus. However, the nasalization does not pass over to the margin, even when the segment immediately preceding the nucleus is very similar to a vowel in its phonetic characteristics. A rapid vowel i at the beginning of a nucleus is quite similar to the consonant y just preceding a nucleus. Nevertheless, the vowel i would be nasalized, but the y would not be nasalized, by a preceding nasalized vowel, as in the following illustration: si^{1}tį^{2}ya^{3} *he shakes*, or *stirs (something)*.

3

Turning now specifically to the margins, one finds the following alphabetical list of single consonants which may precede the nucleus in a syllable: b, c, č, ç, d, g, h, k, l, m, n, ñ, p, r, r̄, s, š, t, v, y, ʔ.

The unaspirated stops t and k become voiced after nasals, unless followed by h: ti$^{3-4}$ *boy*, ki^{3}šo$^{1-3}$ *landslide*, na^{3}nta$^{1-3}$ *water*, nka^{4}hao^{4} *a water hole*. An extremely small number of loans containing t from Spanish do not follow this rule, and words containing them are marked with an asterisk to show that they are not completely assimilated; in them, stops remain voiceless: *sie^{2}nto^{4} *hundred*.

The voiceless unaspirated stop p occurs only in loan words, as does also the voiced stop b and the voiced fricatives d and g: bo^{1}r̄o$^{1-3}$ *burro*, mba$^{3-4}$ *godfather* (Spanish compadre), šo^{3}mbe$^{3-4}$ *hat* (Spanish sombrero), se^{2}da^{4} *silk* (Spanish seda), *ga^{2}nčo^{4} *crochet hook* (Spanish gancho).

The glottal stop ʔ at times is actualized as a complete stop, and at other times optionally as a laryngealization (or "glottalization") of the following vowel. When ʔ is the second member of a consonant cluster, a vowel which follows it phonemically may phonetically have a slight prearticulation before the ʔ, but such a sequence with light pre-articulation contrasts phonemically with a sequence of consonant, full vowel, glottal stop, and full vowel: nʔąį$^{4-3}$ *father*, na^{4}ʔi^{4}-vi^{4} *a mother (who is) here*; čʔo^{4} *bud*, čo^{4}ʔo^{1} *hiccough*; note also nʔo^{1}ya$^{1-3}$ *class of potato*, no^{2}ʔya^{2} *we (inclusive) hear*; sʔoia^{1} *we (incl.) grind*; šo^{1}ʔya$^{1-3}$ *rose*.

The affricates act like the stops in becoming voiced following nasals unless the combination of nasal plus affricate is in turn followed by h. Three affricates occur: alveolar c [ts], alveo-palatal č, and a retroflexed alveo-palatal ç: coa^{4} *he will hold*, čoa^{4} *sign*, çoa^{4} *plate*; nca^{4} *my hand*, ya^{1}nčhį$^{1-3}$ *women*, ya^{1}nçhį^{4} *meat hook, clothes tree*, nça^{4} *horn*, nčąǫ^{3} *tomorrow*, ncha^{3} *his hand*.

These phonetically complex units must be considered single phonemes because they act like simple consonant phonemes in their entrance into consonant clusters. Occasional unassimilated loan words contain č unvoiced after nasals and are marked with an asterisk: *ga^{2}nčo^{4} *crochet hook* (Spanish gancho).

Of nasals, there are m, n, and ñ; the alveolar n becomes velar before velar stops: ha^{4}ma^{4} *a root*, ni^{3}sa$^{3-4}$ *water jug*, ño^{3} *four*, to^{3}nka$^{3-4}$ *small gourd*.

The sibilant s has no marked variants; alveo-palatal š has considerable retroflexion before vowels, but less before consonants: sa$^{1-3}$ *moon*, ša$^{1-3}$ *work*, ška$^{1-3}$ *trousers*.

The phoneme h takes many forms: before vowels or y, it assumes their shape; before nasals, it becomes a voiceless nasal fricative: ha^{4} *hawk*, li^{4}hi^{4} *grass*, hnti^{1} *dirty*, hma^{2} *black*.

The phoneme v is a bilabial fricative with flat (i.e. not markedly rounded) lips; before h it becomes voiceless: va^{3}-na^{3} *I am sad*, vha^{3}ti^{2}-na^{3} *I am thirsty*.

The alveo-palatal voiced glide y has no marked variants. It differs from i in that it does not carry contrastive tone, is not nasalized by contiguous nasalized vowels, and may begin the syllable. The y always goes with the chest pulse of the nucleus which it precedes, whereas the i often enters a syllable pulse with a vowel which it follows; the break between syllables is different in the following words, occurring before y in the first illustration, but after i in the second: sʔa^{4}-yʔa^{3}na^{3} *he is going to carry for me*, sʔai^{4} ʔa^{3}na^{3} *I will not be busy in the afternoon*. The y is not nasalized in the following word: si^{1}kį^{2}ya^{3} *he lends*.

Of the three remaining consonant phonemes, the voiced lateral l is the most frequent; r (a light, voiced flap) is very rare (in only three morphemes of native origin in the data at hand); r̃ (a trill) occurs only in Spanish loans: la^{4}hao^{4} *stone*, to^{1}ro^{1}hčo$^{1\text{-}4}$ *lizard*, ko^{2}r̃e^{4} *godmother* (Spanish comadre).

The consonants which have been listed are found in various combinations. These combinations present a definite structure. In the structure of the clusters certain of the consonants may be considered the principal ones, and others subordinate.

In the great majority of clusters of two consonants (43 out of the 47 recorded), one of the two must be h, n, or ʔ. In the remaining clusters, s or š must be present The h, n, ʔ, s, or š may well be considered a subordinate element in the cluster, whereas the other consonant—chosen from a much larger list—may be considered the principal member, (1) because the articulation of the subordinate one tends to be secondary,[4] tertiary, or subprimary in relation to the primary articulations of the other members of the clusters, and (2) because of the drastic limitation in the number of clusters which the restricted number of subordinate elements imposes.

The subordinate member of the two-consonant cluster may come first or second. Note the following specific clusters:

With subordinate h as first member: ht, hk; hc, hč, hǫ̌; hv, hy; hm, hn (varying to nhn in the word hne^{4} *tepexilote*—a certain palm nut), hñ; hti^{4} *fish*, hka$^{3\text{-}4}$ *stubble*, hce$^{1\text{-}3}$ *a sore*, hči^{4} *small*, ha^{4}hǫ̌o^{3} *in the opening of*; hva$^{4\text{-}3}$ *watery*, hyo^{3}-na^{3} *I want*; hma^{1} *black*, hno^{4} *corn*, hña$^{1\text{-}3}$ *woods*.

With subordinate n as first member: nt, nk; nc, nč, nǫ̌; nta$^{4\text{-}3}$ *good*, nka^{4}hao^{4} *water hole*; nca^{4} *my hand*, nči^{2}ʔę^{3} *bent*, nǫ̌a^{4}ti$^{1\text{-}3}$ *comb*.

With subordinate ʔ as first member: ʔv, ʔy; ʔm, ʔn, ʔñ; ʔva^{4} *hook*, ʔya^{4} *rainbow*; šo^{1}ʔma$^{1\text{-}3}$ *earthen jar*, na^{4}ʔni$^{1\text{-}3}$ *brier*, ni^{3}ʔña$^{3\text{-}4}$ *writing pen*.

With subordinate h as second member: th, kh; ch, čh, ǫ̌h; vh; mh, nh; sh, šh; tha^{4} *light in weight*, khą^{3} *bad smelling*; che$^{4\text{-}3}$ *clean*, čha^{4} *brother-in-law* (brother of husband), ǫ̌hoa^{4} *skin*; vhi^{2} *he goes*; vʔa^{3}mhę$^{4\text{-}3}$ *I walk*, nhę^{3}-na^{3} *it is gained by me*; sha^{4} *bitter*, šhao^{3} *dew*.

Clusters with a stop or affricate as the first member and h as the second member cannot be considered as single complex aspirated consonant

phonemes, (1) because of the pressure of the pattern from parallel clusters with the h as the first member (th, ht; kh, hk; ch, hc; čh, hč; c̣h, hc̣); (2) because of the presence of clusters with h as the second member but nasal or sibilant as the first member (mh, nh, sh, šh); and (3) because of the parallel types with ʔ as the first or second member of the cluster (ʔv, ʔm, tʔ; mʔ, sʔ, lʔ, etc.).

With subordinate ʔ as second member: lʻ, kʔ; cʔ, čʔ, c̣ʔ; vʔ, yʔ; mʔ, nʔ, ñʔ; sʔ, šʔ; lʔ; tʔi^{3} *go* (imperative), kʔia^{4} *then*; ɸʔe^{2} *lazy*, čʔoa$^{1-3}$ *parrot*; c̣ʔoa$^{1-3}$-le^{4} *pieces left over*; vʔe$^{4-3}$ *I hit*, yʔa^{3} *I carry*; mʔę$^{4-3}$ *he is sick*, nʔǫ$^{1-3}$ *rope*, ñʔą^{3} *difficult*; sʔoi$^{1-3}$ *fiesta*, šʔį^{4} *man*; lʔi$^{1-3}$ *fire*.

Clusters with a stop or affricate as the first member and ʔ as the second member cannot be considered as single complex glottalized consonant phonemes, (1) because of the parallel with the clusters with ʔ as the first member (ʔv, ʔm, etc.); (2) because of the presence of the clusters with ʔ as the second member but a nasal, sibilant, lateral, or voiced fricative as the first member (mʔ, sʔ, lʔ, vʔ, etc.); (3) because of the parallels with h; (4) because there is usually a very slight open transition between the stop and the ʔ in the same syllable, so that the stops are not phonetically glottalized—i.e. they are not made with egressive pharynx air; and (5) this phonetic gap between the stop and the ʔ in clusters is often further accentuated in that ʔ may be actualized as the laryngealization of the following vowel rather than as a separate complete stop, while often there is a slight pre-articulation of the vowel before the ʔ (but after the oral stop in the sequence of oral plus glottal stop).

With subordinate s as first member: sk; ska^{1} *crazy*.

With subordinate š as first member: št, šk; šn (rare—only in the illustration given); šti$^{3-4}$ *children*, ška$^{1-3}$ *trousers*; nka^{3}šni$^{3-4}$ *Chiquihuitlan*.

In certain of the clusters just listed, it may be observed that both members of the cluster may occur elsewhere as the subordinate member. This affects the clusters hn, ʔn, nh, nʔ, sh, šh, sʔ, šʔ, and šn. Apart from this list, the consonants h and ʔ never occur as the principal member of a cluster; for this reason it is convenient to consider them the subordinate members here also. Thus, they occur before the principal member in hn, ʔn, but after the principal member in nh, nʔ, sh, šh, sʔ, and šʔ. Supporting this conclusion are the following facts: s and š are rarely subordinate members, and are best considered principal ones in sh, šh, sʔ, and šʔ; there are no parallels for n subordinate but second in the cluster, so in hn, ʔn, and šn the n is best considered the principal member.

Clusters of three consonants also occur. In them, two consonants of each cluster are always found to be chosen from the list of subordinate consonants already listed.

The two subordinate consonants in a cluster of three consonants may be distributed in one of two ways: either the two subordinate consonants may precede the principal one, or one of the subordinate consonants may precede

but the other follow the principal consonant. Note the following lists of clusters:

With the subordinate consonants ʔn before the principal member of the cluster: ʔnt, ʔnk; ʔnc, ʔnč, ʔnǰ; ʔnto^{3} *rotten*, ʔnki$^{4\text{-}6}$ *he hoes*; li^{4}ʔnci$^{2\text{-}3}$ *brown hawk*, ʔnči^{4} *wet*, či^{3}ʔnǰo^{3} *blackberry*.

With the subordinate consonants hn before the principal member of the cluster: hnt, hnk; hnč, hnǰ; hnti^{1} *dirty*, hnka^{3} *wing*; vi^{3}hnči$^{4\text{-}3}$ *you* (*sing.*) *look for*, hnǰa^{3} *salty*.

With the subordinate consonant n preceding the principal member of the cluster but with ʔ following the main member: ntʔ, nkʔ; ncʔ, čʔ, ǰʔ; ntʔe^{1} *industrious*, nkʔa^{3} *tall*; ncʔe^{4} *his brother*, čʔą^{1} *cold*, ǰʔoe^{1} *he hears*.

With the subordinate consonant h preceding the principal member of the cluster but with h following the main member: nth, nkh; nch, čh, ǰh; nthao^{4} *wind*, nkhį^{2} *many*; nchao$^{1\text{-}3}$ *rust*, čha^{1} *fat*, ya^{1}ǰhį^{4} *meat hook, clothes tree*.

With the subordinate consonant n preceding the principal member of the cluster but with ʔ following the main member: hcʔ, hčʔ; hcʔę$^{1\text{-}3}$ *sprout*, ʔnti^{1}hčʔą^{4} *orphan*. These clusters are rare, and tend to vary to cʔ and čʔ.

With the subordinate consonant s or š preceding the principal member of the cluster, but with ʔ following the main member: skʔ; štʔ, škʔ; skʔao^{1} *it will break*; ha^{4}štʔa$^{4\text{-}3}$- la^{2}nka^{1} *goodbye*, škʔę^{1} *thin*.

When two consonants comprise a consonant cluster, its immediate constituents are the two consonants, respectively, with one of them the principal constituent and the other the subordinate constituent. When three consonants comprise the cluster, it is best to consider that the first consonant comprises the first constituent, and the next two consonants the second constituent, (1) since the first consonant tends to be phonetically very weak when the syllable comes at the beginning of utterances and (2) since that consonant occasionally syllabifies partially with the preceding syllable in the middle of utterances. Thus the immediate constituents of the cluster hnt are h and nt, and then the constituents of nt are n and t.

The layers of immediate constituents of the syllable ncʔoai$^{3\text{-}4}$ *our* (*excl.*) *stomachs*, in so far as has been analyzed in the preceding paragraphs, can be symbolized as follows: ([n][c/ʔ])(oai$^{3\text{-}4}$); subdivisions of the nucleus will be given in following sections.

4

Turning to the nuclei, one must conclude that the entire sequence of vowels in a single syllable constitutes the first immediate constituent of the nucleus, and that the entire sequence of (contrastive) tones on that nucleus constitutes its second immediate constituent. It will not do to attempt to correlate each vowel with one and only one tone, or each tone with one and only one vowel.[5]

The reasons for this analysis of the constituents are the following: (1) Each nucleus is of approximately the same length, as has already been pointed out, but since the nuclei may contain from one to three vowels in this length of time, the vowels do not constitute units of length coincident with the length of the nuclei of the syllables; similarly, since the nuclei may contain from one to three tones in approximately the same length of time, neither do the tones constitute units of length coincident with the length of nuclei. (2) If the nucleus has three vowels and but one tone, that one tone is spread over the three vowels; if the nucleus has one vowel but two tones, those two tones are both pronounced on the single vowel, forming a rapid glide. In summary, the number of vowels is independent of the number of tones, and the number of tones is independent of the number of vowels, while the length of the nucleus remains—within perceptual limits—nearly constant.

In the following illustrations, notice that the first syllable has a single vowel and single tone; the second, two vowels but one tone; the third, three vowels but one tone; the fourth, one vowel but two tones; the fifth, two vowels but two tones; the sixth, three vowels but two tones; the last syllable of the seventh, two vowels but three tones. All of these nuclei should be pronounced with approximately the same speed: (1) ki^{3} *he went*, (2) skai^{4} *you will fall*, (3) koai^{4} *he will go*, (4) se$^{4-3}$ *he sings*, (5) čai$^{2-3}$ *you (sing.) dance*, (6) nčoai$^{2-3}$ *you* (*sing.*) *come*, (7) va$^{4-3}$ntia^{4-2-3} *I travel.*

The first layer of immediate constituents of the nucleus of the syllable may now be added to the formula previously given, as follows: ([n]-[c/ʔ])([oai][$^{3-4}$]).

The vocalic constituent may be considered the principal one, and the tonal constituent subordinate, (1) because the articulations for the vowels are primary[6] but for tone are tertiary, and (2) because the first part of the vocalic element seems to be morphologically slightly more stable than the first part of the tonal element, though the second part of each is likely to change in the morphology.

5

There are four non-nasalized vowels: i, e, a, o, and their corresponding nasalized types: į, ę, ą, ǫ. The vowel a varies freely toward [ʌ]; e tends to be phonetically [ɛ]; i has no prominent varients; o varies freely over a considerable range from [o] to [u]. Following nasals—but not preceding them—the oral vowels tend to become slightly, though nonphonemically, nasalized. Note the following illustrations for the vowels: khi^{3} *it appears*, khį^{2} *far*; cʔe^{4} *his*, cʔę^{4} *bad*; ša$^{1-3}$ *work*, šą$^{1-3}$ *liquor*; čho^{3} *you* (*pl.*) *write*, čhǫ$^{4-2}$ *woman.*

The vowels occur in various combinations. Oral vowels may occur in sequence within a nucleus, and nasalized vowels may do likewise, as in hkoe^{3} *rough*, or tǫą^{2} *fierce*. No sequence is found of an oral vowel followed by a nasalized vowel, or of a nasalized vowel followed by an oral vowel, in the

same nucleus—nor are mixed sequences found between syllables, since every nucleus is preceded by its consonantal margin.

When the nucleus of a syllable contains but one vowel, any of the vowels may be found: ti$^{3-4}$ *boy*, te^{3} *ten*, ša$^{1-3}$ *work*, to^{3} *fruit*; ya^{1}sį^{3} *his neck*, thę^{3} *his forehead*, są^{3} *sour*, nti^{4}tǫ^{4} *immediately*.

When the nucleus of a syllable contains two vowels, any vowel may occur as the second of the two, but only a, i, or o may occur as the first; e does not appear in a vowel cluster as the first of two. When a stem vowel e has some other vowel fused to it in the morphology, the following changes occur: ei > ai, ea > e, eo > ao: vʔe^{1}te$^{4-3}$ *he chases* + -i^{3} *dependent pronoun of second person singular* > vʔe^{2}tai$^{4-3}$ *you* (*sing.*) *chase*; vʔe^{1}te$^{4-3}$ *he chases* + -a^{3} *dependent pronoun of first person singular* > vʔe$^{4-3}$te$^{4-3}$ *I chase*; vʔe^{1}te$^{4-3}$ *he chases* + -o^{3} *dependent pronoun of second person plural* > vʔe^{2}tao$^{4-3}$ *you* (*pl.*) *chase*.

For two reasons the second vowel of two may be considered the principal one: (1) Usually the second is phonetically the more prominent, since in the rapid pronunciation of the two-vowel nucleus the first tends to be reduced very sharply while the second remains the stronger and seems to carry the larger share of the tonal glide if one is present. (2) In two-vowel clusters the second position may have the more diverse types of vowels, since the vowel e may occur there but not in the first position. Morphological divisions do not help to establish the principal and subordinate positions in clusters of two vowels, since many clusters which contain a morpheme boundary between their vowels may have homophonous clusters with no such barrier and with no difference of phonological juncture. Note the following words: in the first word of each pair the vowel cluster will be part of the stem, but in the second word there will be a morpheme division between the vowels: cʔoi$^{1-3}$ *sun*, ni^{2}choi$^{2-3}$ *you* (*sing.*) *toast*, nkį$^{1-3}$ *shade*, vʔe$^{4-3}$hį$^{4-3}$ *I put in*.

The vowel e occurs in clusters only when the entire cluster is part of the stem; it never occurs in a vowel cluster as a morpheme distinct from the stem even though fused to it; all other vowel clusters can be found either as part of a stem or with morpheme division between them, as in the preceding illustrations.

Note the following specific clusters of two vowels in single-syllable nuclei:

With subordinate i as first member: ie (rare, only one sample, and tending to vary to e), ia, io; si^{1}khie^{2} *he uses up*, si$^{4-3}$kʔia$^{4-3}$ *I paint*, ni^{2}kʔio$^{4-3}$ *you* (*pl.*) *paint*.

With subordinate a as first member: ai, ao; nʔą$^{4-3}$ *father*, čhao$^{4-2}$ *an egg*.

With subordinate o as first member: oi, oe, oa; vi^{2}thoi^{4} *you* (*sing.*) *go out*, shoe^{2} *hot*, khoa^{4}soa$^{4-3}$ *shame*.

Nasalized vowels occur with the same distribution in clusters as do the oral vowels:

With subordinate į, ą or ǫ as first member; į̨ (rare, and tending to vary to ę), į̨a, į̨ǫ; ą̨i, ą̨ǫ; ǫ̨i, ǫ̨e, ǫ̨a; kʔį̨ę^{3} *dead*, ki^{3}cį̨ą$^{4-3}$ *I was born*, ki^{3}cį̨ǫ$^{4-3}$ *you* (*pl.*)