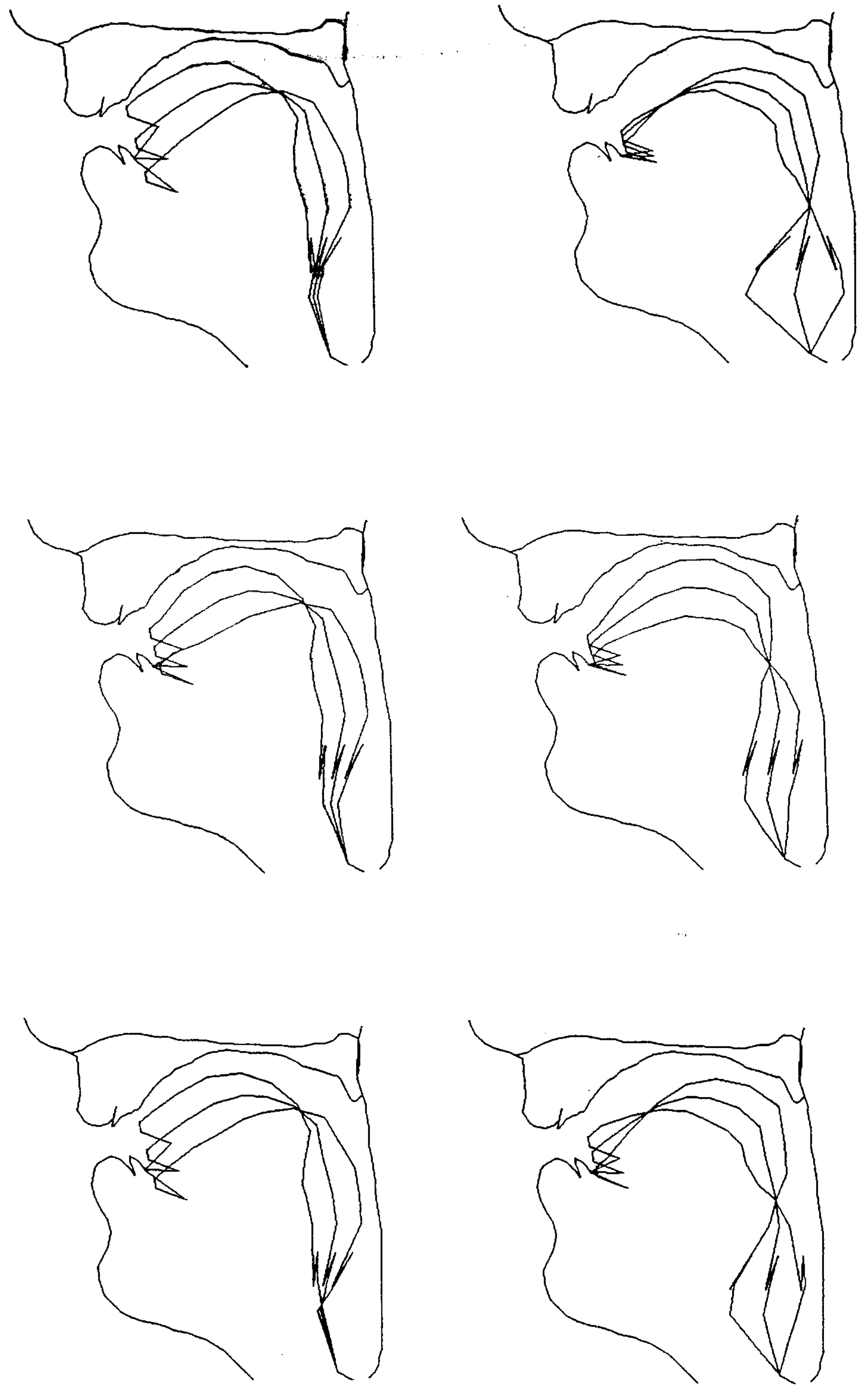

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Revising the International Phonetic Alphabet

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Abstract

The International Phonetic Alphabet (IPA) is widely used by many different groups of people. Before revising it we should consider the needs of the users. We should also realize that the symbols represent particular phonetic categories, which have to be set up in accordance with some implied theory of linguistic phonetics. Decisions concerning what needs to be symbolized have to be taken before deciding on the symbols required.

Hundreds of scholars in many different disciplines rely on phonetic symbols to convey their meaning. Some form of phonetic alphabet is essential for work in linguistics, speech pathology, computer speech processing, language teaching, anthropology, studies of ancient manuscripts, descriptions of social class, singing, criminal voice identification; the list of topics that require the use of phonetic symbols is obviously very lengthy. Some of these topics need special symbols that are suited only for them; but all of them require a common core for their basic needs. By far the most widely used common core is the International Phonetic Alphabet (IPA); this is the set of symbols that most scholars take as their starting point, and then, if necessary, augment with special symbols for their own needs.

The present set of IPA symbols had its origins nearly 100 years ago, shortly after the International Phonetic Association was founded in 1887. It was revised many times in its early years, but in the last 40 years there have been few changes. As a result the alphabet is sadly out of date. New theories of linguistic phonetics have been developed, so that we need to reconsider the principles on which the IPA rests; there are no agreed symbols for many recently reported sounds; and additional diacritics need to be established for newly described categories of sounds.

Any attempt to revise the IPA must begin by recognizing that by far the majority of those who use the IPA are not phoneticians. This point is obvious from the list of users given above. Some linguists, speech pathologists, communication engineers and language teachers may be interested in phonetics; but most regard the IPA simply as a tool. Phoneticians must therefore regard themselves, at least in part, as manufacturers providing a product. If we want our product to be accepted, we must ensure that consumers are satisfied with what we provide. This will require a certain amount of customer research, noting both where the IPA has been succesful, and where it has failed. The successes are, perhaps, more extensive than is realized. There are a number of generally accepted standard usages, even among those who do not recognize that they are often following traditional IPA usage. For example, most English speaking linguists and phoneticians use basically IPA vowel symbols, rather than the symbols commonly found in dictionaries of English; and all phoneticians use [k] rather than "c" for a voiceless velar fricative. These are simply IPA usages.

The failures of the IPA seem to be in small and disparate ways, with a variety of different causes, some of which will no doubt persist. For example, the influence of different national orthographies on the usage of particular symbols such as [j] and [y] are likely to be difficult to overcome. Europeans, many of whom need to distinguish front rounded vowels, and who are also accustomed to using the letter "j" for the first sound in words such as German *ja*, will no doubt continue to use these two symbols in the official IPA way; but Americans, who are not known for their internationalism, will probably stick to their own orthographic "y" for the first sound in *yes*.

Phoneticians have long recognized that their discipline is in part a servant to others. Revising the IPA will require us to maintain that attitude, although, of course, we must make sure that we provide for our own needs as phoneticians as well. The theory represented by the IPA should be high powered enough to take care of the complexities of phonetics, while at the same time allowing others to grasp the essence of our subject. This will involve both determining our own needs and seeking the cooperation of other organizations, such as national and international associations concerned with linguistics, speech pathology, language teaching and communication engineering.

The second major point that must be emphasized before we begin is that revision of the IPA involves revising a theory of phonetics. It is not just a matter of getting agreement on what symbols to use. This is part of the problem; but there is also the much more difficult task of getting agreement on what to describe. Symbols stand for something; they are shorthand descriptions of sets of phonetic categories. Choosing the symbols required for an international phonetic alphabet is a simple task in comparison with choosing the categories that need to be represented by these symbols. The present IPA chart is a theory of phonetics specifying how sounds should be described in terms of particular articulatory categories. For example, [θ] stands for 'voiceless dental fricative' and [ɮ] is just a short hand way of writing 'voiced dental or alveolar lateral fricative'. We now have to consider whether these articulatory terms are still sufficient for our needs. There are many current phonetic theories ranging from acoustically based theories through more traditional IPA categories to elaborate articulatory notation systems. What do we want our symbols to symbolize?

These considerations force us into thinking about a topic that phoneticians have sometimes considered to be outside their field. Why do we need categories? What is this theory of phonetics trying to do? In a sense this brings us back to the very first point of this paper: the IPA has many uses. Speech pathologists, for example, may want to think of sounds in terms of articulations, communication engineers in terms of acoustic categories, and linguists in terms of distinctive features. It is at this point that my own biases begin to show. I am a phonetician, but I also think of myself as a linguist. The IPA was originally devised by linguists for the purpose of describing languages in phonetic terms. It was not set up to be able to symbolize all the different sounds that humans can produce. I do not want to deny the need for a set of symbols and categories that can be extended to do this. Speech pathologists, scholars studying language acquistion, and many others have these special requirements. But it would be difficult to devise a practical alphabet that had no linguistic basis but simply aimed at symbolizing all possible combinations of movements of the vocal organs.

The set of categories represented within the present alphabet is not entirely satisfactory from a linguistic point of view. Historically the IPA was needed largely for practical purposes of language teaching, and writing down little known languages, rather than for the furtherance of general linguistic theory. As a result, the symbols reflect categories that are slightly different from those required by present day linguists. Nowadays we would like the categories symbolized by IPA segments to be those that make evident how languages work. This means that they should reflect the feature systems that divide and combine segments into natural classes that are made explicit in phonological descriptions.

While noting the necessity for a feature-based IPA system, it should not be assumed that we know which feature system would be most appropriate. The traditional IPA categories for specifying sounds in terms of state of the glottis, place of articulation, manner of articulation, and airstream mechanism are one example of a basic feature system. We need to make some additional distinctions, and to show how the traditional categories can be related to other feature systems; but a revised version of the IPA need not reflect an entirely different set of features from those that it currently uses.

The final point that we have to consider before setting up an international phonetic alphabet is the matter of how we limit the set of sounds that has to be described. This problem is addressed in the first two of the historic principles on which the IPA is based:

> 1. There should be a separate letter for each distinctive sound; that is, for each sound which, being used instead of another, in the same language, can change the meaning of a word.
> 2. When any sound is found in several languages, the same sign should be used in all. This applies also to very similar shades of sound.

The first of these principles is an early formulation of the phonemic principle. The second starts from the assumption that the same sound can be found in different languages. In other words, it suggests that we begin by assuming that languages do not differ in innumerable ways. This is equivalent to what we would now regard as a tenet of Universal Grammar, a statement that there is a universal set of phonetic categories that can be defined independently of any particular language.

These two historic principles imply that we should start setting up a set of categories by making sure that we can symbolize all the contrasts that can occur within any single language; and that we should also compare different languages to determine what we consider to be distinct sounds. This is essentially the approach adopted by Ladefoged and Maddieson (1986) in their attempt to assess how many different "places of articulation" must be recognized. They suggest that there are 17, providing as primary evidence the set of within-language contrasts that occur in the languages shown in the Table 1. The important point to note is that there are languages contrasting nearly all these so-called places of articulation. Ladefoged and Maddieson go on to compare different languages and suggest that the gaps in Table 1

Table 1. A matrix giving examples of contrasts among consonants. (Data from Peter Ladefoged and Ian Maddieson (1986) *(Some of) The Sounds of the World's Languages: (preliminary version).* UCLA Working Papers in Phonetics. 64, with some later additions and corrections. All the contrasts shown are based on the authors' own observations, except for those in languages named in italics, for which references are given in Ladefoged and Maddieson. Missing contrasts due to the distribution of labials are indicated by #; those due to dentals or alveolars by --; to sublaminal retroflexes by + ; and to radical articulations by &.

	(2) Labio-dental	(3) Linguo labial	(4) Inter dental	(5) Apical dental	(6) Laminal dental	(7) Apical alveolar	(8) Laminal alveolar	(9) Apical retroflex	(10) Laminal postalveolar	(11) Sublaminal retroflex	(12) Palatal	(13) Velar	(14) Uvular	(15) Pharyngeal	(16) Epiglottal	(17) Glottal
(1) Bilabial	ɸ f Ewe	m ɱ V'enen Taut	m n̼ Malayalam	p t̪ Temne	p t̪ Isoko	p t English	p t̻ Temne	b ɖ Ewe	p ṯ Nunggubuyu	p ʈ Tamil	p c Yanuwa	p k English	p q Quechua	&&&&&	p ʡ *Chechen*	p ʔ *Ko*
(2) Labiodental		######	f θ Ca.English	f θ RP English	f s̪ Polish	v z English	------	f ʂ Polish	v ʒ English	v ɻ Malayalam	f ç Bura	f x Ewe	f χ Arabic	f ħ *Agul*	f ʜ Arabic	f ʔ Arabic
(3) Linguolabial			######	p̼ d̼ Vao	#####	p̼ t Tangoa	######	p̼ ʈ *Mafea*	-#-#-#	+#+#+#	######	p̼ k Tangoa	######	&#&#&#	&#&#&#	######
(4) Interdental				------	------	n̼ n Malayalam	------	------	n̼ n̠ Malayalam	n̼ ɳ Malayalam	n̼ ɲ Malayalam	n̼ ŋ Malayalam	------	-&-&-&	-&-&-&	------
(5) Apical dental					ǀ ǂ !Xóõ	ǀ ! !Xóõ	t̪ t̻ Temne	------	------	------	t̪ c *Breton*	t̪ k Temne	-----	-&-&-&	-&-&-&	------
(6) Laminal dental (Dentialveolar)						t̪ t Isoko	------	t̪ ʈ Ewe	t̪ ṯ Nunggubuyu	t̪ ʈ Malayalam	t̪ c Malayalam	t̪ k Tamil	t̪ q Urdu	s̪ ħ *Agul*	s̪ ʜ Arabic	t̪ ʔ Arabic
(7) Apical alveolar							------	t ʈ Nunggubuyu	t ṯ Malayalam	t ʈ Malayalam	t c Ngwo	t k English	t q Quechua	s ħ *Dargi*	t ʡ *Chechen*	t ʔ *Ko*
(8) Laminal alveolar								------	------	------	------	t̻ k Temne	------	-&-&-&	-&-&-&	------
(9) Apical (postalveolar) retroflex									ʈ ṯ Nunggubuyu	ʈ ʈ *Toda*	ʈ c Logba	ʈ g Ewe	ʈ q Urdu	&&&&&	&&&&&	ʈ ʔ *Maba*
(10) Laminal postalveolar (Palatoalveolar)										n̠ ɳ *Malayalam*	n̠ ɳ *Malayalam*	ṯ k Yanuwa	ṯ q Quechua	ʃ ħ *Dargi*	ṯʃ ʡ *Chechen*	tʃ ʔ *Dargi*
(11) Sublaminal (palatal) retroflex											ʈ c Malayalam	ɳ ŋ Malayalam	+++++	&&&&&	+&+&+&	ʈ ʔ *Kuvi*
(12) Palatal												c k *Jaqaru*	c q *Jaqaru*	ç ħ *Agul*	&&&&&	c ʔ *Ko*
(13) Velar													k q Quechua	x ħ *Agul*	k ʡ *Chechen*	k ʔ Hausa
(14) Uvular														&&&&&	χ ʜ Arabic	χ ʔ Arabic
(15) Pharyngeal															ħ ʜ *Agul*	ħ ʔ *Agul*
(16) Epiglottal																ʡ ʔ *Agul*

- the cases in which they could not find contrasts between certain places of articulation within a single language - are simply accidental. For instance they point out that IndoAryan languages such as Hindi typically have a retroflex stop in which the tip of the tongue touches just behind the alveolar ridge; but Dravidian languages such as Malayalam have an articulation in which the tongue is curled backwards so that the contact is made by the underside of the tip against the hard palate (Ladefoged and Bhaskararao, 1983). This difference is very easy to hear. It may not be used in any language to distinguish one word from another; but there is no theoretical reason why it should not occur as a phonemic difference.

There are other more subtle cases in which it may not be just chance that no language uses a particular distinction. For example, it seems that there is a difference between speakers of the form of British English known as RP, and the form of American English spoken in California. Approximately 90% of RP speakers have a dental fricative in which the tip of the tongue is close to the back of the upper teeth in words such as *thick* and *thin*; but 90% of Californians actually protrude the tongue between the upper and lower teeth during the pronunciation of these words, making an interdental fricative. Should we therefore say that the IPA should be able to symbolize the difference between dental and interdental sounds? Or are we really talking about a subdivision of a single category that should be describable in words (as I have just done), but not be regarded as two distinct items by the IPA? Essentially what we have to decide in all these cases is whether the lack of a language contrasting a particular pair of sounds is just an accidental gap, or whether it is impossible for a language to use such a distinction. This was the general approach followed by Ladefoged and Maddieson in compiling Table 1.

The 17 items used for row and column headings in Table 1 are much too detailed for an everyday IPA chart. For example, most phoneticians do not need to be able symbolize linguo-labials; but the IPA must be capable of doing this because linguo-labials contrast with labials and dentals or alveolars in a small group of languages spoken in Vanuatu. One way of reducing the complexity in an IPA chart would be to group the categories, perhaps as shown in Table 2. We could then designate the difference between at least some subgroups by means of diacritics. This proposal has the added advantage that it shows some of the relations among categories (features). It also makes explicit which differences are more marked in the sense of being more unlikely to be found distinguishing words in a language. In addition, Table 2 exemplifies a convenient way of showing the relationship between

Table 2. A hierarchical arrangement of places of articulation.

Articulatory region	Lingual attribute	Specific place	General articulatory term
Labial		1	Bilabial
		2	Labiodental
		3	Linguolabial
Coronal	Laminal (distributed)	1	Interdental
		2	Laminal dental
		3	Laminal alveolar
		4	Laminal postalveolar
		5	Palatal
	Apical (Non-distributed)	1	Apical dental
		2	Apical alveolar
	Retroflex	1	Retroflex postalveolar
		2	Subapical palatal
Dorsal		1	Velar
		2	Uvular
Radical		1	Pharyngeal
		2	Epiglottal
Laryngeal		1	Glottal

detailed phonetic specifications and the terms used in other feature systems.

I am aware that in setting up categories in this way I have not really addressed the problem of how to know when two sounds in different langauges should be considered "very similar shades of sound" (Principle 2). I do not know of any way in which such decisions can be made on theoretical grounds. What seems an impossibly small or difficult distinction for a foreigner to hear, is completely obvious to native speakers who use it regularly in their language. It seems that we can never know whether we have the complete set of features or categories that we wish to symbolize. We are not like chemists trying to fill in elements in a pre-existing table of theoretically possible atomic numbers. We are more like biologists trying to determine how many species there are in the world, without fully having understood what intersections of categories are possible. It is not so long ago that biologists thought that there were no mammals (hairy, breast feeding animals) that laid eggs. But that did not stop the duck-billed platypus from existing.

I have purposefully left to near the end of this paper the matter of individual symbols and diacritics. The notion that seems to leap to most people's minds when one talks about revising the IPA is the necessity for changing certain letter shapes, or adding particular symbols. As I have tried to emphasize above, what seems much more important to me is the theory of phonetic description that is involved. Nevertheless, it is true that there is a need for agreement on additional symbols to represent sounds not previously considered, (e.g. bilabial trills for which, following the notion that capital letters represent trilled sounds, the obvious symbol is [ʙ]) and for standardization of the shapes of some symbols that appear in the current alphabet in more than one form (e.g. [ɡ , g]). But again, from my own particular point of view in which the phonetic theory that we are trying to represent is of paramount importance, the most interesting topic in connection with new symbols is the matter of diacritics. One of the historic principles of the IPA is that:

6. Diacritics should be avoided, being trying for the eyes and troublesome to read.

This principle was originally introduced as a counter-measure to the prevalent nineteenth century habit of piling several diacritics on to a single symbol. But it is nowadays quite normal practice to use a single diacritic above a symbol, and another one below. We should encourage this practice, in that, as noted above, it shows the similarity among symbols that refer to the class of sounds that is defined by the diacritic. All we have to do, as in other cases, is to decide what categories or features we want to symbolize by means of diacritics.

Diacritics also have the advantage of being easy to handle on a typewriter or in a computer word processing system. With a single diacritic stored in a dead key we can extend the set of different (complex) symbols by a very large number. The IPA was developed before the widespread use of typewriters, and suffered because the

International Phonetic Association never recognized the advisability of offering an alphabet that could be easily managed on a typewriter. We hope that the Association will not make the same kind of mistake by overlooking the need for computer compatibility.

There is, however, a potential problem in the widespread use of computers. This paper is being produced on a Macintosh computer, using, for the phonetic symbols, a font that is available from the author. The existence in the public domain of fonts such as this should offer considerable help in the standardization of symbols. But it may also have the opposite effect, as it is now very easy for people to develop their own sets of symbols. Let us hope that we do not have a proliferation of many personally defined symbols.

There are no doubt several other topics that will have to be considered before we have a truly revised IPA. But whatever is done, it seems to me that the most important thing is to have thorough discussion that takes notice of the two points emphasized at the beginning of this paper: all *users* of the IPA must be encouraged to have their say; and we must realize that we are not revising just a set of symbols, but a whole theory of phonetic description. Only in this way can we make lasting improvements in one of the most important and widely used tools in our field.

Ladefoged, Peter and Ian Maddieson (1986). *(Some of) The Sounds of the World's Languages: (preliminary version). UCLA Working Papers in Phonetics* 64.

Ladefoged, Peter and Peri Bhaskararao (1983). "Non-quantal aspects of consonant production." *Journal of Phonetics* 11. 291-302.

Updating the Theory

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The International Phonetic Association is not usually considered as a group of theoreticians. If the members have a self-image, they probably consider themselves as practical people, who apply their particular skills to real problems such as pronunciation teaching, speech pathology, the description of spoken languages, and speech recognition. They probably do not think of themselves as part of one of the very few organized groups in the world that promulgates an official theory about its subject matter. But that is precisely what the International Phonetic Association does. It sanctions an official set of symbols for representing the sounds of spoken language. By doing so it prescribes a certain way of describing sounds; the symbols are, after all, just symbols. They are shorthand ways of representing certain information, namely, the choices permitted by the phonetic theory.

The general framework of this theory has remained basically unchallenged for more than a century. It has grown with our deepening knowledge of phonetic events; but it is still much the same articulatory schema that our phonetic forefathers developed. We have a set of dimensions that form the parameters of our description, and a number of options that form the set of preferred values of those parameters. Originally there were just three phonetic dimensions for consonants: the state of the glottis, the place of articulation, and the manner of articulation. Vowels have always been somewhat more controversial, with the three basic dimensions, height, backness and rounding, being sometimes supplemented by extra possiblities such as primary vs. wide, tense vs. lax, and others. More recently we have recognized the airstream mechanism as an independent parameter. We have also recognized several additional articulatory possibilities within each of the traditional consonantal parameters; for example, the early IPA charts did not include columns for retroflex or palatoalveolar sounds, or rows for lateral fricatives or flaps, and the diacritics did not include additional states of the glottis beyond voiced vs. voiceless.

The way the official IPA chart is changed is by the Council of the IPA voting to accept new possibilities. It is this procedure that makes our field unusual. Zoologists do not vote on whether to recognize a new species. Physicists have no formal procedure for recognizing the existence of a new particle. The IPA has always voted on symbols; usually, however, without acknowledging (or perhaps even noting) that by doing so they are giving official status to a particular theory of phonetics. We do not spend a great deal of time debating, for example, the nature of the set of possibilities that should be distinguished among states of the glottis, arguing over whether creaky voice and laryngealized voice are distinct items. We just vote on the appropriateness of the symbols that might be required.

The phonetic events that the IPA symbolizes are only a subset of the data communicated by speech. People talking convey information about their attitudes, their state of health, their individuality, and many other factors that it would be difficult to symbolize. The principal purpose of the IPA is to enable people to write down spoken *languages*, and not all the emotional and personal characteristics that are also present in utterances. It is possible to use the symbols to convey some of the non-linguistic nuances that occur in speech, such as vowel lengthening or idiosyncratic nasalization. But the system was not devised with the intent that the symbols should be able to represent all the different kinds of information that could possibly be conveyed by speech. Babies will always be able to make noises that their parents can understand perfectly well, but the IPA as such will not be able to represent them.

Although the IPA is essentially a system for representing facts about languages (and dialects), even here it must inevitably fall short. The subtle variations in quality that characterize, for example, the vowels of Danish as different from those of Norwegian (Disner 1980) are better expressed in terms of vowel charts rather than symbols. But where should we draw the line in deciding what to symbolize? Do we need, for example, a way of symbolizing the difference between dental and interdental sounds? The *Principles* on which the IPA is based require that there should be a separate symbol for each sound that produces a change in meaning within a language. We should, in traditional terms, be able to distinguish all the phonemic difference that are known to occur. But this is really rather a poor basis for deciding what constitutes a distinct phonetic event. From a scientific point of view it would be better if we tried to symbolize all the differences in sound that *could* possibly distinguish meanings, rather than those we have happened to have been able to observe in languages. But so far there is no scientific basis for making this determination, and we have to have a theory that is, at least in part, only observationally adequate.

This issue underlies a longstanding concern with IPA charts with respect to the status of the empty cells. It has long been realized that they sometimes denote physiologically impossible sounds such as pharyngeal nasals and laterals, and sometimes they are just gaps in the inventory of sounds known to occur in the languages of the world. But what is often not made clear is that we sometimes cannot decide which of these two possibilities is the case. For example, are uvular laterals possible? They are just as plausible as velar laterals which are still not recognized on the IPA chart, but are known to occur in many Austronesian languages (Ladefoged, Cochran and Disner, 1977). The nub of this problem is the difficulty noted above: we do not have a phonetic theory that enbles us to determine which phonetic events are capable of causing phonemic differences within a language. We can certainly blank out some of the cells on a chart, thus indicating that these combinations of categories are physiologically impossible; but in many other cases it is appropriate for the cell to be left blank as an indication that we do not know whether there is, or could have been, a significant sound of this kind. Who knows what the Hittites did with their tongues?

It is course possible for phoneticians to hold different theories of phonetics, but to use the same symbols for the same sounds. One person may regard [h] as a voiceless vowel, and another as a glottal fricative, but both can use the symbol [h] to refer to the same sound. Surely, it can be argued, as long as we can have a set of symbols that everybody uses in the same way, that is all the standardization that the International Phonetic Association can expect to be able to achieve?

This view neglects the fact that it is virtually impossible to present the symbols without giving them names or locations on a chart. It is conceivable that the International Phonetic Association could agree to cease its current practice of presenting the IPA in one or more charts, and simply present a list of symbols defined by reference to sounds in different languages. But this list would not be very useful, either to beginning students or to expert phoneticians, all of whom want to know how sounds are grouped together. Although we may be reluctant to accept it, it seems that the International Phonetic Association must remain guardians of an official theory of phonetics in which symbols are representative of certain categories.

This could still leave individual phoneticians with a certain amount of flexibility. The categories may not mean the same things to everybody who uses the symbols. What exactly is meant by palatoalveolar and alveolopalatal? The categories can also be regrouped and reinterpreted. Charts such as those shown in Table 1 are useful in explaining or designating relations; and they need not be regarded as part of the official theory as approved by the International Phonetic Association. But when all this has been said the IPA will still have to be presented in some way that groups the symbols and defines the diacritics in phonetic terms. These terms are the formal elements of the International Phonetic Association's theory of phonetics.

Table 1. A hierarchical arrangement of the traditional places of articulation

Labial		Coronal			Dorsal			Radical	Glottal
bilabial	labiodental	dental	alveolar	postalveolar	palatal	velar	uvular	pharyngeal	glottal

Some of the present elements seem clearly open to challenge. For example, it is surely time to recognize that there are two types of fricatives, sibilant and nonsibilant. In addition we should recognize the distinction between apical and laminal sounds. If we do this we might also revise the meaning of the term retroflex, so that it is made clear that it describes a particular tongue gesture. Retroflex does not usually refer to just a place on the roof of the mouth; like apical and laminal, it is a characterization of how the tongue is used. It generally implies a raising and slight curling of the tip of the tongue. Extreme retroflex sounds of the kind that occur in Dravidian languages, and which have sometimes been called cacuminal, are in fact equivalent to sublaminal articulations, and could equally well be called retroflex (in this new sense) postalveolar, or even palatal, sounds. Furthermore, just as there is a continuum of places on the roof of the mouth, with certain of those places being more favored, and given theoretical status by terms such as palatal, velar, and uvular, so equally there is a continuum of places on the tongue. Retroflex, apical and laminal are simply named types within this continuum.

All this argues in favor of recognizing an additional dimension, tongue shape, which would result in the present dimension, place of articulation, being redefined. It would be possible to regard retroflex and palatoalveolar stops as simply postalveolar, the difference between them being specified in terms of the shape of the tongue. The difference among fricatives of this kind is further complicated by the fact that some are sibilants and some are non-sibilants. Bearing this in mind, we might even be able to incorporate the domed tongue shape that occurs in alveolopalatals as being included within this dimension, as shown in Table 2. When we do this, some ambiguities in the use of the traditional terms become apparent. A theory of phonetics should be able to ensure that these ambiguities do not occur. We can do this by using the terms for the tongue shapes and the articulatory regions, eliminating altogether the terms palatoalveolar, alveolopalatal, and retroflex when the latter is considered to be a "place of articulation."

Table 2. The arrangement of some traditional terms for "places of articulation" in a two dimensional array specifying tongue shape and region of articulation.

	dental	Coronal alveolar	postalveolar
Domed			*Alveolopalatal*
Laminal	*Laminal dental*	*Laminal alveolar*	*Palatoalveolar*
Apical	*Apical dental*	*Apical alveolar*	*Retroflex* or *Palatoalveolar* if sibilant
Sublaminal		*Retroflex*	*Cacuminal (retroflex)*

Because of the way in which the IPA is given official approval, it is bound to be a little conservative. Outright approval is unlikely to be given to innovative phonetic theories that are expressed in terms of entirely new categories of phonetic dimensions that could be symbolized. But we should at least seek the best possible presentation of the current wisdom of our field. With this in mind the International Phonetic Association will be sponsoring a meeting in the summer of 1989 for the purpose of revising the IPA. Virtually all the Council have agreed to attend; and we hope that as many members of the Association as possible will also be present, so that we can come to some agreement on the best form of one of the most important tools of our trade. The International Phonetic Association should be the guardian of the best available generally accepted theory of phonetics.

References

Disner, S. (1980). Evaluation of vowel normalization procedures. *Journal of the Acoustical Society of America.* 67:1, 253-61.

Ladefoged, P., Cochran, A. and Disner, S. (1977). Laterals and trills. *Journal of the International Phonetic Association* 7:2, 46-54.

Revision of the I.P.A. : Linguo-labials as a test case

Ian Maddieson

The president of the International Phonetic Association has called for a discussion of issues concerning the revision of the International Phonetic Alphabet (Ladefoged 1987, forthcoming). This discussion needs to be concerned with the actual use to which the IPA is put by its 'consumers' as well as with the way that the design of the alphabet reflects and interacts with the notion of a phonetic theory. However, for many phoneticians perhaps the first issue to come to mind will be the need for possible additions to the alphabet to represent sounds that at present have no recognized transcription. The present paper discusses suggestions for the transcription of one class of such sounds, namely, linguo-labials. A number of proposals are evaluated in the light of their advantages and drawbacks and the implications they have for principles of transcription and phonetic theory.

First, let us briefly describe the sounds we have in mind in this discussion. Several of the Austronesian languages spoken in Vanuatu employ a linguo-labial articulation in producing stops, nasals and fricatives; that is, they have consonants produced with a constriction between the tongue blade or tip and the upper lip. These languages also have bilabial and dental or alveolar segments in contrast with the linguo-labials. I have worked first-hand with speakers of three of these languages. A preliminary report on the articulatory and acoustic nature of the linguo-labials is provided in Maddieson (1987a), and a fuller description is in preparation. Briefly we may note that their articulation is highly distinctive, with the tongue tip frequently protruding forward of the upper lip. Acoustically, linguo-labials are distinct from both bilabial and alveolar segments of the same manner, but linguo-labial stops and nasals are more similar to alveolar ones than to bilabial ones. The linguo-labial fricatives are acoustically reminiscent of the inter-dental fricatives of English.

Illustrative examples of words showing contrasts in one of the relevant languages, V'enen Taut ("Big Nambas", Fox 1979), are given in Table 1 below. In this table, the temporary transcription device adopted is to use symbols for bilabial segments with the dental diacritic underneath to represent the linguo-labials.

Table 1. Words illustrating linguo-labial, bilabial and alveolar sounds in V'enen Taut.

	linguo-labial	bilabial	alveolar
plosive (initial)	**p̪atel** "breadfruit"	**potok** "my head"	**tatel** "father"
nasal (medial)	**nom̪ok** "my tongue"	**nomok** "my spirit"	**nanl** "goat"
fricative (medial)	**naβ̪at** "stone"	**naβal** "songfest"	(voiceless only)

Linguo-labial sounds with a more marginal linguistic function are also reported in Chaga (Maddieson 1987b), and in Pirahã (Everett 1982), where a sublaminal linguo-labial occurs with socio-linguistically restricted function. Given that the existence and contrastive linguistic function of linguo-labials in natural human languages has been demonstrated, we may now consider what is the appropriate modification to make to the I.P.A. to accommodate their existence. We will discuss five alternative strategies to deal with the question.

The first option would be to choose to provide no 'official' symbolization on the grounds that linguo-labials are so rare that they can be represented on an ad hoc basis as and when required. The implication of this choice is that other rare sound types should also be handled in the same way; only sounds with a certain (unspecified) breadth of distribution would be provided with standard transcriptions. The advantage of this approach is that the I.P.A. avoids the burden of designing and standardizing symbols and conventions which are only rarely required and hence of limited utility. Its drawbacks are that the I.P.A. would fall short of its aim of providing a comprehensive set of symbols for linguistic contrasts in the world's languages, and that the failure to recommend a standard transcription results in the proliferation of individual variations in transcribing the same segments. This latter problem can be seen in current practice with linguo-labials. For example, in a number of published sources the voiced linguo-labial fricative of Vanuatu languages may be found variously transcribed as **v̈, v̄, v', v̜, δ̼ and β̼** . The first three of these are simply means to differentiate the linguo-labial from **v**, the second three attempt to provide a phonetically motivated symbolization. All suggest our second option below.

This second option is to use a set of existing symbols, such as those for bilabials, modified by use of an existing diacritic, such as that for dental place of articulation, as in Table 1. The implication of any choice along these general lines is that linguo-labial consonants are a modified version of some other type of segment, or at least bear a close relationship to them. One advantage gained is that the transcription could represent the diachronic relationship of linguo-labials to labials or alveolars. The linguo-labials derive from Proto-Oceanic bilabial consonants in the languages we are discussing. Additional languages appear to have developed but then lost their linguo-labials as they merged with alveolar consonants, presumably due to acoustic similarities. A second advantage is that no new symbols are required, hence the further question of allocating a key in a keyboard layout for computer or typewriter does not arise.

The problem with this approach is that it is not obvious which choice of core symbols and diacritic is appropriate. The unusual combination used in Table 1 has a certain shock value, and succeeds in suggesting both the involvement of the upper lip and the forward position of the tongue in the production of linguo-labials, but it is unsatisfactory. The relation of linguo-labial and bilabial places of articulation is not parallel to that of dental and alveolar. This is true both in terms of their articulatory relation and in terms of linguistic function. The active articulator in linguo-labials is the tongue, whereas in bilabials it is the lower lip. Hence, representing linguo-labials with core symbols that indicate primarily ***labial*** articulation, either bilabial or labio-dental, seems inappropriate. Core symbols **t,d,n** etc - which suggest a tongue tip or blade articulation - seems more appropriate. Linguo-labials are lingual articulations in which the tongue is displaced forward from its normal place of contact or approximation in the dental or alveolar region. They may be viewed as extremely fronted versions of dental/alveolar consonants; hence the notion of using the dental diacritic, which indicates a more forward position for the tongue. However, the dental diacritic cannot be used with **t̪, d̪, n̪** without ambiguity, since this is already how dentals are transcribed. Other existing diacritics which represent fronting, such as + (perhaps doubled ++ to represent extreme fronting), could perhaps be used with the dental/alveolar core symbols. This convention would still demand rather flexible interpretations of the meaning of both these core symbols (now extended to include articulations in front of the teeth in a different articulatory region) and the diacritic in question (again indicating a shift across articulatory regions). Beyond that, we might doubt if it would be appropriate for linguistic reasons. Where core symbols are used to represent two (or more) distinguishable places of articulation, there is an implicit claim about the typical pattern of contrast in languages. For example, most languages have either dental or alveolar consonants but not both. But all known languages with linguo-labials also have both bilabial and dental/alveolar consonants in addition.

A third possibility would be to use a set of existing core symbols with a newly invented diacritic. This choice raises the same problems relating to the set of core symbols selected, but has the advantage that a diacritic can be designed which has the unambiguous meaning 'linguo-labial articulation'. This advantage must be balanced against the consequent increase in the number of diacritic symbols. Historically, proliferation of diacritic symbols has been discouraged in the IPA.

The fourth strategy would be to design a set of new symbols specifically to represent linguo-labials. This choice carries the implication that linguo-labial place is of similar rank to other places of articulation. Consequently, it represents the fully contrastive status of linguo-labials in the most satisfactory way. There is, of course, always some difficulty in inventing new and distinctive letter shapes. Most informal suggestions I have received from my colleagues propose new symbols with a mnemonic character, combining elements of labial and alveolar symbols, such as adding the cross-stroke of **t** to the letter **p**. But there is a more difficult problem than the one of design. This concerns the uncertainty over how many symbols to provide. An added place of articulation in the IPA chart sets up the possibility of finding symbols for every combination of that place with the manner categories. The minimum set of symbols required for the

Vanuatu languages would be just four: symbols for voiced and voiceless stops, and voiced fricatives and nasals. But how many additional ones should be devised? The languages with linguo-labials do not have a voicing contrast in fricatives, although in utterance-marginal positions these fricatives may be allophonically devoiced. Should a symbol for a voiceless linguo-labial fricative be provided? It is possible to produce laterals, implosives, clicks and many other manners of consonants with linguo-labial place of articulation. The decision to devise new core symbols for linguo-labials would require some attempt to anticipate which of these might be found to occur in the course of future research. This problem does not arise if a solution using a diacritic is adopted.

The fifth option to consider is the use of digraphs. Representation of segments by digraphs carries the implication that the segments in question are complex articulations, either because they have sequential organization (as is the case with affricates) or because they involve two or more articulators (e.g. labialized sounds or doubly-articulated labial-velars). This solution would have the advantage of incorporating into their representation the fact that linguo-labials do 'pre-empt' two articulators. For production of a linguo-labial both the tongue blade and the lips are used and the linguo-labial cannot be co-produced with a simultaneous primary articulation requiring either of these articulators. In terms of recent hierarchical models of the organization of phonological features (e.g. Archangeli and Pulleyblank 1986), labial and lingual (coronal) nodes are both present. Besides this theoretical advantage, the digraph approach has the advantage that it requires no new symbols to be devised. The drawback is that linguo-labial articulations are not complex in the same sense as other segments which receive representation by digraphs. They do not involve a sequence of elements, nor do they involve combination of two different but simultaneous articulations, as in labial-velars such as **kp, gb**. The use of the digraph **t͡p**, say, to represent a linguo-labial plosive suggests either a doubly-articulated (labial-alveolar) stop or, without the ligature, simply a sequence of **t** and **p**. I have argued elsewhere (Maddieson 1983, 1987a) that the languages usually cited as providing evidence that labial-alveolar double articulations occur in natural human languages, namely Margi and Bura, do not in fact have have such an articulation. Whether this justifies reassigning the digraphs used to represent these putative labial-alveolar segments so that they have a new value is another question.

These transcriptional alternatives raise important questions about the theoretical and pragmatic principles on which the IPA is understood to be based. Deciding between the alternatives requires selecting a particular balance between these factors. All users of the alphabet are invited to join the debate and contribute their suggestions.

References.

Archangeli, Diana and Douglas Pulleyblank. 1986. *The Content and Structure of Phonological Representations.* Ms, University of Arizona, Tucson, and University of Southern California, Los Angeles.

Everett, Daniel Leonard. 1982. Phonetic rarities in Pirahã. *Journal of the International Phonetic Association* 12: 94-96.

Fox, Gregory J. 1979. Big Nambas Grammar. *Pacific Linguistics*, Series B, No. 60.

Ladefoged, Peter. 1987. Revising the International Phonetic Alphabet. Paper presented at the 11th International Congress of Phonetic Sciences, Tallinn, August, 1987.

Ladefoged, Peter. (Forthcoming). Updating the theory. To appear in *Journal of the International Phonetic Association.*

Maddieson, Ian. 1983. The analysis of complex phonetic elements in Bura and the syllable. *Studies in African Linguistics* 14: 285-310.

Maddieson, Ian. 1987a. Labio-coronals? Paper presented at the 18th Conference on African Linguistics, Universite du Quebec a Montreal, April 1987.

Maddieson, Ian. 1987b. Linguo-labials. Paper presented at the 113th Meeting of the Acoustical Society of America, Indianapolis, May 1987. Abstract in *Journal of the Acoustical Society of America* 81/S1: S65.

Tryon, Darrell T. 1976. New Hebrides Languages: An Internal Classification. *Pacific Linguistics*, Series C, No. 50.

Linguo-labials

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1. Introduction.

A sound produced by an articulation involving the tongue and the upper lip can be described as a linguo-labial. None of the standard texts on phonetics provides for a linguo-labial place of articulation, neither does the International Phonetic Alphabet include symbols for sounds with this articulation. A few authors, e.g. Smalley (1963), recognize the *potential* for the tongue blade to articulate with the upper lip, but do not consider this to be linguistically used. But linguo-labial sounds do, in fact, occur in several Austronesian languages spoken in the South Pacific republic of Vanuatu. In these languages they contrast with both bilabial and dental (or alveolar) segments. In the most comprehensive available survey of Vanuatu languages, Tryon (1976) reports linguo-labials from eight different survey points, apparently representing seven different languages. This paper will provide the first description in some detail of these segments from both the articulatory and acoustic points of view, based on material from three of the languages. It will also consider the implications for phonetic and phonological theory of including this place of articulation among those which must be accounted for by these theories. But, before these issues are discussed, we will review previous work on the relevant languages and discuss the history and distribution of linguo-labials.

2. History and Distribution

2.1 Occurrence of linguo-labials

Linguo-labial segments are only known to occur as regular linguistic units in the area of two of the larger islands in the northern part of Vanuatu, the former Anglo-French condominium of the New Hebrides in the South-West Pacific. These islands are Malekula and Espiritu Santo (usually known simply as Santo). In these islands, as in the rest of Melanesia, there is a situation of great linguistic diversity. Tryon's survey suggests that there are over a hundred languages spoken in Vanuatu, which has a land area of only 12,189 km^2 and a population of less than 150,000. Tryon probably overstates the number of distinct (i.e. mutually unintelligible) languages, but there is no doubt that Vanuatu's rugged forested islands, its history of small mutually hostile village-based societies and sparse population created favorable conditions for linguistic diversification. Current trends are rapidly altering this situation, creating more homogeneous linguistic circumstances as smaller groups are absorbed by more dominant ones, and as Bislama - the national language based on the pidjin principally developed by indentured workers transplanted from the islands to work on sugar plantations in Queensland - replaces the older languages. Some of the languages with linguo-labials are at or approaching the point of extinction, or are undergoing changes which will result in loss of the linguo-labials.

Linguo-labials are not entirely unknown elsewhere. Hockett (1955: 99) reports an 'apico-labial' place of articulation for stops in Umotina (which he calls Bororo) on the basis of personal communication from Lounsbury, who confirmed this to Ladefoged (1971), but the data remains unpublished. A linguistically marginal linguo-labial stop occurs in a couple of exclamations in Chaga, a Bantu language of Tanzania. And Everett (1982) describes an articulation involving a sublaminal linguo-labial contact in Pirahã, a Mura language of Brazil. This has a sociolinguistically restricted function in the language and is, surprisingly, a variant of /g/.

2.2 Previous description

Although no phonetic classification provided for linguo-labial articulations (prior to Ladefoged and Maddieson, 1986) they had been described in the literature almost a century before. The articulation may have been first noted by the Rev J. Annand in an outline grammar of Tangoa sent to the Rev D. MacDonald, and published in 1891 (MacDonald 1891: 1-14). A version of Annand's manuscript formed the basis of S. H. Ray's grammar of the Tangoa language (Ray, 1926: 356-370), which is both more accessible and more systematic than that published in 1891. Ray lists three labial stops, p, *p*, b and three nasals, m *n*, n among the consonants of the language. He notes that "The italic *p* is a sound between t and p pronounced with the tongue between the teeth touching the upper lip". The phrase describing the articulation is quoted from Annand. Annand heard words with the linguo-labial nasal as being pronounced either as m or n "indifferently", but words with this apparently variable pronunciation must have been noted in the grammar that Ray saw, since he regularly records certain words with the italic *n* . Examination of the words transcribed with *n* confirms that these items had linguo-labial nasals, e.g. ta*n*aku 'my father'. The linguo-labial fricative is represented as 'th', having been heard as similar to the dental fricative in English *they*. Acoustic similarity between linguo-labial and dental/alveolar articulations is clearly reflected in these notes. We will return to this point below.

The anthropologist John Layard briefly described the occurrence of linguo-labials in Vao in several publications. For example,

> "In Vao, however, and at places like Matan-vat on the northern coast of Malekula, a peculiar phenomenon is present. In all labial and nasal

consonants the tongue is protruded slightly beyond the lips, so that pairs of consonants so pronounced, such as *d* and *b* , *m* and *n* , *p* and *t* , are at first almost indistinguishable without comparative philological knowledge. One effect of this is that *v* and *w* assume a sound almost exactly corresponding to the English voiced *th* ." (Layard 1934: 132).

This passage contains some confused notions, but does correctly note the similarity between linguo-labial and alveolar sounds. Layard later stressed the relative rarity of the linguo-labial pronunciation among the languages of Malekula.

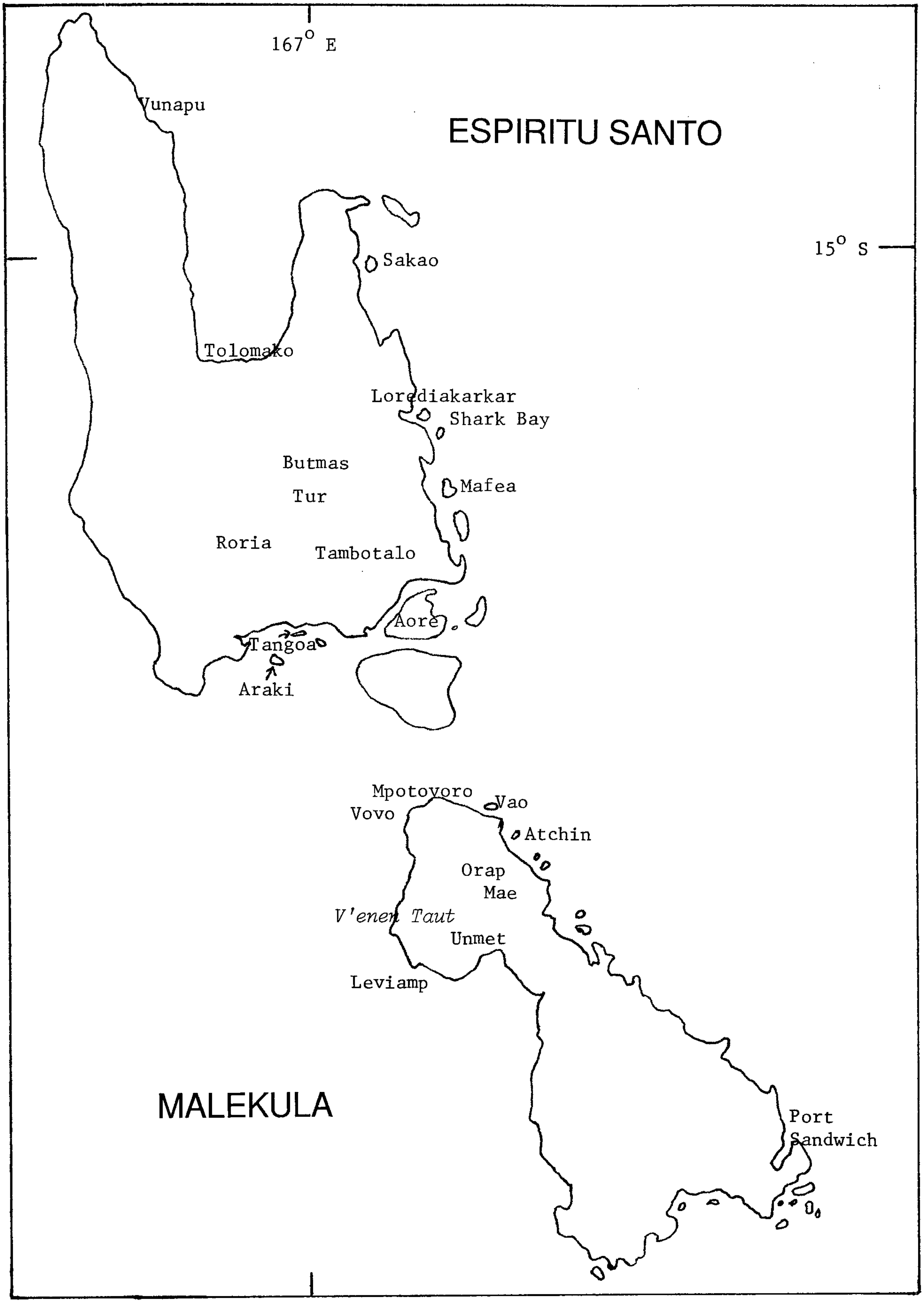
> "Of all these languages that which differs from the others most is that of Vao, not only in vocabulary but also in pronunciation, since, by a peculiar forward movement of the tongue betweeen the lips, certain consonants take on a very un-Malekulan form ..." (Layard 1942: 25).

More recently, linguo-labials have been noted in more technical linguistic publications, such as those of Guy (1974), Fox (1979), Camden (1979) and Capell & Layard (1980). These sources describe the linguo-labials as 'apico-labials', but, as we will show below, they are often laminal rather than apical; hence we prefer the more general term 'linguo-labial'. Despite these records, linguists have continued to overlook their existence when providing frameworks for the description of human speech sounds.

2.3 Distribution and history of linguo-labials in Vanuatu

The survey points for which Tryon reports linguo-labials are Mafea, Aore, Tangoa and Araki (small islands offshore of Santo to the east and south), and Vao (a small island off the north coast of Malekula), Mpotovoro, Leviamp and Unmet (on the mainland of Malekula). These locations are shown on the adjoining map. The last two points represent a single language, that spoken by the people commonly known as the Big Nambas. We will refer to this language as V'enen Taut, the orthographic version of the speakers' own name for it.[1] In Tryon's survey, the lists for Mafea, Aore and Tangoa were contributed by Jacques Guy, that for Mpotovoro by Gregory Fox and those for Araki, Vao, Unmet and Leviamp by Tryon himself.

Tryon reports three types of linguo-labial segments, a (voiced) nasal, a voiced fricative and a voiceless stop. According to Tryon's wordlists, Araki has only the linguo-labial nasal, but the other languages have all three. In our own materials from three languages, Tangoa, V'enen Taut and Vao, we found that voiced linguo-labial nasals and fricatives ocurred in all three, but that the reported voiceless stops in Vao



Map showing language and place names referred to in text are in fact prenasalized voiced stops. A voiceless stop did occur in Tangoa and V'enen Taut. We do not know how reliable Tryon's reports on the other languages are, but as with many surveys of the type some caution should be exercised in trusting the details, particularly as the wordlists are from several hands.

All of the languages in question, and in fact all the indigenous languages of Vanuatu, belong to the Oceanic branch of the Austronesian family of languages. The historical source of the linguo-labials is discussed briefly by Tryon (1976: 52-3). in relation to a Proto-Oceanic (POC) phoneme inventory based on Grace (1969). According to Tryon's account, the three linguo-labials - nasal, fricative and stop - are reflexes of POC *m/*ŋm, *p and *mp respectively in the environment before non-back vowels. In other environments bilabial reflexes with these same manners are found. In fact, bilabials occur before non-back vowels also. Tryon does not comment on the origin of these. We will discuss a different historical scenario below.

Tryon also suggests - and he is certainly correct in this - that the distribution of linguo-labials was formerly much wider, encompassing almost the whole of the east and south of Santo and the northwestern tip of Malekula. This claim is based on the occurrence of dental (or alveolar) segments as reflexes of POC labials. Survey points Tolomako, Butmas, Tur, Tambotalo, Sakao, Lorediakarkar, Shark Bay, Roria, Orap, Mae (and possibly Vovo) all have one more reflexes indicative of this development, for example /ð/ for *p, /t/ or /nd/ for *mp, /n/ for *m before nonback vowels (according to Tryon's view). The remaining languages in this area show bilabials in all instances. This distribution is one reason to reject the suggestion by Camden (1979) that linguo-labials in Tangoa are a recent stylistic affectation in place of bilabials in the elevated speech style of men. In the case of such a stylistic trait, the linguo-labials would not correlate with any well-defined historical category. They are clearly a conservative element in the speech of older people, rather than a recent innovation. Younger speakers use only bilabials.

The historical data is more complex than the table of reflexes given by Tryon suggests. Also, as we have noted, Tryon cannot correctly account for the distribution of labials and linguo-labials on the basis of vowel environment. The full picture will not emerge until more intensive study of Austronesian linguistic history is undertaken. For the present time, we accept Geraghty's (1983) arguments that there were three rather than two labial obstruents in Proto-Oceanic (or at least in Proto-Eastern Oceanic (PEO)). The *p of earlier POC reconstructions is more plausibly reconstructed as a fricative, probably bilabial (Geraghty 1983 writes *v, instead of the more accurate *β), the previously reconstructed *mp was more probably voiced *mb, and additionally there was also a voiceless stop *p. There were also labialized *mbw and *pw. Beside the bilabial nasal *m, there was another proto-segment which is likely to have been a labialized bilabial (*mw) but is sometimes treated as a labial-velar (*mŋ, or *ŋm, as in Grace 1969). The reconstructed proto-vocabulary of POC needs to be re-examined in the light of the positing of an original contrast between plain and labialized sets of labial consonants. We have culled some examples on which several authorities might agree from examination of Geraghty (1983), Blust (1980, 1983-4) and the forms cited in Wurm and Wilson (1975).

Examples of reflexes of words with POC plain (non-labialized) bilabials are given in Table 1. On the other hand, examples of the reflexes of POC words with labialized bilabials are given in table 2. The languages from which forms are cited are separated into three groups. The first are those languages with linguo-labials of which I have first-hand experience. The second are languages which show evidence of formerly having had linguo-labials, and the third are languages which show no sign of this development. Forms from the latter two groups are cited from Tryon or, occasionally, other published sources. In these tables, recognized prefixal elements are separated from stems by a hyphen, and words which must be obligatorily possessed are quoted with a final hyphen to indicate that a possessive must follow. Linguo-labials are indicated by use of the dental diacritic under a symbol for a bilabial articulation (see Maddieson 1987 for discussion of transcription of linguo-labials).

From our data it appears that the contrast between linguo-labial and bilabial articulation in the languages which use this distinction goes back to the reconstructed contrast between plain bilabials (which became linguo-labials) and labialized bilabials (which became plain bilabials). There does not seen to be any dependence between vowel quality and the type of consonant which results, as may be seen from examples like "eye" and "snake", except that labials before back rounded vowels remain bilabial, as in "navel" and "pig". This may be simply because in this position the labials were in fact labialized, and so show the same reflexes as other labialized labials.

This new theory of the origin of linguo-labials in these languages does not make their development appear any less unusual. Their occurrence is still highly marked, and we have no explanation to offer as to why the bilabial to linguo-labial shift took place. It is possible that the labialized labials did not share in this shift because the narrowing of the lip aperture associated with rounding inhibited the forward protusion of the tongue.

Table 1. Some correspondences of POC plain labials in Vanuatu languages.

	*v *vati "four"	*mb *mbuto "navel"	*p *lepa/*pela "mud, earth"	*m *mata "eye"	*m *me(me)- "tongue"
Vao	ɣe-β̼at	p̼ito-	na-leβ	m̼ata-	mem̼e-
Tangoa	mo-β̼ati	(puto-)	lep̼a	m̼ata-	m̼em̼e-
V'enen Taut	i-β̼a	p̼ətə-	---	m̼ata-	ne-m̼ə-
- - - - - - - - - -					
Sakao	---	œβyð	œlɒð	œnɒð	œnɒ-
Tolomako	βati	pito-	leta	nata-	nene-
Lorediakarkar	θar	futo-	fa-leðe	naði-	nene-
Orap	i-βat	mbeti	ne-leβ	nata-	nenee-
Butmas	fo-fat	boto-	---	nata-	nenɛ-
Tambotalo	ðati	puto-	pilia	neto	nene-
- - - - - - - - - -					
Achin	e-βats	---	na-lew	meta-	memæ
Port Sandwich	e-βats	mbœro-	---	mara	memæ
Vunapu	βati	pwito	---	mata	meme

	*m *tama "father"	*m *lima "hand"	*p *pua(ku) "pig"
Vao	tam̼a-	nim̼a-	na-mbo
Tangoa	tam̼a-	lim̼a-	poi
V'enen Taut	---	(ləm̼a-)	pua
- - - - - - - - - -			
Sakao	ðana-	---	---
Tolomako	tana-	lina-	poe
Lorediakarkar	tani-	arine	---
Orap	---	---	mboxo
Butmas	---	---	bu
Tambotalo	tonu	---	poia
- - - - - - - - - -			
Achin	tima-	---	pua
Port Sandwich	rama-	---	mbuas
Vunapu	tama-	lima-	poe

Table 2. Some correspondences of POC labialized labials in Vanuatu languages

	* mbw * mbwatu "head"	* mw * mwata "snake"	* mw * umwane "house"
Vao	mbatu-	na- mat	ne- ime
Tangoa	patu	mata	ima
V'enen Taut	pətə-	nə- mat	(nə- max)
- - - - - - - - - -			
Sakao	œβyð	- - -	- - -
Tolomako	- - -	mata	- - -
Lorediakarkar	puðu-	mata	jɨmə
Orap	mbati-	ne- mwat	na- im
Butmas	butu-	fi- mat	ime
Tambotalo	patu-	mata	anuma
- - - - - - - - - -			
Achin	patu-	ni- mwet	ne- im
Port Sandwich	mbaru-	na- mwar	na- im
Vunapu	patu-	mata	- - -

Notes to tables 1 and 2.

( ) an item enclosed in parentheses in the Vao, Tangoa or V'enen Taut rows is one which I have not personally checked.

--- indicates an item for which the available form is clearly or probably not cognate with the reconstructed form in question. A blank in the table represents missing data.

y is written in Sakao words where Guy used ü, on the assumption that ü was intended to represent a high front rounded vowel.

3. Phonetic Description

3.1 Materials and Methods

Direct observations and audio recordings were made of three speakers of Vao (VA, RL, MS), two of V'enen Taut (AT, JA), and one of Tangoa (CM). The words elicited illustrated bilabial, linguo-labial and alveolar sounds, but particular attention was paid when selecting words to look for minimal contrasts between bilabial and linguo-labial sounds. As an adjunct to study of the Vanuatu languages, the production of linguo-labial stops by one speaker of Chaga (LM) was also observed and recorded.

A videotape was made of the Vao speakers and of one V'enen Taut speaker producing selected words contrasting bilabial and linguo-labial sounds. Each subject was filmed from a frontal and lateral position. This tape was examined by freeze-frame techniques and selected individual frames were traced directly onto an acetate sheet from the screen. Still photographs were made of one of the speakers of V'enen Taut. Palatograms were also made of the production of the linguo-labial stop by the Chaga speaker.

The acoustic patterns of linguo-labials and contrasting bilabial and alveolar or dental sounds were examined by use of wide-band spectrograms made from the audio tapes and the audio track of the videotape.

Spectral envelopes of selected nasals and fricatives were computed. The signals were digitized at 10 kHz after low-pass filtering with a 4-pole Butterworth filter, giving 18 dB of attenuation at 5 kHz. A DFT spectrum of the steady state portion of these sounds was obtained using a Hamming window of variable length depending on the duration of the steady state in question.

3.2 Articulatory Description

In production of linguo-labials stops and nasals the tongue is moved forward so that the tip contacts the inner surface of the upper lip or the blade contacts the lower surface of the upper lip, with the tip protruding between the lips. All speakers were observed producing both tip and blade (and intermediate) articulations, but some were more likely to produce apical (e.g. VA), others laminal (e.g. RL) articulations. In addition to this primary articulatory movement, the upper lip is lowered and retracted to some degree to meet the tongue. Some speakers do this consistently to a greater degree (e.g. JA, RL) than others (e.g. CM). The jaw and lower lip are raised. If the tongue is protruded, the lower lip may contact the under side of the tongue. The degree of jaw raising appears similar to that observed in alveolars.

This pattern of articulatory movement can be seen in the sequence of tracings showing production of the linguo-labial nasal in /nam̼at/ "snake" (RL, Vao) in figure 1. This sequence shows every other frame starting from the one preceding that in which the tongue first becomes visible in the lateral view. The frame rate of the videotape is 30 frames a second, thus each successive tracing in this figure is 66 ms later than the preceding one. The tongue gesture reaches its maximum in frame 7 when the tongue is making a laminal contact with the upper lip. This position was sustained in frame 8. In frames 7-9 the lower lip also touches the tongue. The upper lip is lowered and retracted between frames 4 and 5; this contraction is relaxed between frames 11 and 13. Judging from the visibility of the tongue tip in the lateral view, the entire tongue gesture occupies on the order of 300-350 ms. Of this, 100 ms is the closure portion (measured from a spectrogram of this utterance). The lip gesture is somewhat briefer than the tongue gesture, being on the order of 200-250 ms. Since the acoustic duration of the linguo-labial nasal and the two surrounding vowels amounts to approximately 370 ms, there is very plainly a great deal of articulatory overlapping of the consonantal gesture with the production of the surrounding vowels. The articulatory movements between the vowels and the initial and final alveolar consonants are apparently executed much more rapidly.

It was not possible to study the stop and nasal articulations by palatographic techniques in Vanuatu, but the articulatory contact area in a Chaga linguo-labial stop is shown in figure 2. This palatogram is of an utterance of the exclamation 'pto', expressive of surprise or relief. It was made by painting the tongue with a mixture of charcoal powder and olive oil and photographing the upper surface of the mouth after the utterance to see where this medium has been transferred. The contact area, shown in black, extends along the lower inside margin of the upper lip and covers the lower surface of the premolars. A very small area at the bottom of the inner face of the incisors is also contacted. In the molar region, there is no contact on the teeth or anywhere on the palate, instead the contact is only on the outer sides of the vocal tract.

The linguo-labial fricatives are also frequently produced with the tongue fully protruded between the lips. In this case, the blade of the tongue is in contact with the lower surface of the upper lip at either side, and air escapes through a very narrow aperture that extends for about one half to two thirds of the width of the lips. These fricatives may also be produced with the tongue articulating with the inner surface of the upper lip. In this case, there is an aperture between the lips of about 3 mm in height (too wide to be the source of turbulence) and the tip of the tongue can just be seen in

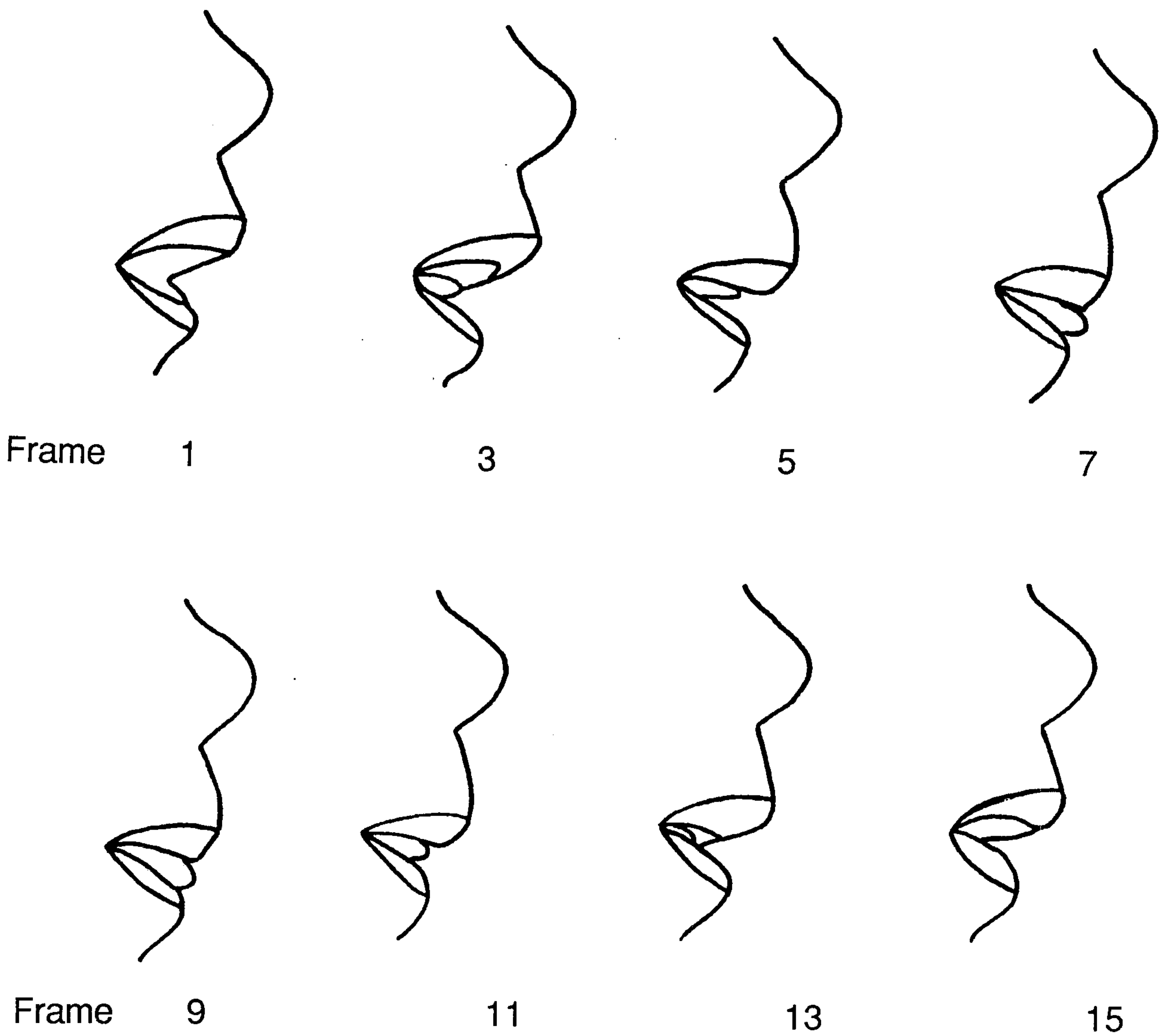


Figure 1. Tracings from videotape of lip and tongue position showing production of linguo-labial nasal /m̼/ in /nam̼at/ "they are dead" in Vao (RL). Every second frame is traced, starting from the last frame in which the tongue cannot be seen during the first vowel.

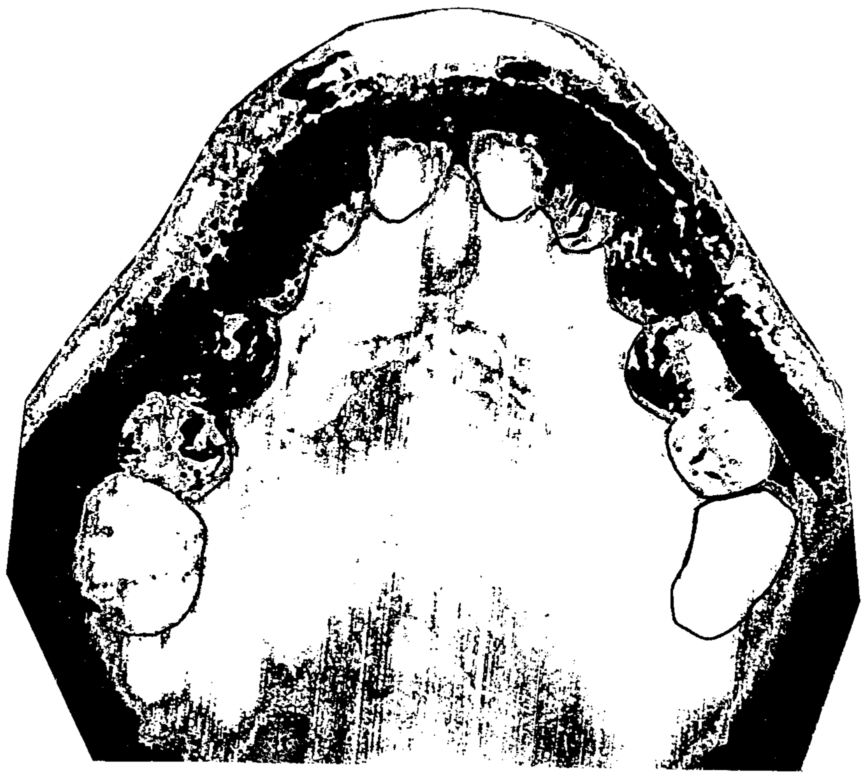


Figure 2. Palatogram of a linguo-labial stop in Chaga. Contact area on lip and teeth is shown in black, the outline of the teeth has been enhanced.

the frontal view. The exact shape of the constriction cannot be determined from our materials.

It is worth noting that the lips remain spread during production of all the linguo-labial segments.

3.3 Acoustic Description

Although the articulation for linguo-labials is made against the upper lip and the distance of this articulation from the glottis is similar to bilabials, the involvement of the tongue means that the vocal tract has a relatively long narrow portion toward the front. Hence the effective acoustic tube shape is more like that for an alveolar. F2 transitions to and from linguo-labials do not have the low position characteristic of other labial sounds, but they are a little lower than transitions to alveolars. The linguo-labial segments themselves also differ from bilabials in that they tend to have more energy at higher frequencies. More specific comments on stops, nasals and fricatives in turn are given below.

In Tangoa and V'enen Taut the linguo-labial stops are voiceless in all positions. In Vao they are voiced and prenasalized; in initial position, the nasal portion may have very low amplitude and short duration, and allophonic devoicing of the stop portion in final position is possible. Representative formant transitions after voiceless bilabial, linguo-labial and alveolar stops can be seen in the spectrograms in figures 3 and 4. Figure 3 illustrates stop transitions to /a/ in Tangoa (CM). The stops are distinguishable by their second formant (F2) transition patterns; F2 is sharply rising from below 1000 Hz after bilabial, level at about 1400 Hz after linguo-labial, and slightly falling from about 1550 Hz after alveolar. Figure 4 shows examples of bilabial and linguo-labial prenasalized stops from a Vao speaker (MS). The F2 transition rises from about 1000 Hz after the bilabial but falls from about 1700 Hz after the linguo-labial. Linguo-labial stop bursts typically have greater energy, especially at higher frequencies, than bilabial ones, but it has not yet proved possible to develop spectral templates which will classify the stops by their burst characteristics.

All three languages contrast voiced linguo-labial nasals with bilabial and alveolar ones. As noted above, Vao also has nasal elements occurring as a component of prenasalized stops. Although there are some indications that the first nasal formant is higher in linguo-labial nasals than in bilabial ones as would be expected (Ladefoged and Maddieson 1986), the nasals are most readily distinguished by adjoining transitions and by the frequency of the second prominent spectral peak in the nasals themselves. Spectrograms of the three nasals of Tangoa are given in figure 5. The

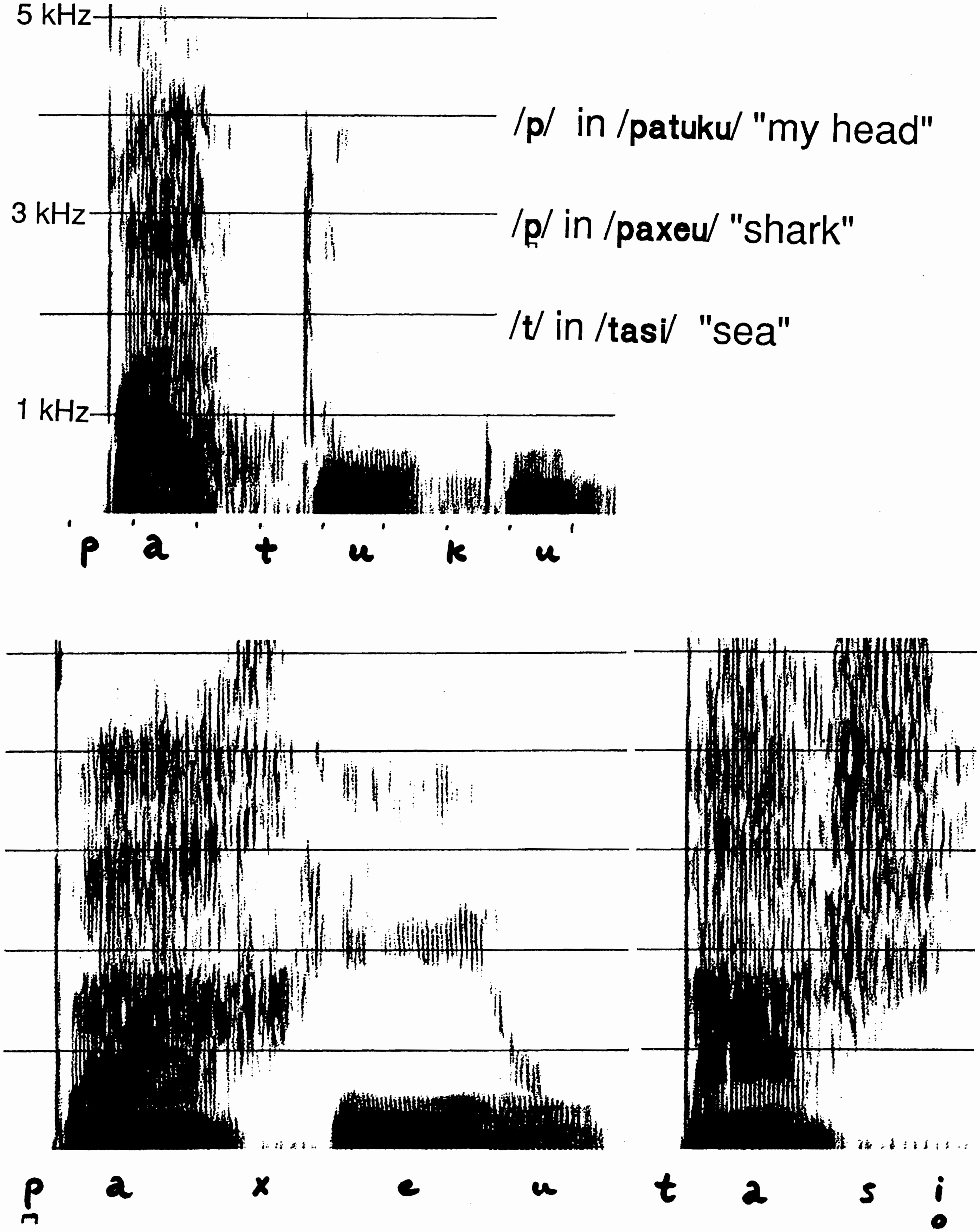
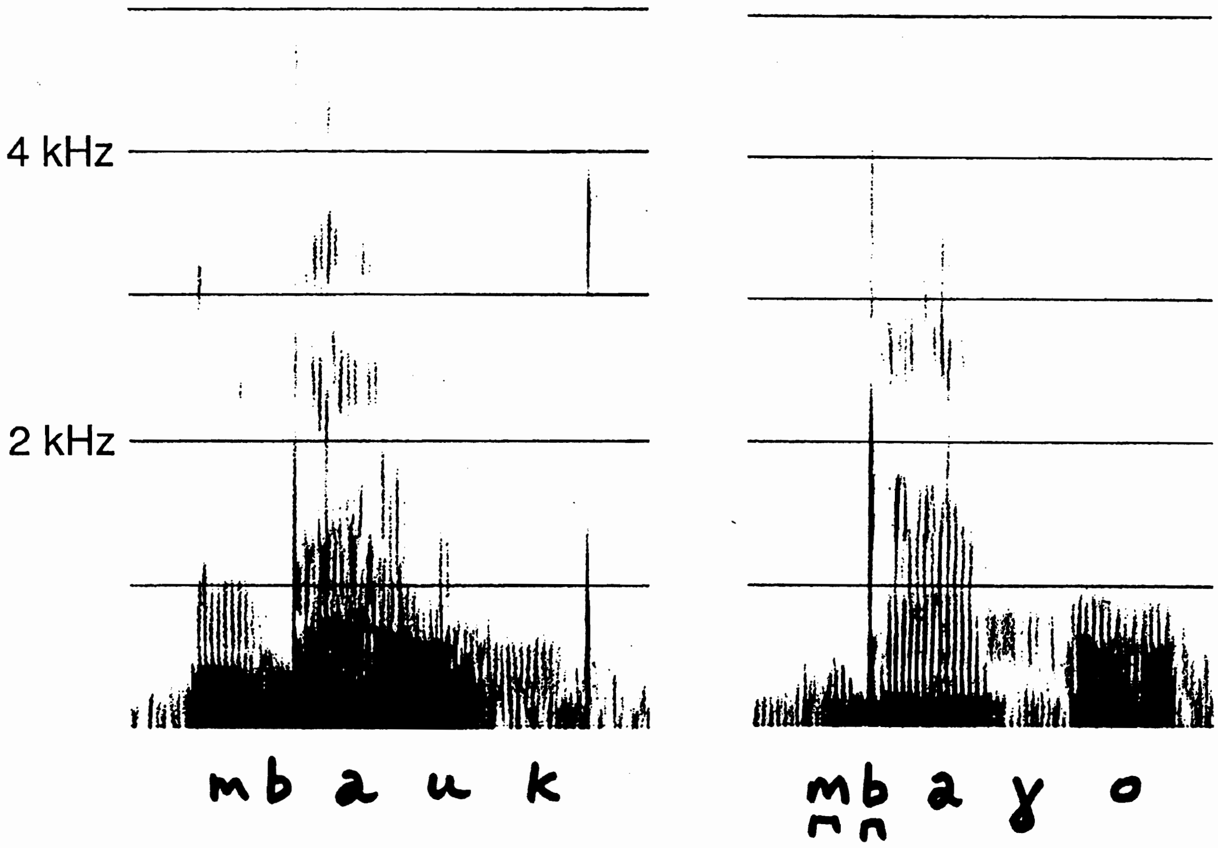


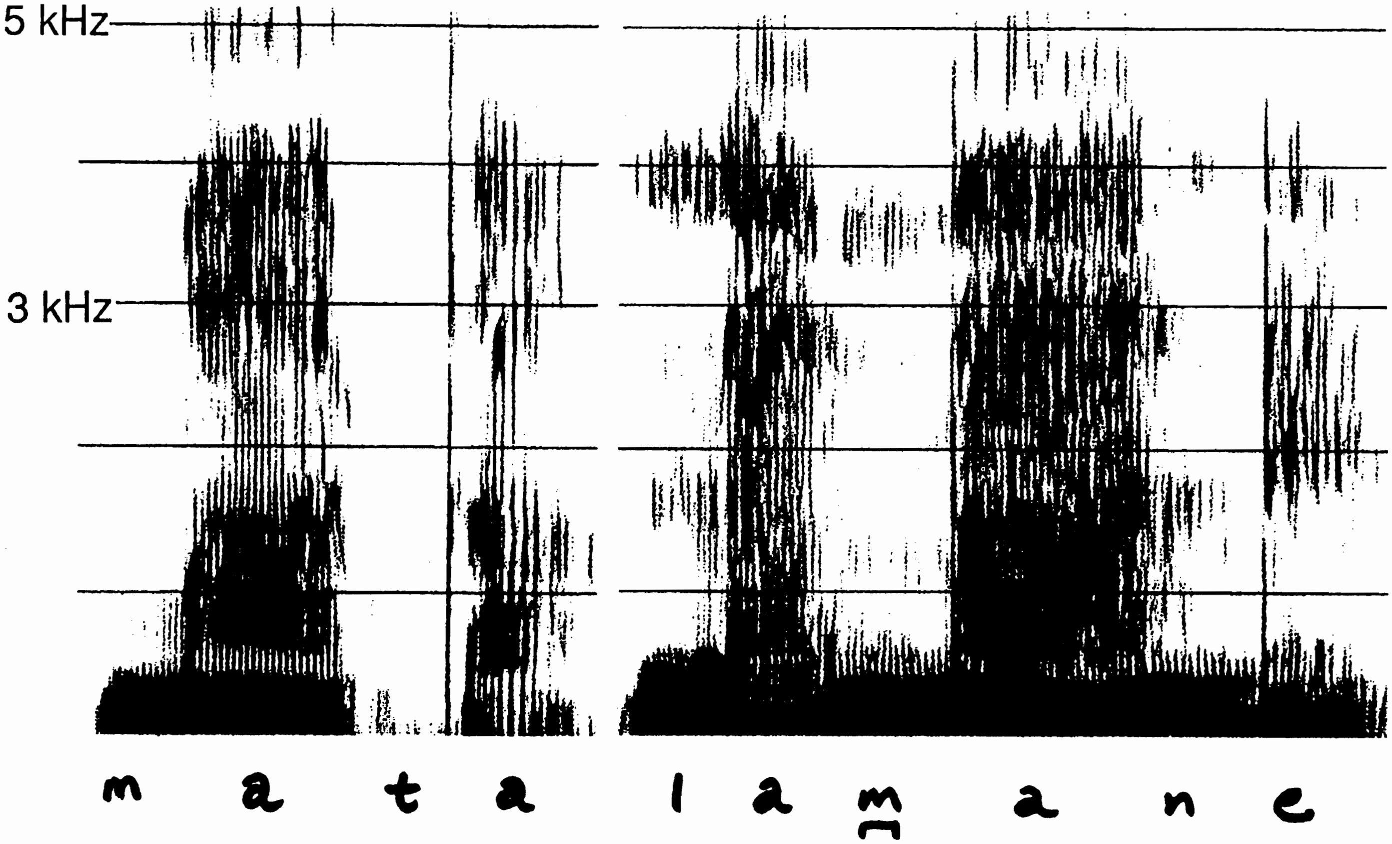
Figure 3. Spectrograms illustrating stop transitions in Tangoa (CM).



/**mb**/ in /**mbauk**/ "my knee"

/**m̼b̼**/ in /**m̼b̼aɣo**/ "shark"

Figure 4. Spectrograms illustrating prenasalized stops in Vao (MS).



/**m**/ in /**mata**/ "snake"

/**m̺**/ and /**n**/ in /**lam̺ane**/ "man"

Figure 5. Spectrograms illustrating nasals in Tangoa (CM).

transitions to or from these segments are quite similar to those seen with the stops in figure 3. These nasals are quite distinct in the frequency of the second resonance, about 800 Hz in the bilabial, 1200 Hz in the labio-dental and about 1700 in the alveolar. The picture is generally similar for all three languages. Mean values, measured from spectrograms, for the second spectral peak in a variety of tokens from two of the Vao speakers are given in Table 3 (the number of tokens measured is given in parentheses):

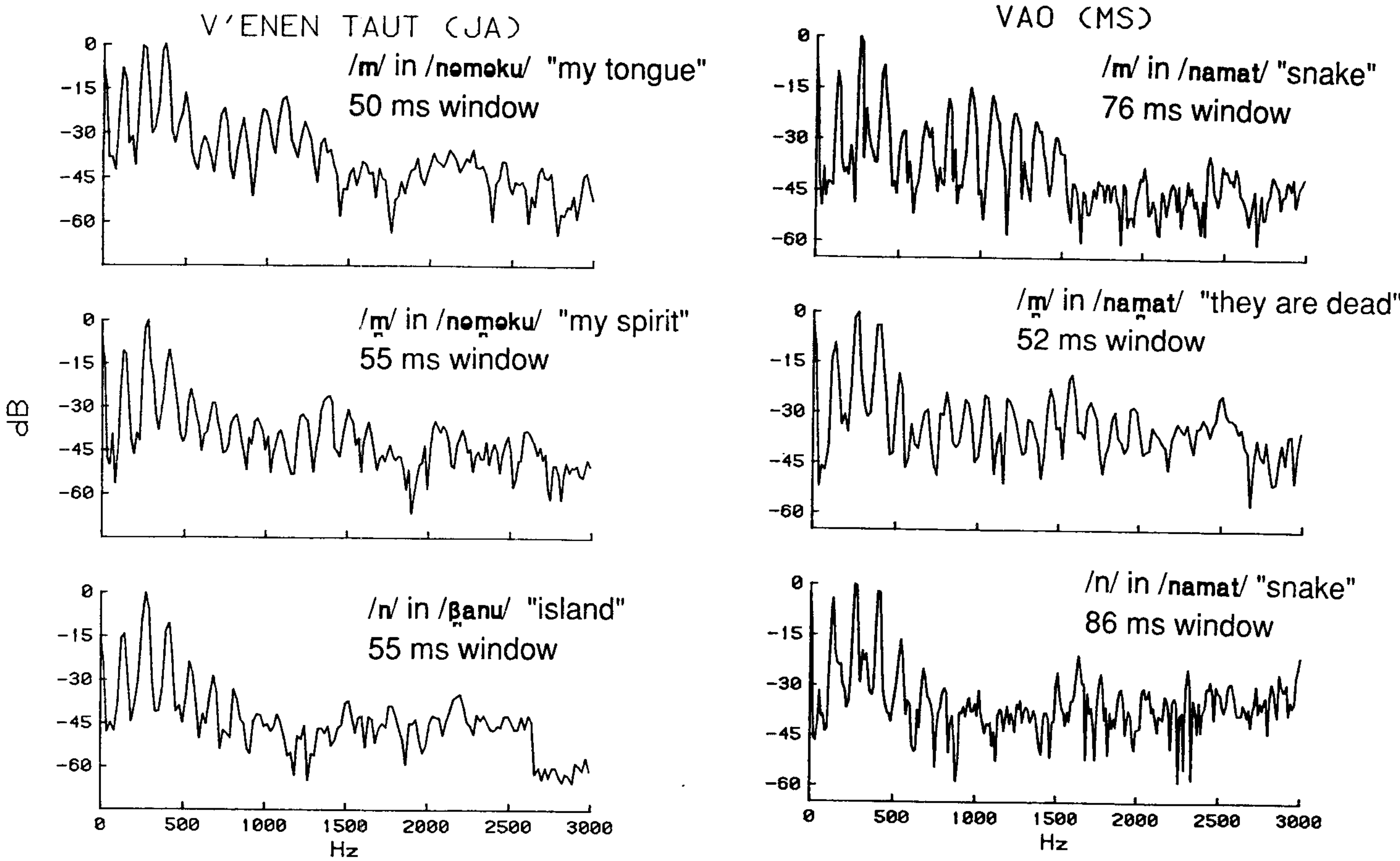
Table3.

	bilabial	linguo-labial	alveolar
RL	955 (15)	1258 (21)	1319 (26)
MS	950 (10)	1296 (14)	1499 (20)

A more detailed picture of the spectral structure of the three types of nasals can be seen in the sample DFT spectra shown in figure 6, representing one token of each type from each of the languages. The different location of the second resonance can be clearly seen in the V'enen Taut and Vao examples; it is less salient in the Tangoa samples. However, the Tangoa examples do show a difference in the location of the first nasal formant between the bilabial and linguo-labial nasals; in the bilabial case it is closest to the frequency of the first harmonic and in the linguo-labial it is closest to the frequency of the second harmonic (The pitch is higher in the bilabial token, but not to a sufficient degree to account for this difference).

All three languages studied contrast voiced bilabial and linguo-labial fricatives; none has a voiced alveolar or a voiced labio-dental fricative. These fricatives are frequently allophonically devoiced in both initial and final environments. The bilabial and linguo-labial fricatives have quite different F2 transitions, as may be seen from the Vao tokens in the spectrograms in figure 7. In these examples, the transitions in the bilabial case seem to originate from around 1100 Hz; in the linguo-labial case from around 1500 Hz. DFT spectra of representative tokens from each of the three languages are shown in figure 8. From examination of these and other spectral displays, it appears that the bilabial fricative may be characterized by a more linear high-frequency rolloff than the linguo-labial, as well as a lower overall amplitude, but this difference is not salient for all speakers (e.g. CM).

In summary, the articulatory and acoustic analysis shows that linguo-labial segments are quite distinct from segments which are either just lingual or labial. However, in both articulatory and acoustic terms they are closer to other segments which involve the tongue tip or blade than they are to bilabial segments.



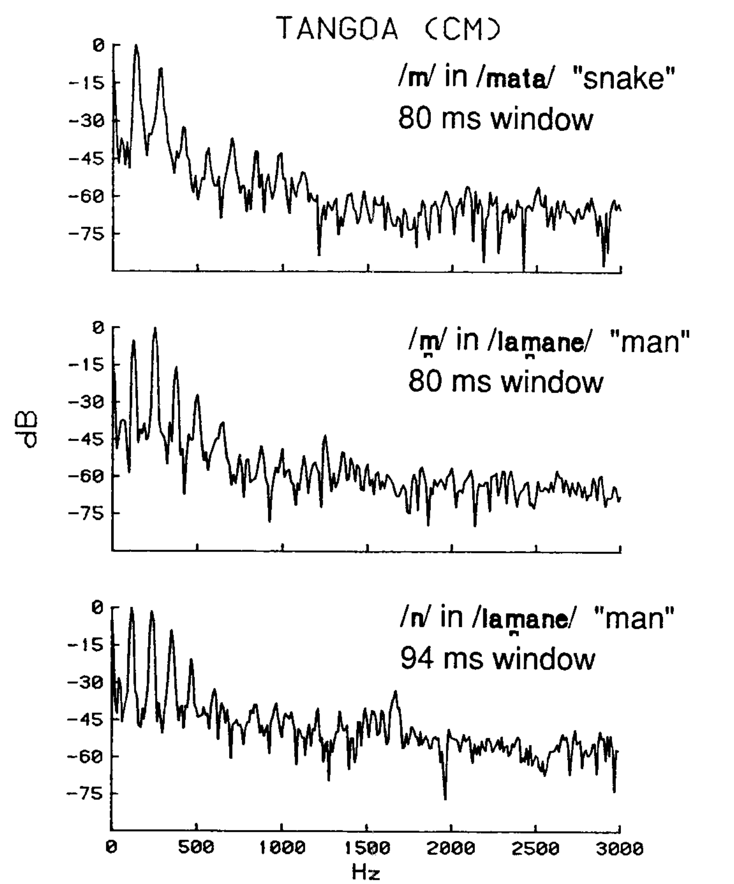
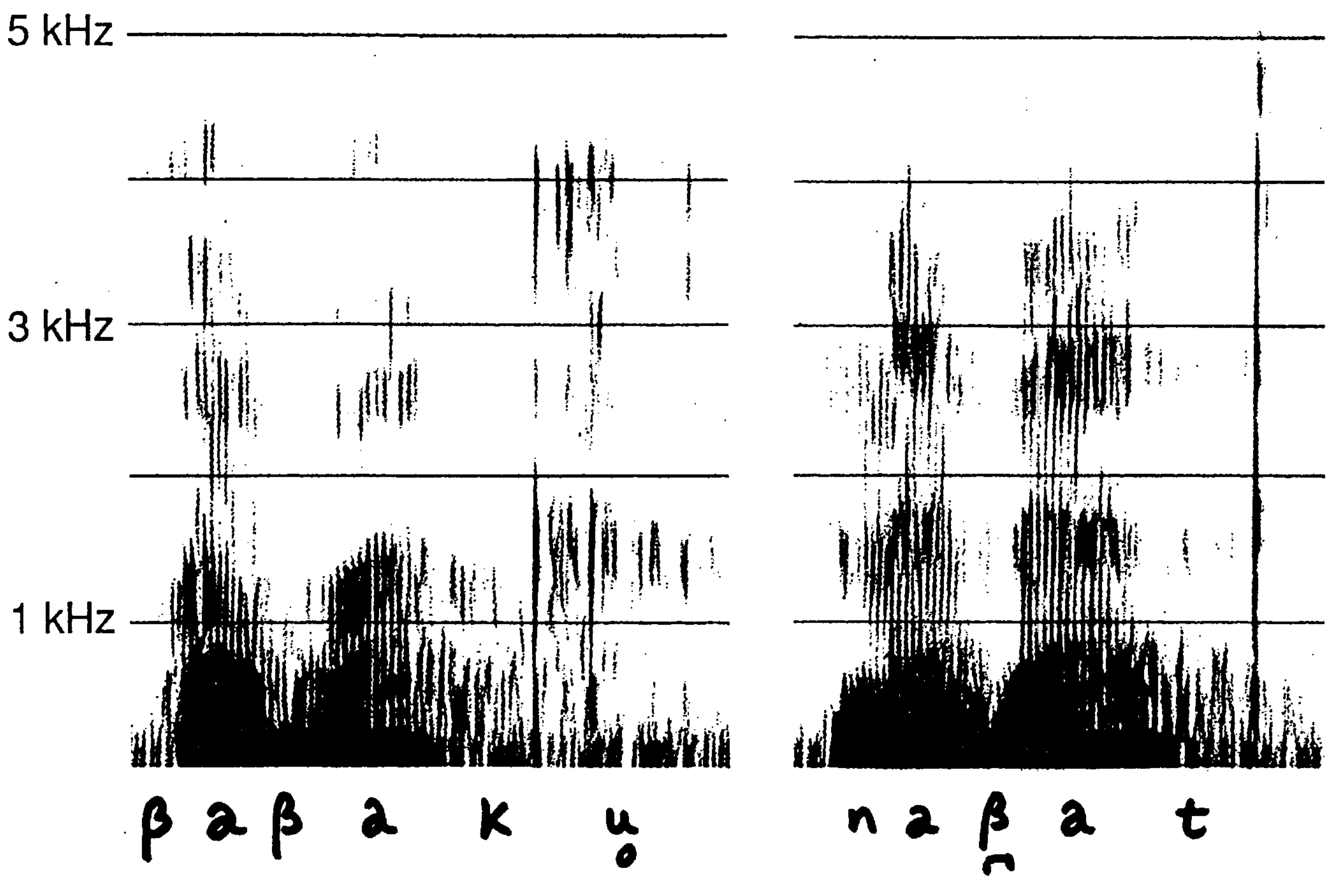


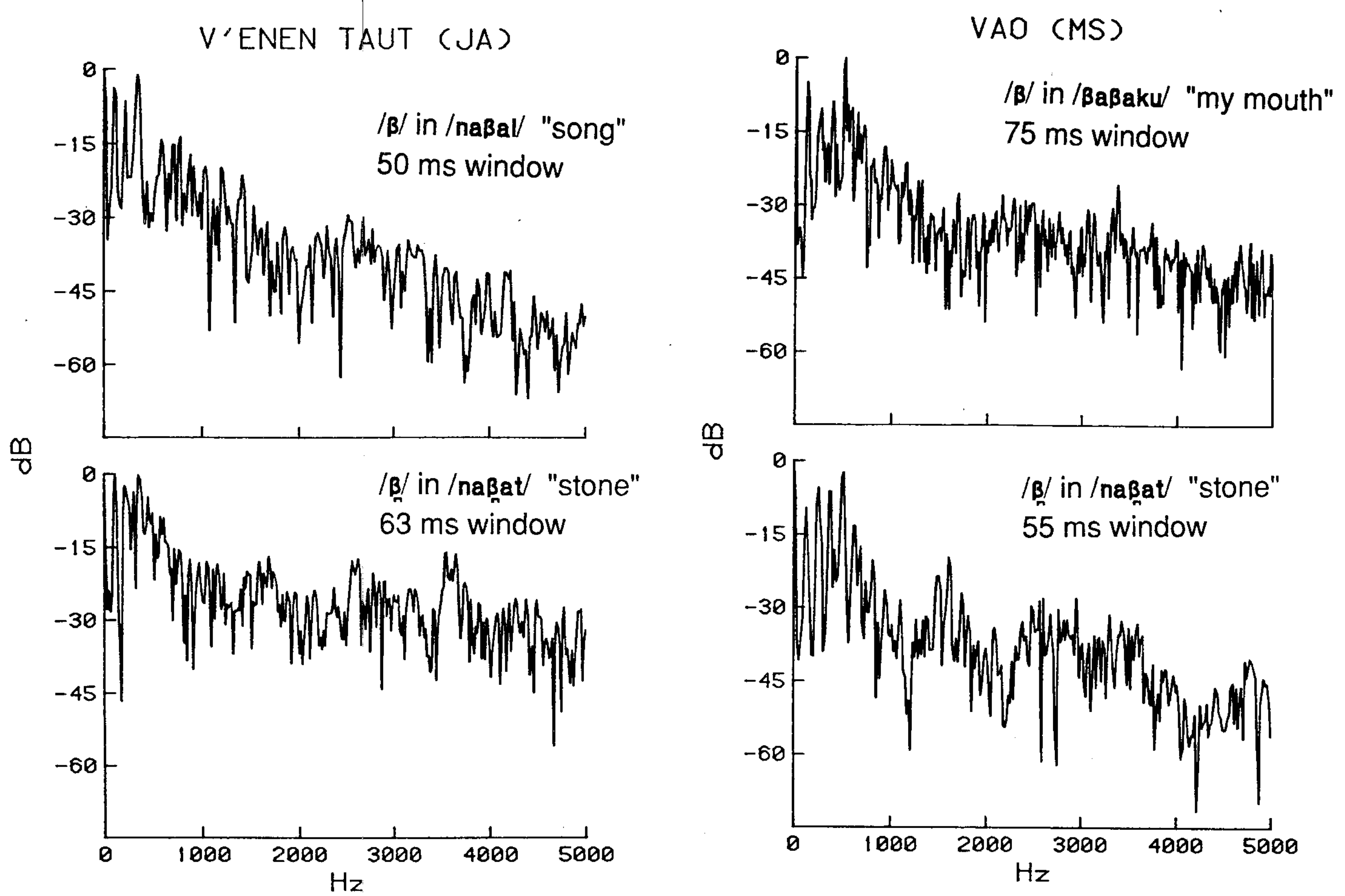
Figure 6. DFT Spectra (0-3 kHz) of sample nasals from V'enen Taut, Vao and Tangoa.



/β/ in /**βaβaku**/ "my mouth"

/β̼/ in /**naβ̼at**/ "stone"

Figure 7. Spectrograms illustrating bilabial and linguo-labial fricatives in Vao (MS).



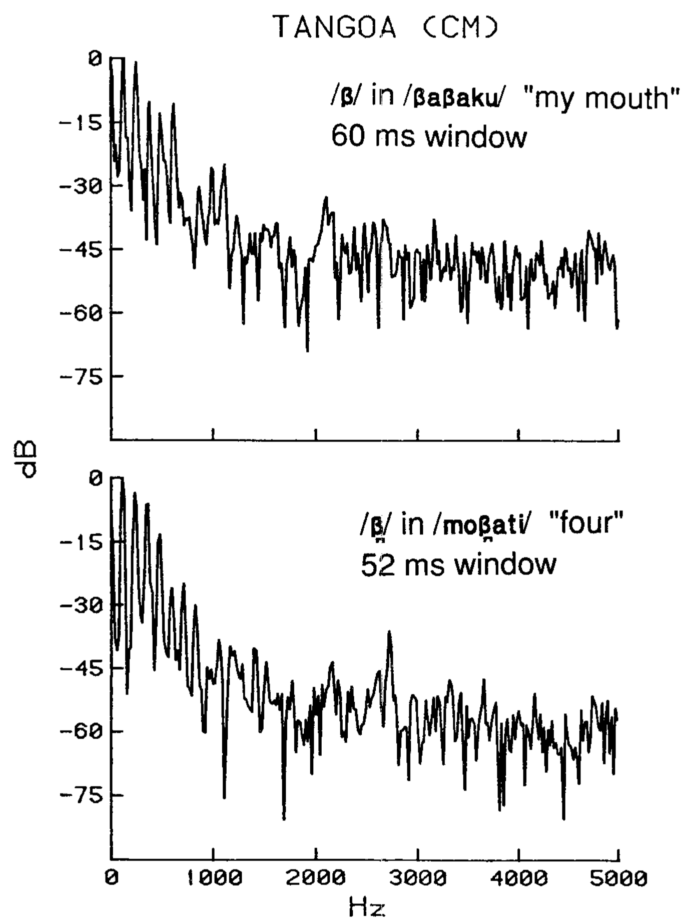


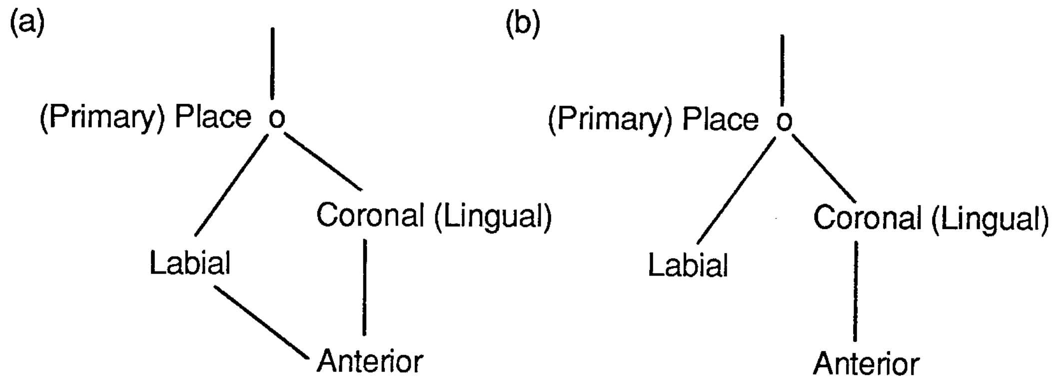
Figure 8. DFT Spectra (0-5 kHz) of sample fricatives from V'enen Taut, Vao and Tangoa.

4. Implications for Phonetic and Phonological Theory

Descriptive phonetic theory can accommodate linguo-labials by adding this place of articulation to the set of places at which various types of articulatory gestures can be performed. But this is not all. In normal articulations "it is taken for granted as that the *active* articulator is the one which lies opposite [the passive articulator] when the vocal organs are at rest" (Abercrombie 1967: 51). A linguo-labial is thus evidently not a normal articulation, since the tongue does not rest in a position where the tip is in front of the front teeth. Linguo-labials fall into the class of *displaced* articulations, of which the canonical instances are labio-dentals (where the lower lip is retracted to articulate with the upper teeth) and retroflex consonants (where the tongue tip is retracted to the post-alveolar region, or the sublaminal surface of the tongue articulates with the pre-palatal or palatal region). Although a distinction can be drawn between laminal and apical linguo-labials, there is at present no evidence to suggest that this distinction plays a contrastive role in any language. For phonological purposes, then, only one distinctive representation for linguo-labial place appears sufficient.

The question is, how should the pairing of active and passive articulator be represented when the passive articulator cannot be inferred from the active. In established terminology, linguo-labials are undoubtedly coronal (Ladefoged and Maddieson, 1986, suggest the term lingual in place of coronal since this term more straightforwardly indicates the active articulator). But there are a range of different articulatory places which are all coronal (or lingual). The feature anterior can be used to distinguish articulations in front of the alveolar ridge from post-alveolar ones, but would not distinguish the former from linguo-labials unless the labial element in their production is represented. Sagey (1986) suggests limiting anterior to only coronal segments by placing it within a hierarchically organized place node in a feature hierarchy of the sort proposed by Clements (1985). Thus if linguo-labials were to be represented as anterior and labial, the anterior specification would imply their coronality. But this description would not indicate that a single displaced articulation is at issue; rather, this would be the representation of a segment which had a double articulation, i.e. simultaneous coronal and labial articulations. It would be an appropriate representation of a segment such as [p͡t]. In other words, labial indicates that the lower lip is the active articulator, rather than that the upper lip is the passive articulator.

Yet, by a test which is implicit in Halle (1982), linguo-labials are labial in that they cannot be combined with a bilabial articulation to form a labial-linguo-labial. Because they rule out an independent labial articulation (though not rounding), they do "occupy" the labial place in the place node. What the formal representation must capture is that the labial place is passively occupied by a gesture which is actively coronal. We suggest that a theories of feature geometry must be modified so that two terminal place nodes can be linked to each other. The representation of [p̪] would differ from that for [p͡t] by the presence of this link, as in the simplified representations (a) and (b) below.



The possible ambiguity as to which articulator is the active one in the representation in (a) is not a real difficulty, since the lip cannot be retracted to reach the tongue tip in its rest position. Hence (a) has only one possible real-world interpretation. A more serious problem is caused by the fact that there are many pairings of an active with a passive articulator which can be represented but which have no meaningful interpretation. An example would be either pairing of the tongue dorsum and the upper lip. Since the tongue tip and blade are the most mobile of all articulators and this portion of the tongue is involved in linguo-labials and in retroflex consonants, it might be appropriate to restrict this kind of linking so that the coronal node, directly or indirectly through anterior, must be one of those involved in the linking.

Note that the displaced articulation used in labio-dentals cannot be represented by linking terminal nodes, as proposed here. Labio-dentals are labial by the test described above, but they are not coronal. Hence the passive involvement of the upper teeth in their production is not correctly represented by linking labial with coronal. And no other feature from the familiar set can be used to refer directly refer to the role of the teeth in this place of articulation. Unfortunately, a full discussion of this issue would lead too far afield from the main theme of this paper.

Footnote

1. A translation of the New Testament in this language was published in 1986. The orthographic convention used for linguo-labials is to add an apostrophe after the letters used for other labial consonants. In Vao, a macron is written above the letters.

Acknowledgments

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References.

Abercrombie, David. 1967. *Elements of General Phonetics.* Edinburgh University Press, Edinburgh.

Blust, Robert. 1980. Austronesian Etymologies. *Oceanic Linguistics* 19: 1-181.

Blust, Robert. 1983-4. Austronesian Etymologies - II. *Oceanic Linguistics* 22-23: 29-149.

Camden, William G. 1979. Parallels in structure of lexicon and syntax between New Hebrides Bislama and the South Santo language as spoken at Tangoa. *Papers in Pidgin and Creole Linguistics No. 2* : 51-117. Pacific Linguistics, Series A, No 57.

Capell, Arthur, & John W. Layard. 1980. *Materials in Atchin, Malekula: Grammar, Vocabulary and Texts.* Pacific Linguistics, Series D, No. 20.

Clements, G.N. 1985. The geometry of phonological features. *Phonology Yearbook* 2: 225-252.

Everett, Daniel L. 1982. Phonetic rarities in Pirahã. *Journal of the International Phonetic Association* 12: 94-96.

Fox, Gregory J. 1979. *Big Nambas Grammar.* Pacific Linguistics, Series B, No. 60.

Geraghty, Paul A. 1983. *A History of the Fijian Languages* (Oceanic Linguistics Special Publication 19). University of Hawaii Press, Honolulu.

Grace, George W. 1969. *A Proto-Oceanic Finder List.* Working Papers in Linguistics 1: 38-84. Department of Linguistics, University of Hawaii, Honolulu.

Guy, Jacques B.M. 1974. *A Grammar of the Northern Dialect of Sakao.* Pacific Linguistics, Series B, No. 33.

Hockett, Charles F. 1955. *A Manual of Phonology.* Indiana University, Bloomington.

Halle, Morris. 1982. On distinctive features and their articulatory implementation. *Natural Language and Linguistic Theory* 1:91-105.

Ladefoged, Peter. 1971. *Preliminaries to Linguistic Phonetics.* University of Chicago Press, Chicago.

Ladefoged, Peter & Ian Maddieson. 1986. *Some of the Sounds of the World's Languages.* UCLA Working Papers in Phonetics 64.

Layard, John Willoughby. 1934. The journey of the dead. *Essays presented to C.G. Seligman,* ed. by E.E. Evans-Pritchard, R. Firth, B. Malinowski, & I. Schapera. Kegan Paul, Trench, Trübner & Co., London. Pp. 113-142.

Layard, John Willoughby. 1942. *Stone Men of Malekula.* Chatto & Windus, London.

MacDonald, Donald. 1891. *South Sea Languages: a Series of Studies on the Languages of the New Hebrides and the Other South Sea Islands, Vol II,* *Tangoan-Santo, Malo, Malekula, Epi (Baki and Bierian), Tanna and Futuna.* Trustees of the Public Library, Museums, and National Gallery of Victoria, Melbourne.

Maddieson, Ian. 1987. Revision of the I.P.A. - linguo-labials as a test case. *UCLA Working Papers in Phonetics* 68: xx-xx. (To appear in Journal of the International Phonetic Association).

Ray, Sidney Herbert. 1926. *A Comparative Study of the Melanesian Island Languages*. Cambridge University Press, Cambridge.

Sagey, Elizabeth C. 1986. *The representation of features and relations in non-linear phonology.* Ph. D. dissertation, M.I.T., Cambridge, Massachusetts.

Tryon, Darrell T. 1976. *New Hebrides Languages: An Internal Classification.* Pacific Linguistics, Series C, No. 50.

Wurm, Stephan A. & B. Wilson. 1975. *English Finderlist of Reconstructions in Austronesian Languages (Post-Brandstetter).* Pacific Linguistics, Series C, No. 33.

Tongue mechanisms in Akan and Luo

Mona Lindau-Webb

Introduction.

Vowel systems in most of the world's languages can be described in terms of features of vowel height and vowel backness in a two dimensional space. Many languages make do with solely these two features for specification of their vowel system. Languages with additional contrasts are conventionally described as if they superimpose other features. Some of these features, such as rounding and nasality, are clearly independent properties; but others, such as tenseness, or features of pharyngal variation are treated as if in some way additive properties that combine with the features of Height and Backness.

Here I want to raise a general question of the relationship between phonological features and phonetic mechanisms in vowels, and in particular the question of how different languages organize their phonetic vowel mechanisms to match phonological features. Ladefoged (1980) demonstrated a complex relationship and a many-to-many type of mapping of vowel features onto their phonetic tongue mechanisms in English. The features of Height and Backness are related to tongue mechanisms of Front Raising and Back Raising in a non-simple way. Each value of Height or Backness is related to a combination of values of both Front Raising and Back Raising. In order to investigate further how different languages map vowel features onto phonetic mechanisms, and in particular how the added feature of Vowel Harmony is integrated articulatorily, Akan was chosen. In addition to features of Height and Backness the vowel harmony feature also involves the tongue in varying the root of the tongue for the two harmonizing sets of vowels.

One possible way of organizing phonetic mechanisms in Akan vowels is that the two phonological features of Height and Backness are phonetically the same as in English, and then there is an added mechanism controlling the Vowel Harmony. In other words, the feature of Vowel Harmony is simply superimposed onto the basic system of Height and Backness in an additive way. Another possibility is that when features are added to the basic system all phonetic mechanisms require a different organization and integration. Related to this are questions of the number of phonetic correlates involved to match features. Are two features implemented by two phonetic mechanisms, and three features by three phonetic mechanisms, etc., or is the number of phonetic correlates involved independent of the number of features?

If the phonetic mechanisms underlying features are organized in an additive way, then Akan would be expected to exhibit the same phonetic correlates for Height and Backness as English, plus an additional phonetic mechanism of Width or Advanced Tongue Root to account for the vowel harmony. This kind of organization was implied in earlier work on Akan by Lindau (1979).

If on the other hand, different languages instead organize their available phonetic mechanisms in different ways, then we would not expect the phonetic correlates of Height and Backness in Akan to be the same as in English.

The vowel system of Akan, a Kwa language spoken in Ghana, is typical of an African vowel harmony language. Akan has nine vowels, in a system of four set 1 vowels /i,e,u,o/ and four corresponding set 2 vowels /i̧, ẹ, u̧, ọ/ as well as a low vowel /a/ that co-occurs with set 2 vowels. As a rule, a word in Akan may contain vowels from one set only. This system is conveniently described with three phonological features of Vowel Height, Backness, and Vowel Harmony.

Procedure

I investigated the articulatory mechanisms controlling the vowels of Akan by using tracings from cineradiographic data from four speakers saying phrases with words illustrating the nine vowels (Lindau 1979). Each vowel is repeated five times by each speaker.

Figure 1 shows superimposed typical tracings of four front and four back Akan vowels of one speaker. The tongue shapes of set 1 vowels are drawn with solid lines, and those of set 2 with dashed lines. In set 1 vowels the tongue root is advanced in combination with a relatively low larynx, with the effect of expanding the pharynx. In set 2 vowels the tongue root is retracted and the larynx is higher than in set 1 vowels, thus constricting the pharynx. The main articulatory difference between the harmonizing sets thus appears to be variation in the size of the pharynx, and Lindau (1979) preferred a label of Expanded over Advanced Tongue Root for the feature. The differences in pharyngal size are also accompanied by differences in the height of the tongue.

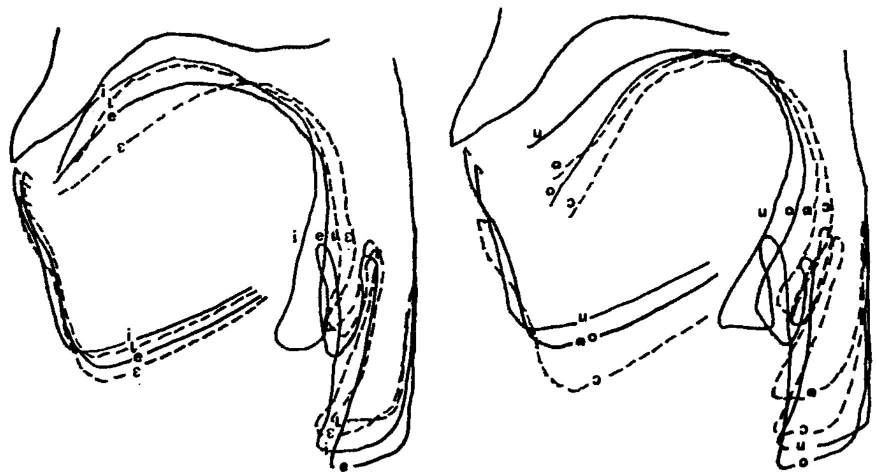


Figure 1. Superimposed tracings of front /i, e, ị, ẹ/ i.e. [i, e, ɩ, ɛ] and back /u, o, ụ, ọ/ i.e. [i, e, ɷ, ɔ] of one speaker of Akan.

The tongueshapes in this dataset were quantified by applying a grid of 16 sections on the tongue shapes. Each tongue shape is thus described in terms of 16 numbers. These measurements were analyzed by applying a statistical procedure of factor analysis. The measurements and analysis were done in the same way as Harshman et al. (1977) had done for analyzing the vowels of English from five speakers, where the results showed that the tongue shapes of English vowels are controlled by two underlying tongue parameters, labelled Front Raising and Back Raising. The particular factor analysis we used is called PARAFAC. It provides a procedure for determing the correct number of 'true' or unique factors that underlie the variation in a dataset (Harshman et al 1977; Harshman and Lundy 1984). Considering a tongue shape, described in terms of 16 or so points, it is evident that the position of any point on the tongue is related to the position of all other points, as well as to the vowel being considered. Taking all this into account the PARAFAC procedure will determine the correct number of factors and underlying tongue shapes in the dataset.

Results and discussion.

The results show that in spite of the third phonological feature of vowel harmony there are two, and only two underlying tongue gestures that determine variation in the tongue shapes of the vowels in Akan. These are illustrated in figure 2. In this figure a Macintosh program has been used to plot the variation in the two underlying gestures. The parameters of variation have been plotted as deviations from a neutral vowel. Note that these gestures do not represent the tongue shapes of Akan vowels, but two basic underlying components of variation, a kind of building blocks that are added together in different ways to form the actual tongue shapes of Akan vowels. The first vowel gesture involves variation of the front part of the body of the tongue as well as the tip of the tongue, and variation of the upper part of the back of the tongue. This component thus varies from something like an [i]-shape to an [ɔ]-shape. The second component involves a lot of action of the middle of the tongue rising towards the velum, in conjunction with large variation of the root of the tongue. The tongue shapes of this gesture vary from an [u]-shape to an [a]-shape. The variation in the tongue root is mostly connected to the second component, but the large movement of the tip of the tongue in the first component may also be a reflection of tongue root movement.

We can get a better picture of how the vowels are related to these underlying tongue shapes, when we plot how the vowels are distributed along these two underlying gestures. Figure 3 shows the distribution of the vowels along the axes of the two gestures. Along the y-axis (factor 1) the vowels vary from an [i]-shape to an [ɔ]-shape, and along the x-axis (factor 2) the vowels vary from an [u]-shape to an [a]-shape.

As expected from the large amount of variation in the tongue root in the [u] - [a] gesture, the harmony affiliation is implemented most strongly along this component. Set 1 and set 2 vowels are at least pairwise separated by a large distance along this axis. But harmonizing pairs of vowels are also separated to some extent along the first [i]-[ɔ] gesture. Thus the phonological feature of vowel harmony is not related in any simple way to any single phonetic mechanism, but it is implemented by a complex interaction of the two underlying tongue gestures.

The resulting shape of this figure is very much like a traditional vowel chart, but rotated and turned. The rotation of the chart in comparison to a traditional vowel chart means that these underlying gestures are not related to the features of Height and Backness in any simple way, but both Height and Backness are related to combinations of both underlying gestures.

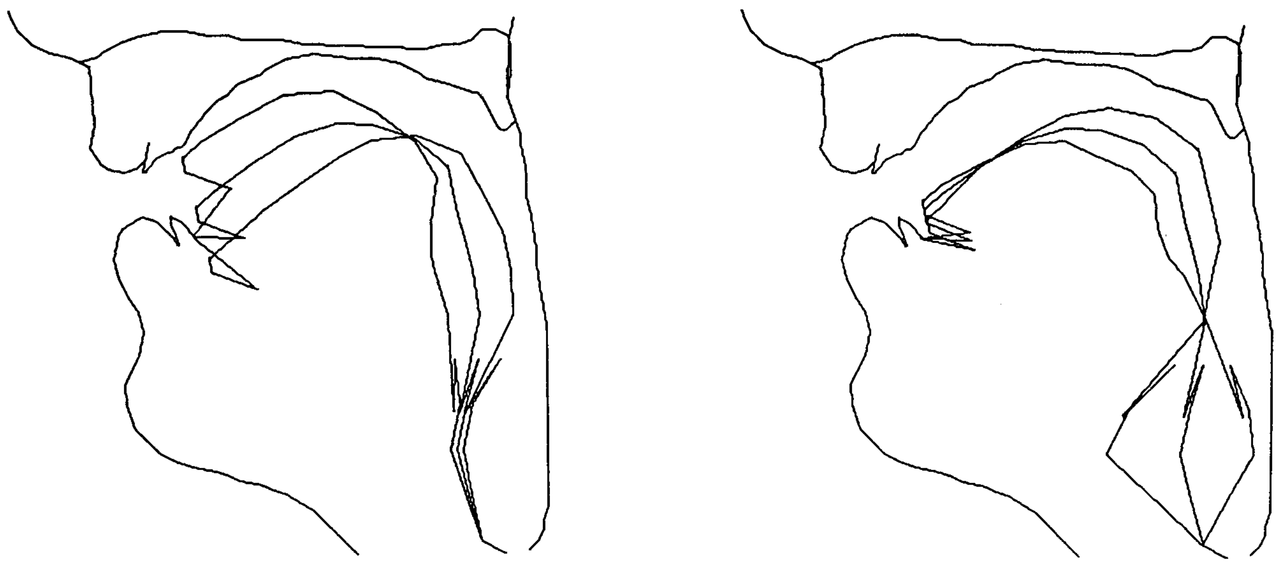


Figure 2. The two underlying tongue gestures that control the tongue shapes of Akan vowels, plotted as deviations from a neutral vowel. The left gesture involves a movement from an [i]-shape to an [ɔ]-shape, the right gesture a movement from an [u]-shape to an [a]-shape.

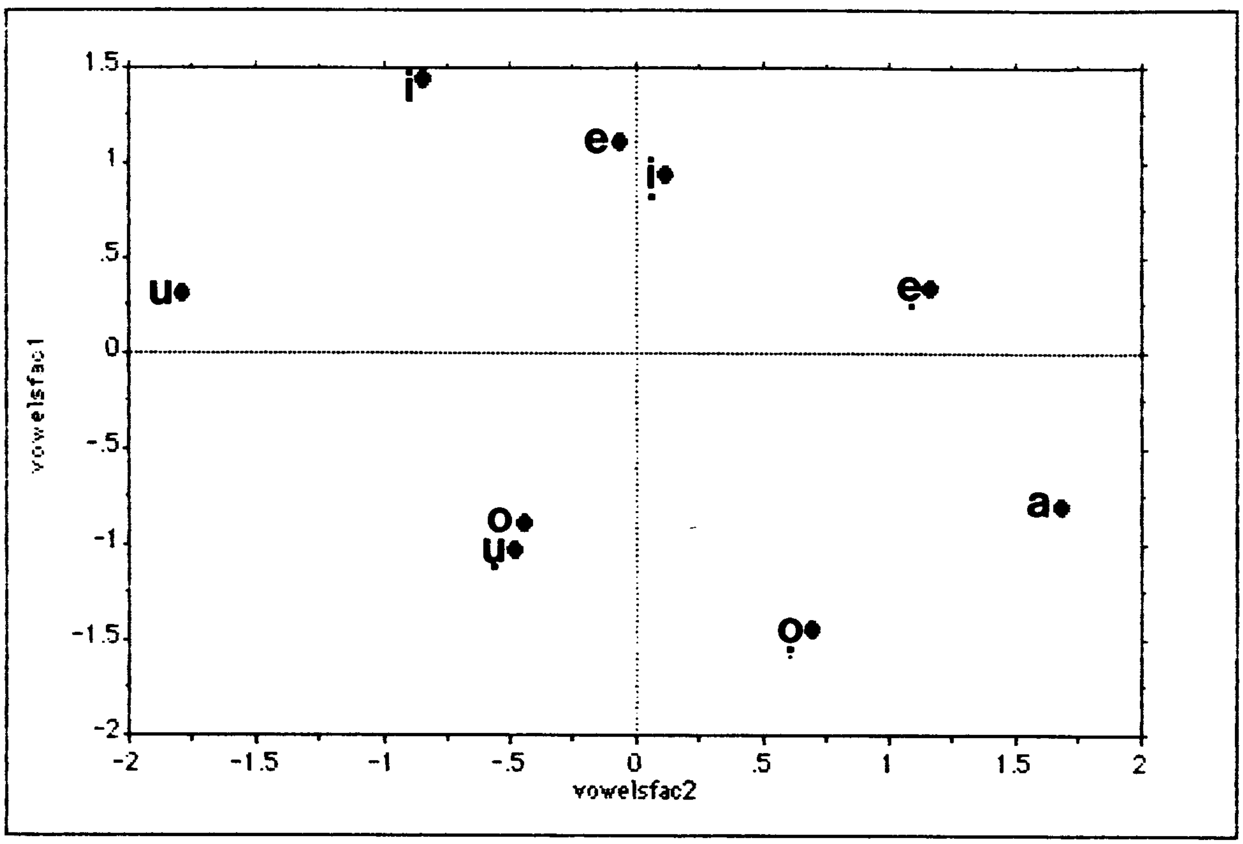


Figure 3. Plot of the distribution of the Akan vowels along the two axes of underlying components ("factor 1" and "factor 2").

The similarity between the chart of the space of the underlying gestures and a traditional vowel chart can be illustrated by comparing the articulatory space in figure 3 to an acoustic chart of the Akan vowels. Figure 4 shows the first and second formant frequencies of the vowels of the same four speakers plotted on a formant chart. The articulatory and the acoustic charts show a similar distribution of the vowels, even to the degree of closeness and overlap between the high set 2 [ι] and [ε] and the mid set 1 [e] and [o]. These two vowel pairs occupy quite similar positions both in an acoustic space and an articulatory space. In spite of the tongue root separating vowels of different harmony affiliation, the result of combining these tongue mechanisms is a merger. This suggests that there may be a case for concluding that for practical purposes these two pairs of vowels have merged phonetically in Akan. However, when additional articulatory mechanisms, like the height of the larynx, are considered, it is found that larynx height is significantly lower for the set 1 vowel than the set 2 vowel.

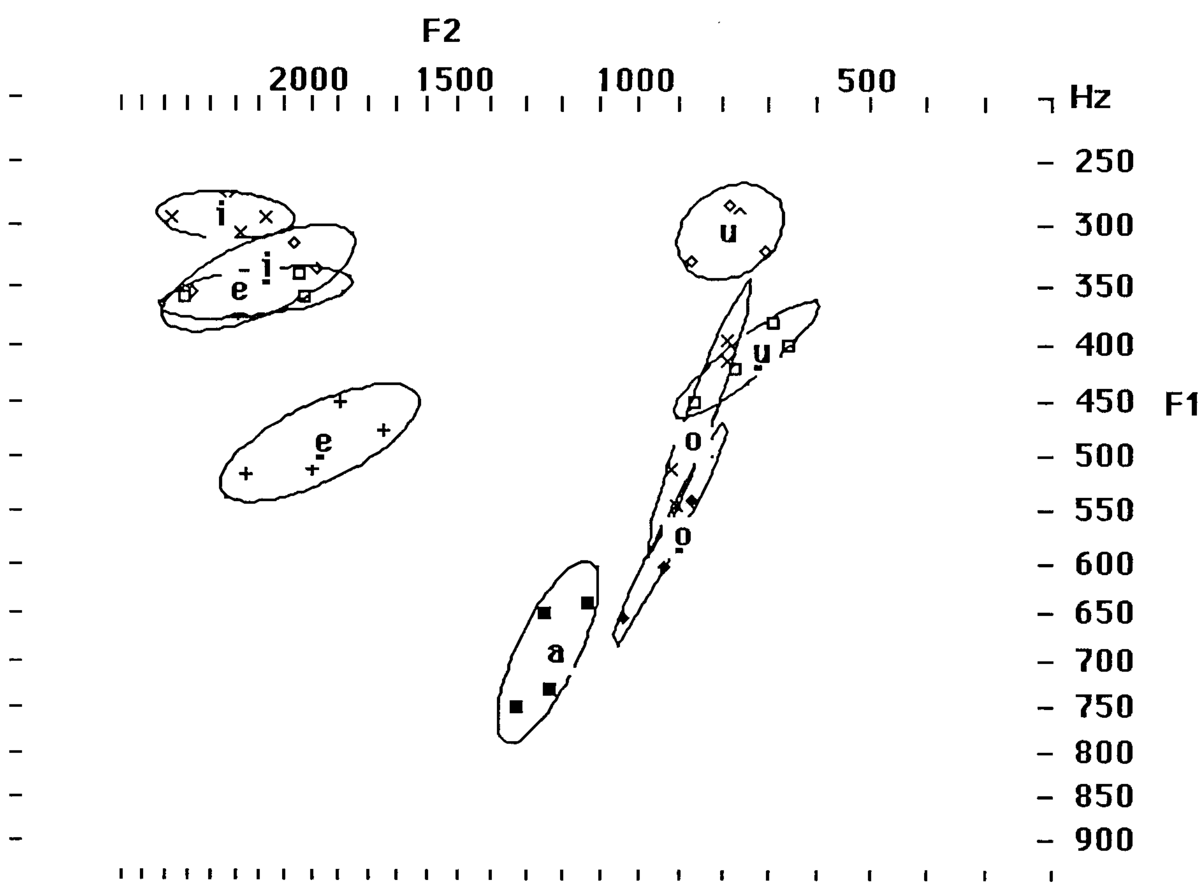


Figure 4. Formant chart of the Akan vowels from four speakers.

Returning now to the general question of how phonetic mechanisms are organized in different languages let us compare the Akan tongue gestures to those in English. Harshman et al. (1977) analyzed x-ray tracings of ten English vowels from five speakers by using factor analysis in the manner described above. Their results show that the tongue shapes of English vowels can be described in terms of two underlying factors, or tongue gestures, illustrated in Figure 5. These gestures were later labelled Front Raising and Back Raising by Ladefoged (1980).

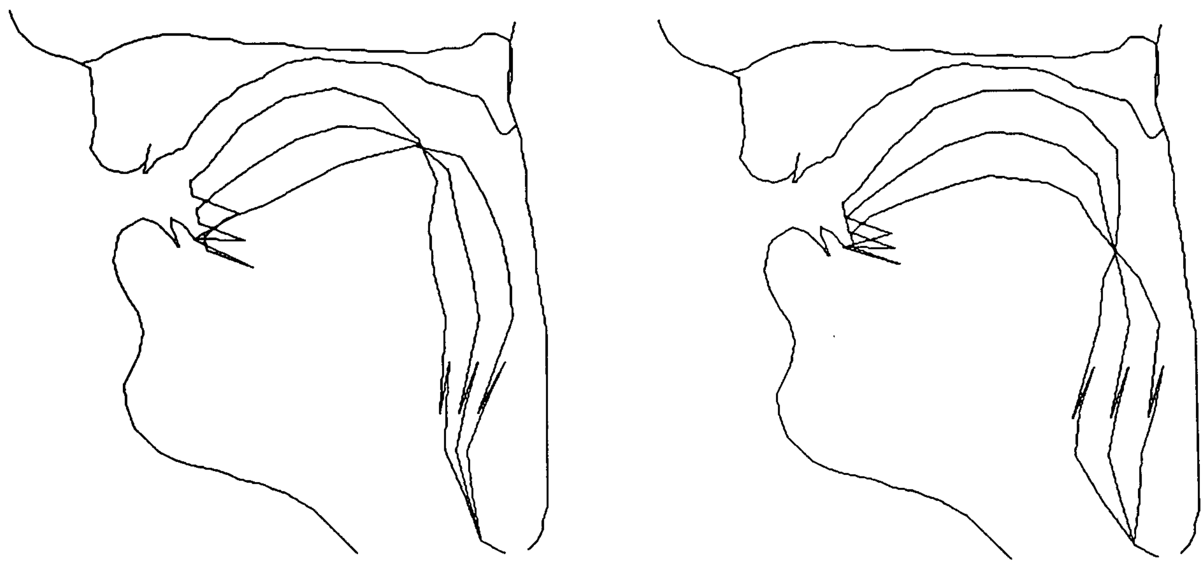


Figure 5. The two underlying gestures that control the tongue shapes of vowels in American English, plotted as deviations from a neutral vowel (from Ladefoged). The left hand one is labelled Front Raising, and the right hand one Back Raising.

Comparing the two Akan components with the two English ones, we find that apart from the greater variation in the tip of the tongue in Akan, English Front Raising and the [i] - [ɔ] component in Akan are largely the same, and we can label this component Front Raising in Akan as well. However, when we compare English Back Raising with the second Akan component of variation, there is no obvious conclusion. These latter components show some movement of the tongue towards the velum in both languages, and they both vary at the root of the tongue, but the amount of variation of the tongue root is much greater in Akan. The precise relationship between the Back Raising gesture in English and the second gesture in Akan is not very clear.

To get a better idea of how underlying tongue gestures in different languages are related, a third language was selected for investigation, where the vowel system appears to fall somewhere in between English and Akan. Luo, a Western Nilotic language from Kenya, has nine vowels and vowel harmony that is structurally similar to that in Akan. In a dissertation (1978) Jacobson analyzed x-ray tracings of the eight high and mid vowels from eight speakers of Luo. Unfortunately the low [a]-vowel is not included in the data, and this omission may have some effect on the results of analysis. Jacobson's results did not show the strong and consistent association between variation in the tongue root and harmony affiliation that is found in Akan, but rather a lot more individual variation. Although some speakers implemented the vowel harmony between some pairs of vowels, using the tongue root, others use tongue height a lot more. The production of Luo vowels thus shows similarities with both Akan and English.

I used Jacobson's published data on x-ray tracings from eight speakers from Luo and measured and analyzed the tongue shapes using the same factor analysis as for English and Akan. The results again establish that the tongue shapes of Luo are determined by two, and only two, underlying tongue gestures, illustrated in figure 6. The Front Raising component appears again in Luo. The variation of the tongue tip of this component falls right between that of English and that of Akan. The other underlying gesture in Luo is similar to both Back Raising in English and to the second componenet in Akan in the variation of the body of the tongue towards the velum. This gesture in Luo also shows considerably more variation of the tongue root than English, but not as much as in Akan.

Figure 7 is a plot of the distribution of vowels along the two underlying tongue gestures in Luo, showing how the vowels are distributed in the articulatory vowel space. The distributional patterns of Luo and Akan show strong similarities. The Luo figure has the shape of a traditional vowel chart, rotated in the same way as Akan, showing that the relationships between Height and Backness and the underlying tongue shapes in Akan and Luo, although complex, are still very much the same in the two languages. As in Akan, harmony affiliation is associated mostly with the second [u] - [a] component, and to a small extent with the Front Raising component. When we compare this articulatory space to the acoustic space of Luo vowels in Figure 8 we find a reasonable similarity, although the back vowels are spaced out more in the

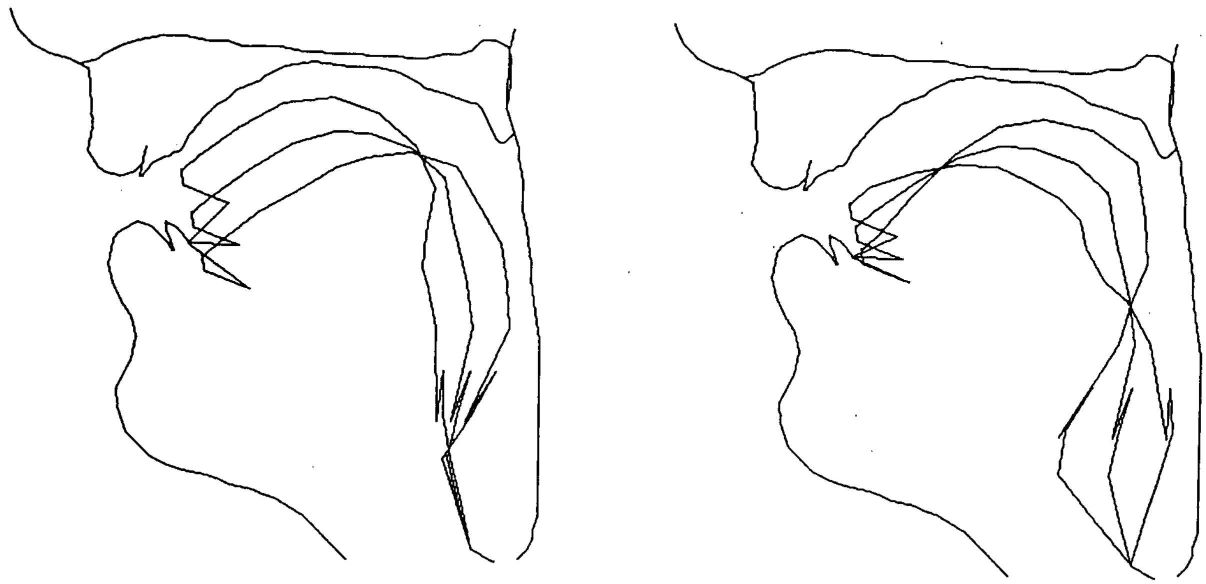


Figure 7. Plot of the distribution of Luo vowels along the axes of the underlying tongue gestures ("factor 1" and "factor 2").

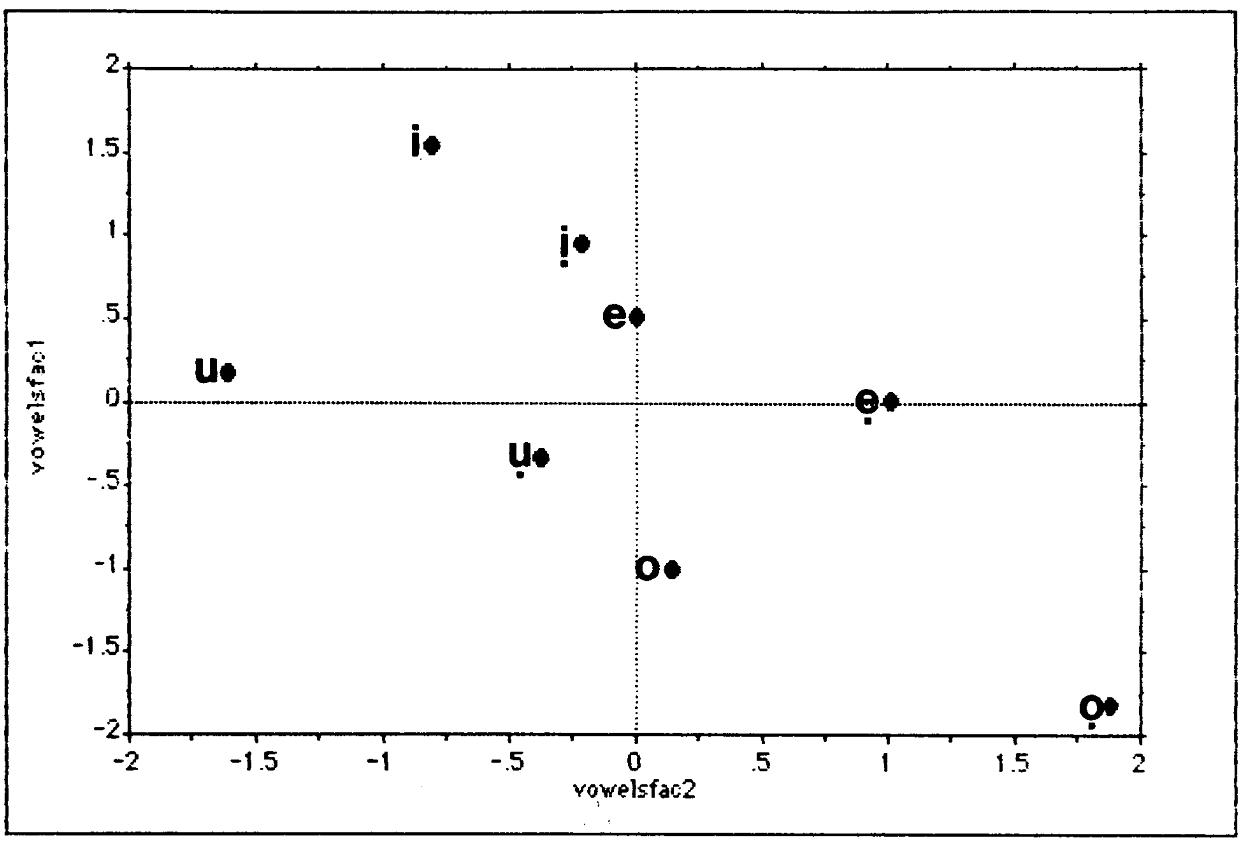


Figure 6. The two underlying gestures that control tongue shapes in Luo vowels, plotted as deviations from a neutral vowel.

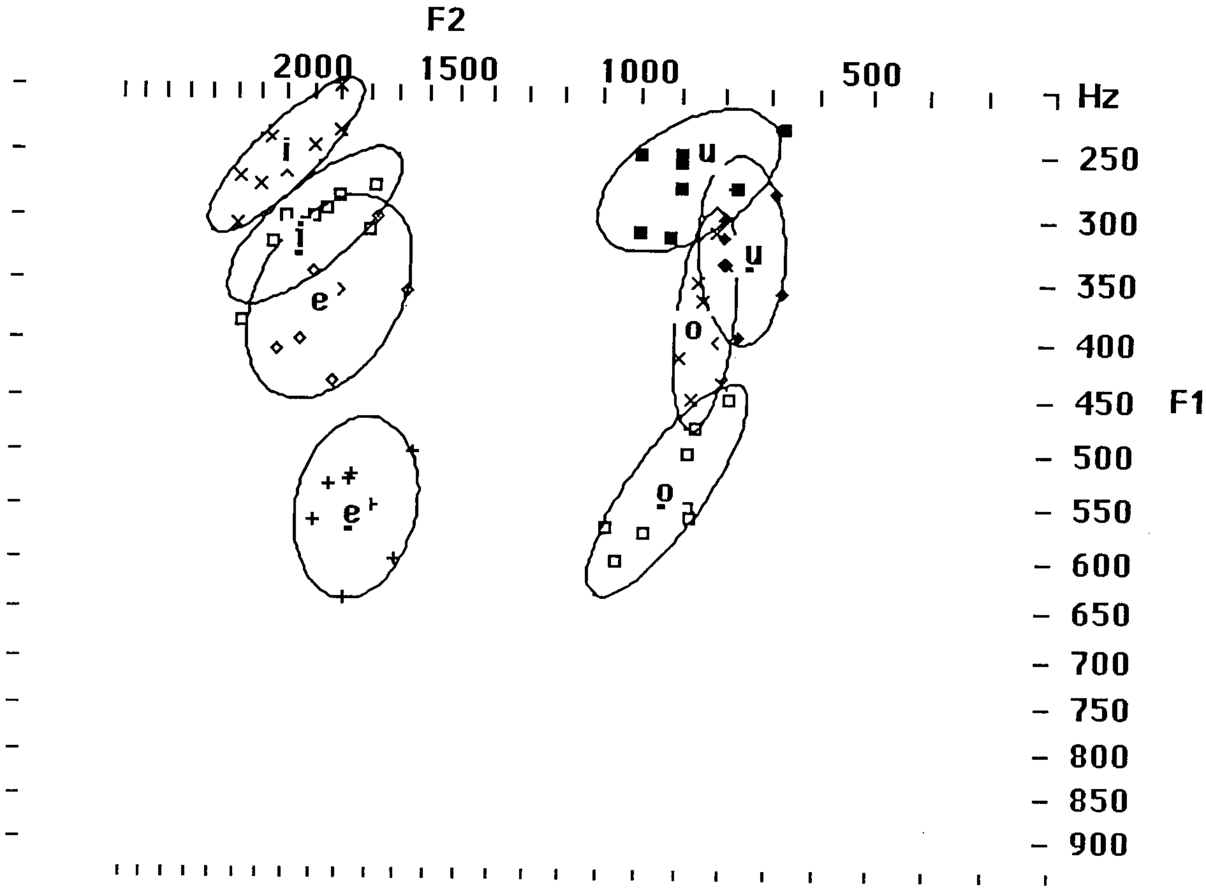


Figure 8. Formant chart of the Luo vowels from eight speakers.

articulatory space than in the acoustic space. This may be due to missing data of the low [a] vowel in Jacobson's dissertation. The eight vowels may in a sense try to take up the space of nine vowels. Also note, that in contrast to Akan there is no evidence of merging between the high set 2 vowels and the mid set 1 vowels in Luo.

Returning now to the original questions posed at the beginning about the relationship between phonological features and phonetic mechanisms, and about the organization of phonetic mechanisms, some conclusions can be drawn from the above analyses. The same complex many-to-many relationship between features of Height and Backness that Ladefoged found for English also exists in Akan and Luo. But the situation is even more complex, as when we compare English to languages with a third feature involving the tongue, like the vowel harmony feature in Akan and Luo, the number of underlying mechanisms for the tongue do not increase. Adding a third feature does not increase the number of underlying tongue gestures, but the three phonological features get mapped onto two underlying tongue gestures.

The tongue shapes of vowels in English, Akan, and Luo are thus all organized in terms of only two underlying tongue mechanisms. Statistical analyses (multiple regression) further show that these two underlying mechanisms are basically the same in all three languages. One component orders vowels on an axis from [i] to [ɔ], and the other from [u] to [a]. Ladefoged labelled these mechanisms Front Raising and Back Raising for English, and these labels still seem adequate for Akan and Luo. Furthermore, the Front Raising component that orders vowels from [i] to [ɔ] can be related to a perceptual property of 'brightness' (Bladon 1986) that has been found in many languages. It seems reasonable to propose a principle that the basic similarities in the shape of the vowel space that is found in language after language be related to the same underlying tongue gestures.

However, although tongue shapes of vowels in different languages are organized in terms of the same two underlying tongue mechanisms, these mechanisms are not implemented in exactly the same way in different languages. Although the basic gesture is the same, the distribution of values along the parameter of Front Raising or Back Raising differs between languages. In English Back Raising there is a moderate variation of the body of the tongue toward the front part of the velum accompanied by a moderate variation in the root of the tongue. In Akan and Luo the body of the tongue varies toward the velum a bit further back than in English, and there is considerably more variation of the root of the tongue. There is more variation at the root of the tongue in Akan than in Luo. Thus the principle of relating basic similarities in the vowel space can be complemented with a proposal that differences between languages are related to differences in the distribution of values of the basic underlying gestures.

Acknowledgements

I am very grateful for all the help and discussions provided by Richard Harshman, Michel Jackson, and Peter Ladefoged.

References:

Bladon, A. (1986). Phonetics for hearers. In G. McGregor (ed.), Language for Hearers, pp. 1-24. Oxford: Pergamon.

Harshman, R., P. Ladefoged, L. Goldstein, and L. Rice (1977). Factor analysis of tongue shapes. The Journal of the Acoustical Society of America, 62.3:693-707.

Harshman, R. and Lundy, M. E. (1984). The PARAFAC model for three-way factor analysis and multidimensional scaling. In H.G.Law, C.W. Snyder, Jr., J.A.Hattie, and R.P. McDonald (eds.), Research Methods in Multimode Data Analysis, pp. 122-215. New York: Praeger.

Ladefoged, P. (1980). What are linguistic sounds made of? Language 56.3: 485-502.

Lindau, M. and P.Ladefoged (1986). Variability of feature specifications. In Perkell, J.S. and D.H.Klatt (eds.) Invariance and Variability of Speech Processes, pp.464-479.

Lindau, M. (1979). The feature Expanded. Journal of Phonetics 7: 163-176.

Acoustic characteristics of the vowel harmony feature and vowel raising in Akan

Susan Hess

Introduction

Two different claims have been made about the nature of vowel assimilation between vowels of different harmony sets in Akan. One claims that the assimilation is complete and involves a complete change in tongue position. The other claims that the assimilation is partial and only involves raising of the tongue body. The objectives of this paper are to investigate the acoustic characteristics of the vowel harmony feature in the Kwawu dialect of Akan in order to determine which description of vowel assimilation is correct. The focus will be to try to determine whether this assimilation is one of tongue body alone, or of tongue root and tongue body.

Kwawu, like most other dialects of Akan, has nine phonemic vowels, all of which can occur independently in monosyllabic noun and verb stems. These vowels are shown in (1) below:

1. Kwawu vowels

i	ɩ		u	ω		(high)
e	ɛ		o	ɔ		(mid)
		a				(low)

Of the four pairs of mid and high vowels, those on the left have an advanced tongue root ([+ATR]), resulting in an expanded pharynx, while those on the right have a retracted tongue root ([-ATR]). The low vowel, /a/, is a [-ATR] vowel, and unlike the high and mid vowels, does not have a [+ATR] counterpart. It does, however, have an allophone [æ] which occurs before syllables containing a [+high, +ATR] vowel ([i, u]).

Clements (1981) argues that [æ] is not derived through vowel harmony, as it is sometimes claimed to be (a claim which is shown to be incorrect from x-ray data), or from an allophonic rule specific to /a/, but through a more general and extensive vowel-raising rule which applies to all [-ATR] vowels when the first syllable of the following word begins with a [+high, +ATR] vowel. /a/ would also be subject to this rule word-internally.

Clements claims that as a result of this rule, high [-ATR] vowels merge completely with the corresponding [+ATR] vowels; mid [-ATR] vowels are acoustically intermediate between the [-ATR] and [+ATR] values for mid vowels, and that the realization of [æ] varies according the the nature of syntactic juncture involved. Thus when the syllable containing /a/ is word internal and precedes a syllable with a high [+ATR] vowel or precedes the indefinite article [bi] or the postposition [mu], /a/ is both raised and fronted. However, when the syllable containing /a/ is followed by a noun object whose first syllable contains the [+high, +ATR] trigger, /a/ is merely raised and not fronted. This suggests that there are at least two different rules that operate after binary feature values have already been changed into more phonetic ones. One rule, which would apply to all vowels, would apply across word boundaries and raise a [-ATR] vowel occurring before a word-initial syllable containing a [+high, +ATR] vowel. The second rule must assume either a deleted or different boundary for the cases involving /bi/ and /mu/ and state that /a/ will be both raised and fronted where there is no boundary (or a different boundary) between the syllable containing /a/ and that containing the [+high, +ATR] vowel. Clements also states that vowel raising "is not local to the syllable immediately preceding the conditioning syllable, but influences the articulation of preceding syllables as well, causing them to acquire increasingly raised variants..." (p 157).

Clements is essentially claiming that there is assimilation of tongue body height but not of tongue root position in vowel raising. On the other hand, Dolphyne (1987: 20) states that "an unadvanced vowel immediately preceding an advanced vowel is replaced by the corresponding advanced vowel," implying that the essential change is one of tongue root position, and further, that the assimilation is complete rather than partial. Dolphyne's examples are given in (2) below. Items on the left show the forms before application of the assimilation rule, while those on the right show the results of the rule.

2. Compounds:

bɔ din	abodin	"praise/title"
asɛm hunu	asenhunu	"useless talk"
ɔhɩnɩ fie	ahimfie	"palace"

Sentences:

ɔpɛ sika	ɔpe sika	"he likes money"
mɛkɔ Kumasɩ	mɛko Kumasɩ	"I will go to Kumase"
frɛ Kofi	fre Kofi	"call Kofi"

We will be addressing three questions below: 1) Acoustically, can one tell if a [-ATR] vowel is raised or if it is replaced by a [+ATR] vowel? 2) What is the domain of raising, i.e one syllable or more? 3) Is raising gradient in nature?

Acoustic analysis of the [ATR] feature

In this section we will look at five kinds of measures to see what distinguishes [+ATR] and [-ATR] vowels. These are: formant frequency, formant bandwidth, duration, pitch, and amplitude of the first three harmonics.

Data were obtained from one speaker of Kwawu, Mr. Yaw Agyakwa from Obomeng, Ghana. The word list was originally adopted from Painter (1976), as he had collected a uniform set of words displaying a VCV syllabic shape (with one exception - æ), all with a common consonant. This list had to be modified for use for the Kwawu dialect because of tonal and nasalization differences and presence or absence of a glottal stop. The word list is given in (3). Words numbered with (a) reflect the original list from Painter while those numbered with (b) reflect modifications. Four tokens of each vowel were recorded in the frame " **kă . . . tɕìrɛ́ mè**" ("say . . . show me" = say . . . to me). As the alveopalatal affricate **tɕ** exerted a stronger influence on low vowels than on high vowels, the frame was changed to "**bɔ̀ . . . tɔ́ mè**" (no meaning, but has the form of a serial verb construction) in subsequent recordings.

3. Word list for [ATR] contrasts.

Gloss		Word	Vowel	Tone
1.	adversary	àsí	i	H
2a.	father-in-law	àséʔ	ɩ	H
2b.	under	àsé	ɩ	H
3.	a yell	òsé	e	H
4a.	a similarity	ɔ̀sɛ̀	ɛ	L
4b.	tiny shrimp	sɛ́sɛ	ɛ	H
5a.	menstruation	àsãbú	æ̃	L
5b.	your measure-of-gold	wó takú	æ	H
6.	a war	ɔ̀sá	a	H
7.	a fine person	òsó	o	H
8a.	a shark	ɛsɔ (unknown to the speaker)		
8b.	a hole	àsɔ́	ɔ	H
9a.	a species	èsṹ	ũ	H
9b.	yam	òsú	u	H
10.	the top	ɛ̀só	ɷ	H

The first four formants of the vowels, various segment durations and pitch were measured form spectrograms produced from these recordings. Formant means of four tokens of each vowel recorded in the original frame are given in (4). Vowels are taken from (b) tokens except in the case of ɩ , in which 3.2a tokens were used.

4. Formant means (n = 4)

vowel	F1	F2	F3	F4
i	260	2141	2678	3565
ɩ	309	1785	2438	3640
e	311	1875	2498	3605
ɛ	458	1564	2430	4000
æ	525	1570	2053	3523
a	630	1319	2137	3460
u	306	780	2225	-----
ɷ	410	1198	2195	3170
o	423	1293	2455	3360
ɔ	524	1108	2065	3415

Formant plots of these four tokens of each vowel are shown in Figures 1 and 2. Figure 1 shows a plot of F2 vs. F1. It is immediately noticeable that the formant values for ɩ (represented by I on the plot) and for e overlap in space, as, to a lesser extent, do the values for ɷ (U) and o (cf. Lindau 1979). Figure 2, which plots F2' (a weighted mean of F3 and F2) vs. F1, shows that the addition of information on F3 does not disambiguate these pairs of vowels. If raised ɛ and ɔ reach normal formant values for ɩ/e and ɷ/o, the formant values alone will not tell us whether partial assimilation of tongue body height or total assimilation, including tongue root position, has taken place.

VOT measurements of p and duration of s before ɩ and e are given in (5).

5. Measures of consonant duration

gloss	word	duration (ms.) (VOT or s)	no. of tokens
he spits	ɔ̀pɩ́	30	2
cat (nickname)	òpé	20	2
father-in-law	àsɩ́	152.5	4
a yell	òsé	153	4

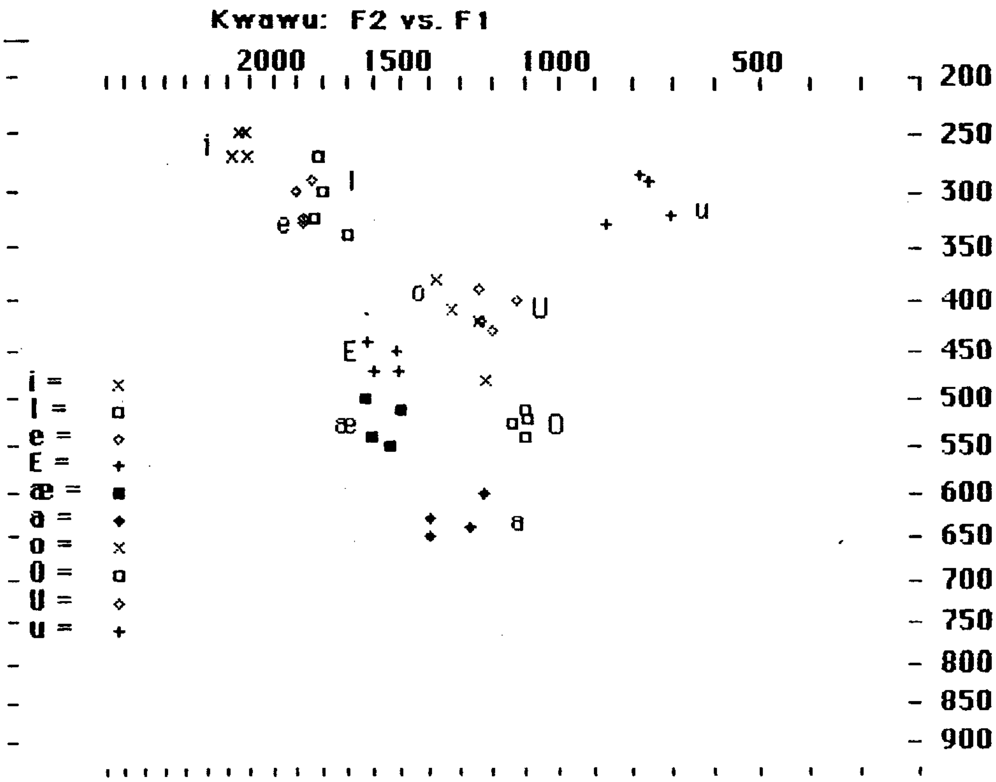


Figure 1. Plot of F1 (ordinate) vs F2 (abscissa) of 4 tokens of Kwawu vowels. Scales marked in Hz but proportional to the mel scale, with the origin in the upper right.

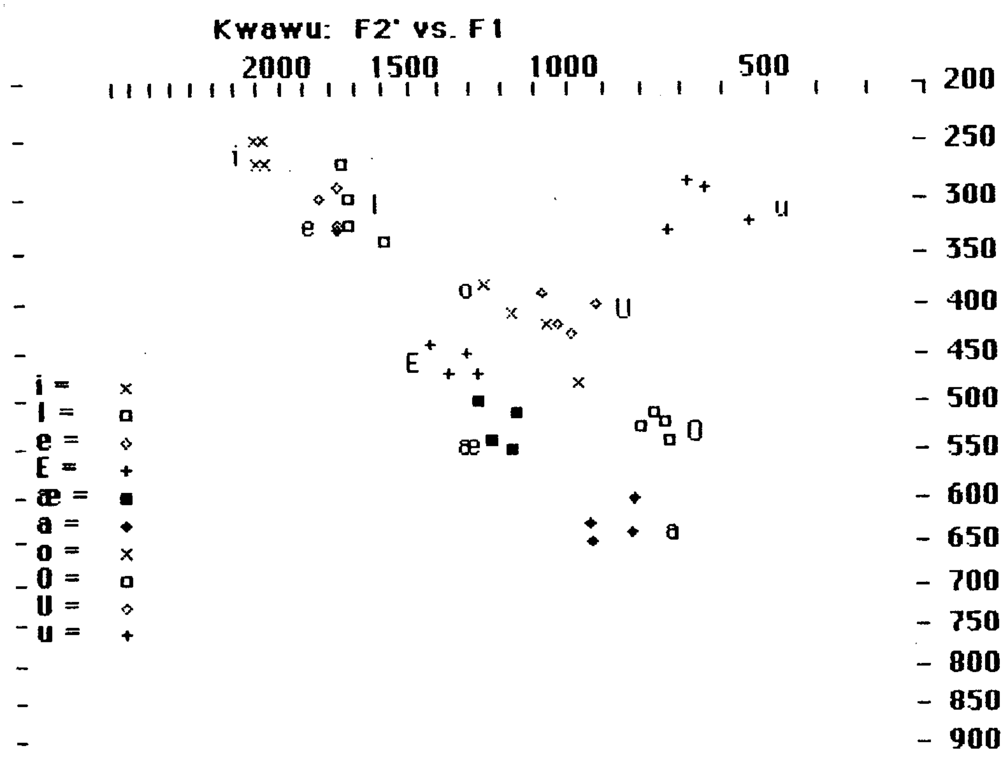


Figure 2. Plot of F1 (ordinate) vs F2' (abscissa), same tokens as in figure 1.

Vowel duration measures for i, ɩ, e, ɛ are given in (6).

6. Vowel duration (second syllable, in ms)

gloss	word	V dur. range	no. of tokens	gloss	word	V dur. range	no. of tokens
"adversary"	àsí	100-140	10	"father- in-law"	àsɩ́ʔ	98-112	3
				"under"	àsɩ́	89-123	6
"a yell"	òsé	111-129	10	"shrimp"	sɛ́sɛ	96-124	10

means	i	114
	ɩ	105
	e	119
	ɛ	106

These measurements suggest tendencies that group [+ATR] vowels vs. [-ATR] vowels: [-ATR] vowels tend to have a longer VOT and shorter vowel duration, while [+ATR] vowels tend to have a shorter VOT and a longer vowel duration. However, duration of /s/ before vowels of both types was the same. It would be difficult to classify a vowel of unknown tongue root position by these measurements unless it exhibited one of the extremes, as ranges of the different vowels overlap.

Pitch shows little variation among vowels of different harmony sets. Examples of pitch measurements of four tokens of high-toned ɩ and e are given in (7):

7. Pitch measurements (in Hz)

vowel	FØ onset	FØ offset
ɩ	179	158
	180	161
	179	149
	171	155
mean	*177*	*156*
e	184	163
	178	158
	175	161
	171	159
mean	*177*	*160*

Two measures of spectral balance (the relative amplitudes of different components of the spectrum) were checked to see if there were any damping effects associated with the different tongue root positions: the difference in amplitude between the first and second formants (F1-F2), and the difference in amplitude between the first and second harmonics (H2-H1). Amplitude measurements were based on spectrographic power spectra of vowels taken at a point one-third of the way through the vowel. Sample measurements are shown in (8) and (9). A second value in (8) indicates a frame taken 10 ms. after the first to check consistency:

8. F1-F2: individual measures (in dB)

i	2.3	ɩ	3.8	e	5.5
	5.5		6.8, 2.5		4.0, 4.2
	8.4, 3.0		4.1, 2.5		1.0
	6.0, 0.2		4.8		3.0

9. H2-H1: means of four tokens of each vowel (in dB)

i	-2.54
ɩ	.8
e	4.1
ɛ	-1.17
æ	-1.0
a	-1.74

The difference in amplitude between the first and second formants appeared to be so random that means have not been calculated. The difference between the first and second harmonics showed more consistency within each vowel, but no generalization emerges from the measurements.

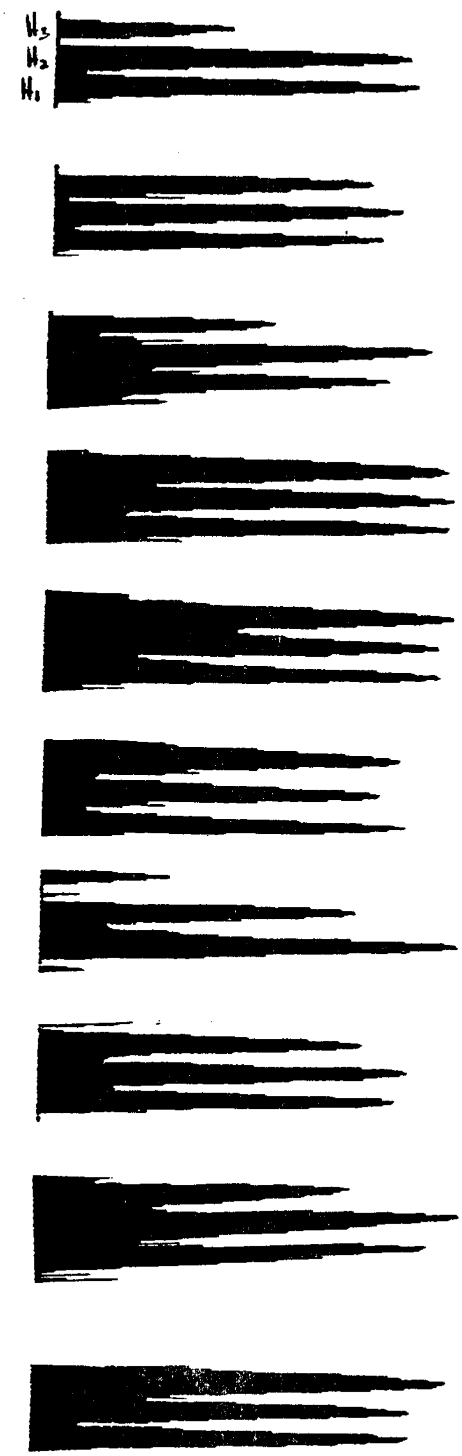
The last measure to be examined, formant bandwidth, is somewhat more promising. Using the same power spectra generated for the amplitude measures, bandwidths of the first three formants were taken at -6dB from the peak amplitude within each formant. The bandwidth of the first formant proved to be the easiest to measure and moreover showed consistent differences between high and mid vowels which belong to the different harmony sets. Sample measurements of ɩ and e are given in (10):

10. F1 bandwidth means of four tokens of each vowel (in Hz)

ɩ	380
e	225

Figure 3. Spectral typology based on three lowest harmonics (examples drawn from Table 3)

		Spectra (0 dB at left)
i	H2 < H1, H3 weak àsí	
ɩ	H2 > H1, H3 strong àsé	
e	H2 > H1, H3 weak òsé	
ɛ	H2 <, = H1, H3 strong sɛ́sɛ	
æ	H2 < H1, H3 strong takú	
a	H2 < H1, H3 strong ɔ̀sá	
u	H2 <,= H1, H3 weak òsú	
ɷ	H2 > H1, H3 strong ɛ̀só	
o	H2 > H1, H3 intermediate to strong òsó	
ɔ	H2 <,= H1, H3 strong àsɔ́	



The difference in bandwidth between ɩ and e in (10) is directly attributable to the strength of the third harmonic: in ɩ tokens, the third harmonic is quite strong and is thus included in the bandwidth measure at -6dB, while the third harmonic in e tokens is quite weak and thus not included. With these two vowels it is clear that the difference is not caused by a difference in the location of F1, as measurements in (4) show that these are virtually identical. It is therefore possible to create a spectral typology of high and mid vowels based on the first three harmonics as shown in Figure 3. [+ATR] vowels display a weak third harmonic and a narrower F1 bandwidth, while [-ATR] vowels display a strong third harmonic and broader F1 bandwidth. [æ] and [a] also have strong third harmonics, but this might well be due to a higher F1 position rather than to their tongue root position.

It was decided to pursue this with a computer program which would allow bandwidth to be measured at different points throughout the course of the vowel. Ten tokens of each vowel were sampled at 20 KHz using the CSpeech program (Milenkovic 1987) on an IBM XT. From LPC coefficients the bandwidth of F1 was calculated at -3 dB from the amplitude peak for a series of windows 20 ms long with a step size of 5 ms. with the first window taken at 20 ms. into the vowel. Means of up to ten frames are given for four tokens of each vowel in (11). Columns labelled F1 variation and bandwidth variation indicate the range of variation in these two measures. (Due to computation problems e and a are only represented by three tokens.)

11. F1 bandwidth measures (in Hz)

vowel	F1 freq.	bandwidth	no. of frames	F1 variation	bandwidth variation
i	250.8	44.0	7	41.6	6.9
	253.4	49.1	5	36.7	22.4
	248.0	49.0	8	20.2	44.1
	243.9	44.1	4	6.4	1.1
mean	*249.0*	*46.6*			
ɩ	342.5	51.8	5	26.8	12.5
	343.1	44.9	6	14.9	13.3
	331.4	42.3	3	7.2	7.5
	317.2	61.3	4	19.4	28.2
mean	*333.6*	*50.0*			

e	342	19.0	7	27.2	13.0
	328.7	32.4	4	26.8	15.8
	335.9	33.0	2	2.7	9.9
mean	*335.3*	*28.1*			
ɛ	449.9	110.1	5	7.5	25.8
	417.9	147.0	6	107.4	43.8
	398.3	145.8	6	86.1	48.4
	429.5	126.9	5	18.7	36.4
mean	*423.9*	*132.5*			
æ	473.8	170.7	7	43.9	50.7
	455.4	146.5	3	34.5	31.7
	427.0	271.8	3	61.3	28.9
	412.8	214.8	7	107.8	68.7
mean	*442.3*	*201.0*			
a	660.2	297.0	7	65.2	138
	634.9	205.0	10	55.1	63.9
	605.1	285.7	6	137.1	97.5
mean	*633.4*	*262.6*			
u	315.8	94.2	4	8.1	10.9
	234.1	49.2	9	58.2	16.5
	231.1	43.5	8	30.2	16.5
	225.5	39.8	5	13.9	6.3
mean	*251.6*	*56.5*			
ɷ	376.1	110.6	3	18.8	10.6
	353.4	82.1	5	46.8	18.9
	339.1	88.5	5	36.9	17.3
	342.6	93.1	4	8.4	29.3
mean	*352.8*	*93.6*			

o	349.4	55.7	7	18.3	17.3
	331.4	49.4	10	20	23.1
	333.6	55.3	9	15.8	30.8
	303.7	62.8	6	41	37
mean	*329.5*	*55.8*			
ɔ	507.6	163.7	6	83.7	55.1
	491.7	163.1	4	53.2	55.6
	467.4	155.9	6	48	62.3
	477.6	201.1	7	48.6	87.1
mean	*486.1*	*171.0*			

The results are not quite as expected. Power spectra (as in Figure 3) showed a consistent difference in the spectral shape of i and ɩ that is not found in these bandwidth measures. However, all other pairs of high and mid vowels, that is, ɩ and e, e and ɛ, u and ɷ, ɷ and o, o and ɔ, and even ɛ and æ seem reasonably well distinguished by this measure. In each case, the [-ATR] vowel has the broader bandwidth. It is noteworthy that bandwidths increase from high to low vowels as F1 rises. Some of the pair-wise bandwidth differences are thus quite likely attributable to F1 differences. However, as the ɩ and e and ɷ and o pairs have very similar F1 locations respectively, the difference found in pair-wise bandwidth measures would appear to be related to their differences in tongue-root position.

Above we have looked at five types of measures with an eye to distinguishing vowels of different harmony sets. We have found that pitch and spectral balance measures either show no real difference between the targeted vowels or do not show a consistent difference that could be linked to articulatory differences. Formant measurements distinguish vowels of the same harmony set, e.g. i and e, but do not distinguish vowels of different harmony sets that have a similar phonetic tongue height, e.g. ɩ and e. VOT and vowel duration measurements display tendencies that differentiate [+ATR] and [-ATR] vowels, but as ranges of the different vowels overlap, these measurements are not suited for use as discriminatory criteria. F1 bandwidth measurements, as displayed in (11), give the most reliable diagnosis of vowel type.

Vowel raising

In this section we will turn to a consideration of the assimilation of [-ATR] vowels to following [+ATR] vowels. For all vowels but /a/, this assimilation takes place only across morpheme or word boundaries. We wish to determine the answers to two questions: is the assimilation complete or partial?, and does it extend over more than one syllable? We will look at the second question first by examining the formant values of /a/ in three successive syllables within the word **adáká** "box" in the six different sentences given in (12). These six sentences are arranged in three pairs, a-b, c-d, and e-f. In each pair a sentence in which **adáká** is followed by a trigger syllable containing a [+high, +ATR] vowel is paired with a sentence in which **adáká** is followed by a word beginning with the same initial consonant and the vowel [a]. If raising is gradient and extends over more than one syllable, we should see a difference in the formants of the /a/ and /da/ syllables of **adáká** between these pairs.

12. Sentence examples for vowel raising

a. "Yaw stands a box under the table"	**Yaw de adáká si pono no ase**
b. "Yaw spreads a box under the table"	**Yaw de adáká sàm pono no ase**
c. "Yaw takes a box's inside to Kumase"	**Yaw de adákámu kɔ kùmáse**
d. "Yaw sends a box to Kumase"	**Yaw de adáká màné kɔ kùmáse**
e. "Yaw takes a certain box to Kumase"	**Yaw de adákábi kɔ kùmáse**
f. "Yaw takes a box/fence to Kumase"	**Yaw de adáká baŋ kɔ kùmáse**

Formant values of one token each are given in (13). Formants were measured at a point one-third through each vowel.

13. Formant measurements on vowel raising examples

	frame	syllable	F1	F2	F3	F4
a.	adakasi	a	600	1420	2120	3620
		da	600	1450	2000	3470
		ka	440	1560	2120	3750
b.	adakasam	a	600	1450	2130	3650
		da	620	1380	2020	3590
		ka	590	1400	1980	3630
c.	adakamu	a	570	1500	2090	3550
		da	580	1400	2000	3560
		ka	415	1380	2180	3580

d.	adakamane	a	600	1450	2210	3580
		da	580	1400	2330	3480
		ka	660	1290	1990	3510
e.	adakabi	a	600	1420	2070	3510
		da	590	1450	1990	3610
		ka	450	1850	2490	3580
f.	adakabaŋ	a	600	1490	2090	3750
		da	600	1400	2000	3660
		ka	660	1280	1925	3310

In each pair in (13), the effects of raising, that is a lowered first formant and raised second and third formants, are limited to the syllable /ka/ immediately preceding the syllable containing the [+high, +ATR] vowel.

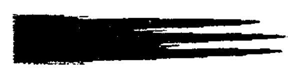
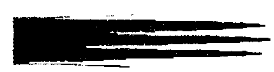
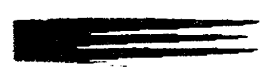
We will now look at data that will suggest an answer to the first question posed in this section, namely, whether assimilation is complete or partial (i.e. only affects height, not ATR value). The structure of the example sentences is similar to that in (12), but in this case we will investigate the effects of raising on the vowel [ɛ]. If assimilation is complete, we would expect to find similar formant frequencies and bandwidths to those of the vowel [e] in the first member of these pairs. Due to lack of time, bandwidths have not been calculated from LPC spectra; power spectra of the first three harmonics will be used as the criterion instead. The sentences used are given in (14):

14. Examples for vowel assimilation

a. "Yaw stands beans under the table"	Yaw de asɛ́ si pono no ase
b. "Yaw spreads beans under the table"	Yaw de asɛ́ sàm pono no ase
c. "Yaw takes beans' insides to Kumase"	Yaw de asɛ́mu kɔ kùmáse
d. "Yaw gives beans to Afua"	Yaw de asɛ́ ma afúá
e. "Yaw takes certain beans to Kumase"	Yaw de asɛ́bi kɔ kùmáse
f. "Yaw brings beans to kumase"	Yaw de asɛ́ ba kùmáse

Formant measurements and power spectra of the first three harmonics are given in (15).

15. Formant measures and spectra (cf figure 3) of assimilation examples

	frame	syllable	F1	F2	F3	F4	Spectra (0 dB at left)
a.	asɛ si -1	sɛ	340	1590	2300	3670	
	asɛ si -2	sɛ	410	1710	2520	3750	
b.	asɛ sam -1	sɛ	410	1510	2300	3690	
c.	asɛmu -1	sɛ	350	1750	2450	3360	
	asɛmu -2	sɛ	375	1725	2390	3560	
d.	asɛ ma -2	sɛ	470	1550	2450	3500	
e.	asɛbi -1	sɛ	375	1880	2550	3540	
	asɛbi -2	sɛ	350	1890	2540	3525	
f.	asɛ ba -1	sɛ	480	1550	2420	3550	
	asɛ ba -2	sɛ	460	1620	2470	3560	
	mean before	i, u	*367*	*1758*	*2458*	*3568*	
	mean before	a	*455*	*1558*	*2410*	*3575*	

For comparison, formant means of ɩ, e and ɛ are repeated in (16) below from (4):

16.	ɩ	309	1785	2438	3640
	e	311	1875	2498	3605
	ɛ	458	1564	2430	4000

It can be seen that the F1 mean for raised ɛ (which will be represented by ɛ̣) does not get as low as the F1 means for ɩ and e. The F2 mean is more similar to ɩ than to e. Formant measures of [ɛ̣] preliminarily confirms Clements' claim that raised mid vowels are acoustically intermediate between mid [-ATR] vowels and mid [+ATR] vowels. As can be seen from the spectra, the third harmonics of [ɛ̣] tokens are as strong as the third harmonics of [ɛ] tokens, and do not show the weakening associated with non-low [+ATR] vowels. This suggests that [ɛ̣] is articulated with a retracted tongue root rather than with an advanced one.

In conclusion, we have found that vowel assimilation is limited to one syllable, and that it appears to be a partial assimilation of tongue body height rather than a complete assimilation involving tongue root position. Corroboration of these findings will of course require analysis of more tokens of each vowel, which will be carried out in the near future.

References

Clements, G. N. (1981). Akan vowel harmony: a nonlinear analysis. *Harvard Journal of Phonology* 2: 108-177.

Dolphyne, Florence. 1987. Akan phonology. Ms.

Lindau, Mona. 1979. The feature expanded. *Journal of Phonetics* 7: 163-176.

Milenkovic, Paul. 1987. *CSpeech Users' Manual.* Department of Electrical and Computer Engineering, University of Wisconsin, Madison.

Painter, Colin. 1976. Pitch control and pharynx width in Twi: an electromyographic study. *Phonetica* 33: 334-352.

Post-stopped nasals in Chinese: an areal study*

Marjorie K.M. Chan

0. Introduction

Similar to most languages in the world, Chinese lacks a series of prenasalized stops contrasting with a series of plain stops on the one hand, and a series of plain nasals on the other in its phonological system. What has been observed in a number of modern Chinese dialects, however, is syllable-initial nasals which are followed by homorganic voiced stops. These post-stopped nasals are often transcribed with the stop component superscripted in more narrow phonetic transcriptions, as a deliberate attempt to indicate the relatively weaker status of the stop. Although post-stopped nasals are described in many Chinese dialects, few linguists are aware of the post-stopping phenomenon (or 'denasalization'), and even fewer realize that the phenonemon is not restricted to two or three dialect groups, nor to a small geographic location.

Post-stopping of nasals is, in fact, fairly widespread among the modern Chinese dialects. The relative obscurity of the phenomenon may be attributed, in part, to the absence of post-stopping not only in Beijing Mandarin, the national standard, but also in other well-known dialects, such as Shanghai and Standard Cantonese. Moreover, important compendiums of the major Chinese dialect groups, such as Yuan (1960, 1983), report only limited cases of post-stopped nasals, while descriptions of individual dialects often ignore this low-level phonetic phenomenon. Last but not least, there are some individual differences, so that some speakers do not exhibit post-stopping of the nasals even though the feature may be characteristic of that dialect. Due to these various factors, the impression is that post-stopping of nasals is relatively rare among the Chinese dialects.

There exists, to date, no in-depth acoustical study of post-stopped nasals in Chinese, nor is there any overall picture of which Chinese dialect groups possess post-stopped nasals and where these nasals are found in China. This paper, therefore, provides a brief acoustical characterization of the phenomenon, as well as a sketch of the Chinese dialect groups reported to have such nasals. Since dialect and provincial boundaries typically do not coincide, the paper will also include an investigation of the provinces where reports of these post-stopped nasals have been made. Phonological conditioning of these post-stopped nasals and some remarks on the historical bases of these nasals will also be explored. The study is based on some of the major dialect surveys conducted this century in China, as well as descriptions of some of the individual modern dialects. The aim is to present a preliminary report using sources that are readily available to the writer.

Correlation between the place of articulation and the nasals which are produced with plosive release, and whether the height or nasalization of the following vowel has any effect of the post-stopping of nasals will also be examined. The paper will include information on whether or not syllable-final nasals serve to inhibit the post-stopping of the syllable-initial nasals.

This paper is organized into four sections as follows. For the benefit of the general reader, section one gives a preliminary acoustical study of post-stopped nasals based in part on a project reported in Chan and Ren (1987). The section then proceeds to a presentation of some background information on the classification of Chinese into seven dialect groups and on where these dialect groups are spoken in China. In section two, each dialect group is discussed in turn with respect to whether post-stopped nasals occur in the dialects of that dialect group and in which provinces they are found. Section three focusses on the distributional pattern of the nasals in Southern Min, a subgroup of Chinese dialects in which the historical nasals had split into a series of plain nasals and a series of voiced stops. Section four deals with the phonological conditioning of post-stopped nasals in the other dialect groups with respect to height or backness of the following vowel, and whether the phenomenon is inhibited by vowel nasalization or a final nasal. The correlation of post-stopped nasals and place of articulation concludes that section. The fifth and last section gives some historical background on the post-stopped nasals in Chinese, and discusses the implications for historical reconstruction.

1. General background

1.1. Acoustic characteristics of post-stopped nasals

To better understand the phenomenon of post-stopped nasals, an example of a plain nasal is presented first for comparative purposes. English is a familiar language with plain nasals; that is, nasals that are not pronounced with plosive release. A spectrographic display of the syllable [ma] is given in Figure 1a. (All figures are placed at the end of the paper.) The syllable is spoken by a male, native speaker of Californian English.[1] Roughly the first 100 msec. of the syllable is the nasal consonant. The transition to vowel onset is not abrupt. Weak nasal murmur (shown by the broken vertical striations) below 3 KHz. extends right up to vowel onset.

In contrast, the syllable [m^{b}a] 馬 'horse' in Figure 1b is produced by a male speaker of Chinese from Changsha city, Kaiping district, Guangdong province. Observe, first of all, that the nasal murmur is somewhat weaker in Kaiping, and is diminished prior to vowel onset. This is particularly noticeable in the total absence of energy in the region between 2000 and 2500 Hz, indicated by an arrow (-->) in the spectrogram. What is perceived as the homorganic voiced stop component is that duration prior to vowel onset, where a drop in nasal murmur intensity occurs. While there is no clear transition between nasal and voiced stop, the transition from stop to vowel onset is quite clearly demarcated.

Contrasting with both the plain nasal in English and the post-stopped nasal in Kaiping are the prenasalized stops in Malagasy. In Figure 1c, the nasal murmur intensity in the Malagasy syllable, [^{m}ba] ('polite particle'), is very strong, and sounds like an unstressed syllabic nasal which is then followed by a stop segment. The transition between nasal and stop is fairly abrupt, as is the transition from stop occlusion to vowel onset. In Malagasy, [^{m}b] is phonemically the prenasalized stop, /^{m}b/, which contrasts with /b/ and /m/ in the language.

The stop closure in Kaiping and Malagasy can also be characterized by a drop in amplitude in the [b] component of the 'nasal + stop' segment in these two languages. Amplitude envelope displays of the examples in Figure 1 are given in Figure 2. (The duration on the amplitude envelope displays in all the figures are expanded to twice that on the original spectrograms.) Observe in Figure 2a that no abrupt drop or increase in amplitude occurs to signal a transition from [m] to [a]. In Kaiping, on the other hand, there is over 10 dB difference from the peak of nasal murmur to peak vowel amplitude. Stop occlusion results in amplitude drop, indicated by the arrow (-->) in the figure. The duration of amplitude drop is about 25 msec. Then, a sudden, sharp rise in amplitude occurs, signalling vowel onset. The amplitude envelop display for the Malagasy example in Figure 2c is similar to that in Kaiping in that there is a significant amplitude difference between nasal and vowel, as well as a drop in amplitude for the stop duration preceding vowel onset.

The Malagasy example differs from the Kaiping one in at least three major aspects: (1) the nasal-vowel amplitude difference is relatively less for Malagasy than for Kaiping due to strong nasal murmur in the Malagasy nasal component, (2) amplitude drop is relatively longer in duration for Malagasy, and (3) the 'nasal + stop' segment in Malagasy is also relatively longer in duration than its counterpart in Kaiping. The differences between Malagasy and Kaiping is even more striking in the case of the velar segment, where the 'nasal + stop' segment in Kaiping is particularly short, as can be seen in the amplitude envelope displays in Figure 3a, showing Malagasy [ŋgali] 'jet black', and Figure in 3b, showing Kaiping [ŋ^{g}a] 瓦 'tile'.

A fourth, but redundant, difference between Kaiping and Malagasy is the difference in amplitude drop for the stop closure: Malagasy tends to have greater amplitude drop than Kaiping because of the relatively stronger nasal murmur in Malagasy. Whether one or more of the above-mentioned differences can be used to make a valid phonetic distinction between 'prenasalized stops' as one kind of segments, and 'post-stopped nasals' when more speakers are used requires further investigation. (See Chan and Ren (1987) for a preliminary investigation into the topic.) It is not crucial to this study whether any significance can be attached to the difference in nomenclature. The main concern here is that instrumental studies corroborate the impressionistic observations made by Chinese linguists that Kaiping nasals are followed by a homorganic stop.

At this point, it is necessary to introduce the post-stopped nasals in Zhongshan Chinese. What is described as a 'stop' is simply an audible burst release, without amplitude drop. The syllable [m^{b}a] 媽 'mother' is given in the spectrogram in Figure 4. The burst transient is indicated by a double-bar arrow (==>). Nasal murmur, indicated by the ssingle-bar arrow (-->), is very weak, and extends to vowel onset. Transition from nasal to vowel is abrupt due to the burst release. The burst is a result of a sudden change in area in the oral cavity as the two surfaces that were in contact at the place of articulation pull apart quickly. The absence of amplitude drop, together with a sudden, sharp amplitude rise is shown in the expanded amplitude envelope display in Figure 4.

While a burst transient best exemplifies the stop-like component in Zhongshan, in a minority of cases, one does find some syllable-initial nasals with actual stop closure. The amplitude drop, however, is less prominent in Zhongshan than in Kaiping. At the same time, a few Kaiping tokens have burst release on the post-stopped nasals, typically occurring on velar post-stopped nasals. There is another difference between Kaiping and Zhongshan that is revealed in studying the spectrograms. In Kaiping, the velar post-stopped nasals are particularly short in duration, in comparison to [m^b] and [n^d]. Furthermore, in some tokens, the nasal murmur is very weak on the velar post-stopped nasals. The segment becomes almost completely denasalized, so that it is practically a plain voiced stop, [g]. In Zhongshan, although the post-stopped nasals tend to average about 100 milliseconds in duration, some tokens of [m^b] are extremely short, lasting only 40 to 50 milliseconds. even though the duration of the entire syllable may exceed 400. Chan (1980:23), on the basis of impressionistic observation, stated that "at times, instead of the nasal consonant being followed by a homorganic stop, the initial segment becomes in fact a prenasalized stop". A phonetic distinction was thus made between a post-stopped nasal (e.g., [m^b]) and a prenasalized stop ([^{m}b]. The judgement of whether the segment was a post-stopped nasal or a prenasalized stop was based largely on the duration of the nasal component: when it was especially short, the segment was perceived as a stop that was prenasalized. A closer examination of the data reveals that the shortening of the nasal duration in Zhongshan is limited to the bilabial nasals, whereas in Kaiping, it is the nasal portion of the post-stopped velar nasal that is shortened.

Additional representative samples comparing Kaiping and Zhongshan post-stopped nasals are presented in Figure 5. Figure 5a is Kaiping [n^dɔ] 努 'to exert strength', Figure 5b Zhongshan [n^dUŋ] 農 'agriculture', and Figure 5c Zhongshan [$ŋ^g$y] 寓 'reside'. The Kaiping form has genuine stop closure with energy loss in the higher frequencies prior to vowel onset, while the most prominent feature of the Zhongshan post-stopped nasals is the burst release immediately before vowel onset.

One can surmise that similar to Kaiping and Zhongshan, the stop component of the post-stopped nasals in other Chinese dialects is probably phonetically realized in at least one of two ways. The stop component may be like the Kaiping case, with genuine stop closure, or it may be more like the Zhongshan case, where the 'stop' component is simply an audible burst release.

Before concluding this subsection, we will take a cursory look at Southern Min, which differs from other Chinese dialects in having a series of plain nasals that contrasts phonetically (and, in some subvarieties, phonemically as well) with a series of voiced stops that are slightly prenasalized. To my knowledge, no systematic acoustical study has yet been conducted on these segments in Southern Min. While such a study is outside the scope of this paper, for completeness of coverage, a few spectrographic displays are given in Figure 6 on the Xiamen (or 'Amoy') dialect spoken in Taiwan.[2] Figure 6a is a display of the syllable [bu] 母 'mother', in the broad phonetic transcription that is conventionally used in the literature. The voiced stop is, in fact, preceded by voiceless nasal murmur, indicated by the arrow (-->). Observe the strong burst release before vowel onset. Figure 6b shows the syllable, [bin] 面 'face', again in conventional broad phonetic transcription. The voiced stop segment is very weakly prenasalized. Once again, there is a strong burst transient preceding the onset of the vowel. Figure 6c shows the syllable, [mã] 罵 'to scold', with a nasal consonant followed by a nasal vowel. The nasal is produced without plosive release, and the transition from nasal to vowel is not abrupt. The nasal is, moreover, produced with voiceless onset. Figure 6d is a display of the syllable [dau] 老 'old'. (The word is regularly transcribed as [lau] in the literature. There is some [l]/[d] subdialectal variation.) In the example, the 'stop' component is similar to the Zhongshan case in having a burst release only, without true stop closure. The segment is phonetically prenasalized, with voiceless nasal onset.

Having presented the acoustical characteristics of the post-stopped nasals in Kaiping and Zhongshan, as well as the nasal versus (prenasalized) voiced stops in Xiamen, we proceed to an introduction of the major Chinese dialect groups and the provinces in which they are spoken.

1.2. The major dialect groups of Chinese

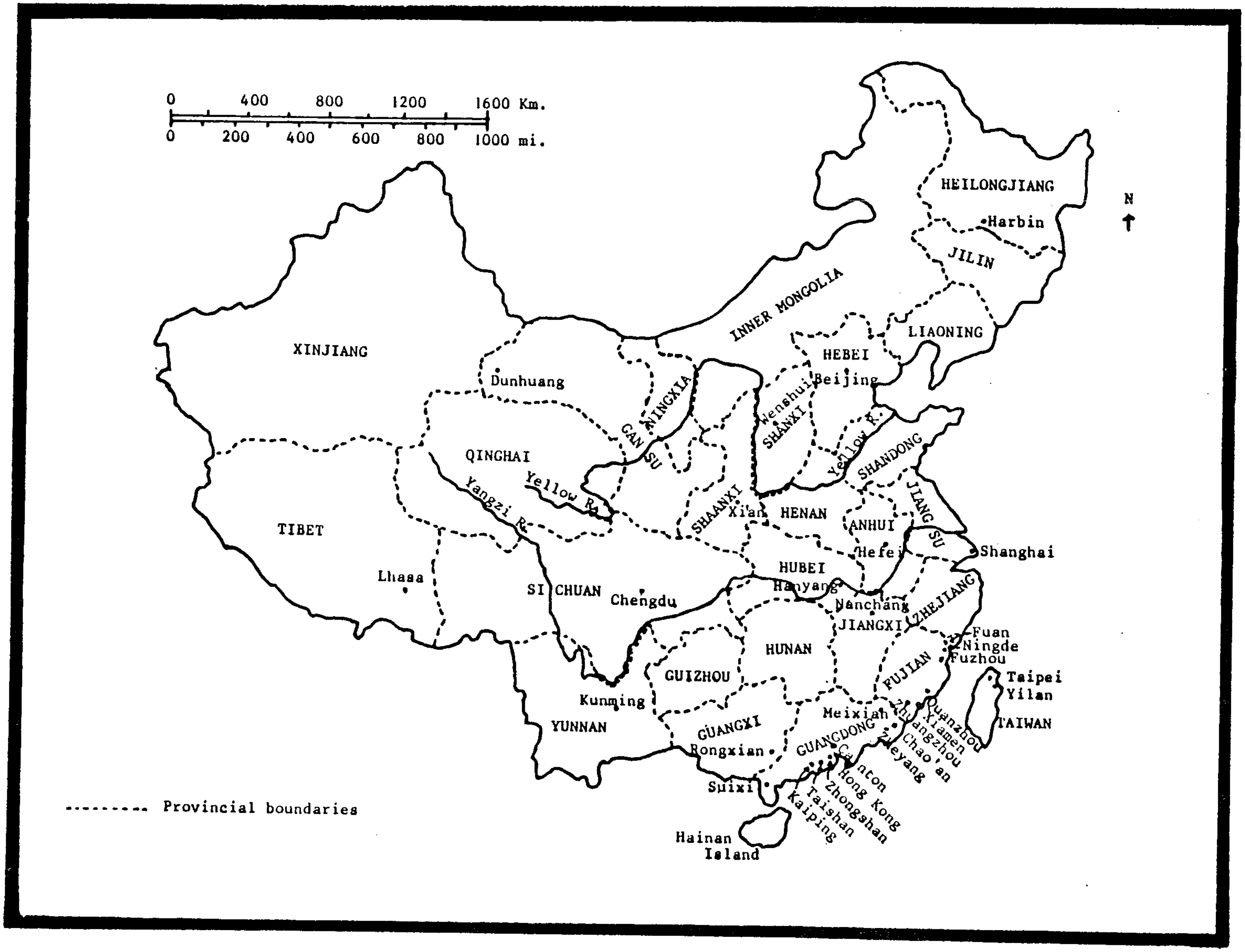
The Chinese language, spoken by over ninety percent of the population of China, is conventionally divided into seven major dialect groups. Speakers of the various Chinese dialects are concentrated in the eastern portion of the country. In (1), the seven major dialect groups are listed, together with population figures based on estimations from a dialect investigation conducted in China in 1955-1958 (Yuan 1960:22).[3] The total Chinese-speaking population at that time was given at 547 million. The subdivision of that figure among the major dialect groups and further subdivisions within Mandarin and Min are also given in (1). The population figures can only be viewed as rough estimates which now outdated, but given to provide some idea of the relative proportion of speakers of each group. Common, or alternate, terms for some of these dialects are included in parentheses.

(1)

Dialect Group		Number of Speakers	Percentage
1. Mandarin		387 million	70.0%
a) Northern	(186 million)		
b) Northwestern	(53 ")		
c) Southeastern	(26 ")		
d) Southwestern	(120 ")		
2. Wu		46 "	8.4%
3. Xiang (= Hunan)		26 "	5.0%
4. Gan (= Jiangxi)		13 "	2.4%
5. Kejia (= Hakka)		20 "	4.0%
6. Yue (= Cantonese)		27 "	5.0%
7. Min		15 "	4.2%
a) Northern	(7 million)		
b) Southern (= Fukienese)	(15 million)		

For reference purposes, the provinces of China are presented in Map 1. Map 2 shows where these dialect groups are located in China. Their distribution with respect to provinces is summarized in Table 1.

MAP 1. Provinces of China



MAP 2. Distribution of the Chinese Dialect Groups in China

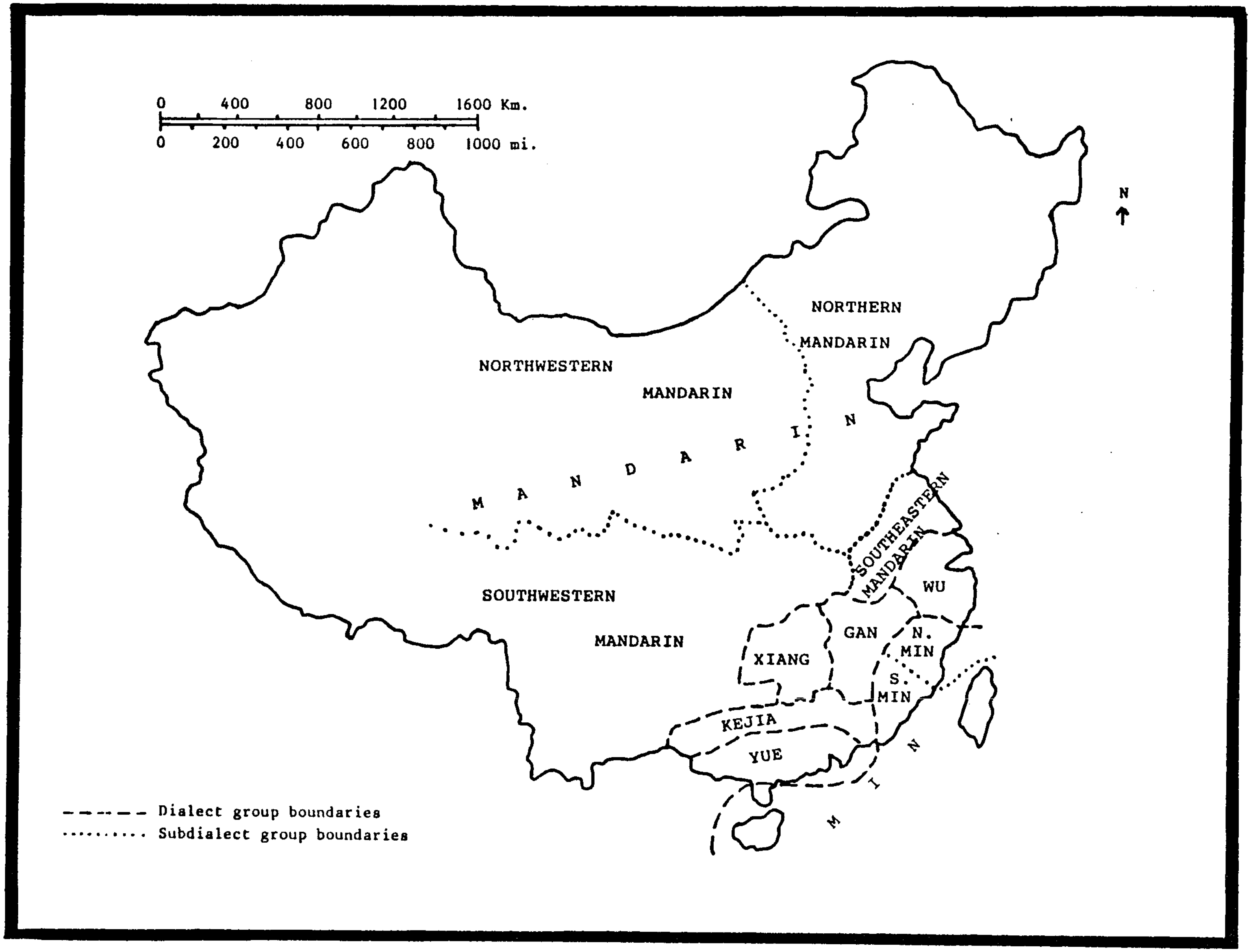


Table 1. Dialect Groups and the Provinces in Which They are Spoken.

1. **Mandarin Dialect Group**	
a) Northern	Hebei (including Beijing and Tianjin) Henan, Shandong Liaoning, Jilin, Heilongjiang (= Manchuria) Northwestern part of Anhui Northwestern part of Jiangsu Eastern part of Inner Mongolia
b) Northwestern	Shanxi (including Taiyuan) Shaanxi (including Xi'an) Gansu (including Lanzhou) Xinjiang, Ningxia, Qinghai Western part of Inner Mongolia
c) Southeastern	Central Jiangsu (including Yangzhou) Central Anhui (including Hefei) Southeastern Hubei Northern Jiangxi
d) Southwestern	Sichuan (including Chengdu and Chongqing) Guizhou, Yunnan Hubei (except southeastern corner) Northwestern part of Hunan Northwestern part of Guangxi (including Guilin)
2. **Wu Dialect Group**	Zhejiang Southern Jiangsu (including Shanghai, Suzhou, Wuxi) Southeastern Anhui
3. **Xiang Dialect Group** (= Hunanese)	Hunan (including Changsha)
4. **Gan Dialect Group** (= Jiangxi)	Jiangxi (including Nanchang) Southern Anhui, Southeastern Hubei
5. **Kejia Dialect Group** (= Hakka)	Communities scattered in Sichuan, Jiangxi, Hunan, Guangdong (including Meixian), Guangxi, Fujian, and Taiwan.
6. **Yue Dialect Group** (= Cantonese)	Guangdong (incldufing Canton, Taishan, Zhongshan, Kaiping, Macao, Hong Kong) Southeastern Guangxi
7. **Min Dialect Group**	
a) Northern Min	Southern Zhejiang Northeastern part of Fujian (including Fuzhou)
b) Southern Min (= Fukienese)	Southern part of Fujian (including Xiamen (= Amoy) Northeastern Guangdong (including Chaozhou, Dongshan and Hainan Islands) Taiwan

The subdivision between Northern and Southern Min is drawn fairly arbitrarily on Map 2, since there are some transitional dialects in the central region. Moreover, recent studies suggest that an east/west division of Min is a more crucial one (Pan 1963, Norman 1970). The Chinese-speaking population is predominant along the coastal belt and in the southeastern part of the country, but quickly diminishes in the outlying regions of the country, which are largely inhabited by various minority groups.

With these introductory remarks, we proceed to the study of the geographical spread of post-stopped nasals in the Chinese dialects. The study is organized with respect to the seven major dialect groups, because the presence or absence of post-stopping is dependent more on dialect group than on provincial boundaries.

2. Post-stopped nasals and their distribution across dialect groups

Based on the literature surveyed, only two dialect groups, Wu and Xiang, do not exhibit post-stopping of nasals. Regarding the Wu dialect group, for example, thirty-three sites were surveyed by Chao (1928) in different parts of Jiangsu and Zhejiang provinces. For each of these locations, Chao recorded one or more informants, with a maximum of eight in one case. He described the nasal consonants as being completely nasal; they were not accompanied by a homorganic stop (p. 29). Other descriptions of modern Wu dialects yield a similar lack of post-stopping in this major dialect group (e.g., Yuan 1960, Zheng 1964, Li 1966, Nakajima 1983).

Post-stopping, or plosive release, is also absent in the nasals reported in the Xiang (or Hunan) dialect group, which is spoken in Hunan province. An examination of the 75 sites in Yang's (1974) dialect survey of Hunan province revealed no post-stopped nasals.[4] Tsuji (1987), however, does record post-stopped nasals for the Xiang dialect spoken in Jiahe district (or county), Hunan province. Tsuji's data is based on fieldwork conducted in Hong Kong in 1977-1978. There is, in addition, an interesting case worth noting from Forke (1903), cited in Karlgren (1940:355). At one location in Hunan, plosive release on the nasal did not occur to an original nasal, but to an original lateral before /i/: that is, *l- was pronounced as [nd] (nd < n < *l). The syllable onset remains distinguished from the regular nasal before /i/, because the original nasal was fronted to alveopalatal position. For example, 伶 'actor' is [ndin] (nd < *l), contrasting with 寧 'rather' [ȵin] (ȵ < *n). For comparative purposes, the corresponding forms in Hefei, Anhui province (Southeastern Mandarin), was given: 伶 and 寧 are homophonous, and transcribed as [ndin], with a post-stopped nasal for both words. No superscripting was given in Karlgren (1940), as is the case in the narrow phonetic transcription of post-stopped nasals in various works. Hereafter, for the sake of a standardized method of transcription and typographical convenience, the stop component of the post-stopped nasals is not superscripted.

For the remaining five dialect groups — Mandarin, Gan, Kejia, Yue, and Min — post-stopping of nasals is observed to a greater or lesser extent. Each of the dialect groups will be discussed in turn in the following subsections.

At this point, it should be noted that in the various dialect surveys (e.g. Yang 1984), the description of the nasals sometimes included a comparison with the national standard, Beijing Mandarin. The comparisons were made on the basis of degree of "coarseness", "heaviness" or "hardness" in the production or perception of the nasals. A given nasal is pronounced in one of three basic ways with respect to the standard: (1) it may be produced in a similar way to Mandarin nasals, (2) it may be pronounced coarser or heavier than the corresponding nasal in the Beijing dialect, without actual specification of plosive release on the nasal, or (3) the nasal may be regarded as being pronounced coarser or heavier than their Beijing Mandarin counterparts, with the nasal followed by a homorganic stop.

2.1. Mandarin Dialect Group

As indicated in (1), Mandarin is spoken by some seventy percent of the Chinese-speaking population. It is distributed over the majority of the Chinese-speaking area of the country. Except for provinces largely inhabited by minority groups (e.g., Tibet, Inner Mongolia, Heilongjiang, etc.), the Mandarin dialect group is the main one spoken in most of the other provinces. Varieties of Mandarin is also found in provinces dominated by speakers of other Chinese dialects (e.g., Guangxi, Jiangxi).

This large dialect group is divided into four subgroups -- Northern, Northwestern, Southeastern, and Southwestern -- and discussed in turn below. Within each subgroup, the survey of post-stopping of nasals is conducted with respect to the individual provinces in which these subgroups are spoken.

2.1.1. Northern Mandarin

Northern Mandarin is spoken in Hebei, which includes Beijing, as well as in Henan, Shandong, the northwestern parts of Anhui and Jiangsu, the eastern part of Inner Mongolia, as well as the three provinces that formerly made up Manchuria, namely, Liaoning, Jilin (Kirin), and Heilongjiang.

Post-stopping has not been observed in Northern Mandarin (Yuan 1983:33), except in the Wanquan dialect, in Hebei province. Post-stopping, however, is absent in the speech of the nation's capital, Beijing, situated in Hebei province. The phenomenon is also absent in the survey conducted by the Hebei Beijing Shifan Xueyuan (1961). That survey involved the division of the province into nine major regions. And finally, in a study by the Hebeisheng Changlixian Xianzhi Bianzuan Weiyuanhui (1960) on the Changli dialect in Hebei, no post-stopping is observed there either. Thus, it appears that the phenomenon is not common in the Northern Mandarin dialects spoken Hebei. Two locations recorded by Karlgren (1915-1926) in Henan province do not yield post-stopping of nasals. Whether the phenomenon is found in the Northern Mandarin dialects spoken in the other provinces remains to be investigated.

2.1.2. Northwestern Mandarin

Northwestern Mandarin is spoken in Shanxi, Shaanxi, as well as in Gansu, Xinjiang, Qinghai, and the western part of Jiangxi province. Nasals with stop occlusion in Chinese are best known in this subgroup of Mandarin, particularly among historical Chinese phonologists. Karlgren (1915-1926) has reported on the existence of this type of nasals in five of the eight locations in Shanxi province based on his own field work. These five sites, scattered roughly over the western two-thirds of the province, are: Guihua, Wenshui, Taigu, Xingxian, and Linfen (formerly Pingyang).

Karlgren has also recorded data from three locations in Shaanxi province -- Xi'an (formerly Chang'an), Xunyi (northwest of Xi'aŋ), and Sangjia subdistrict (west of Xi'an) -- but did not find post-stopping of nasals in those places. Nonetheless, post-stopping is noted by Maspero (1920) for certain locations in both Shanxi and Shaanxi, without actually naming them. Post-stopping is noted by both Karlgren and Maspero precisely because of its historical significance. Maspero (1920), for example, provides evidence of 'nasal + stop' segments in Chang'an speech in the eighth and ninth century. The pronunciation of nasals with stop occlusion is regarded by Maspero (1920:36) as having survived to the modern day in certain dialects of Shanxi and Shaanxi. Thus, the observation of 'nasal + stop' segments is not merely an idle one by Karlgren and Maspero, but one which has historical significance, as section 5 will demonstrate. Other modern dialects with post-stopped nasals have been reported in the northeastern part of Shaanxi province, adjacent to Shanxi; for example, Ansai, Yanchuan, Qingjian, Wubao, Suide, and Mizhi (based on Dizhou Bai's field work, cited in Luo 1933:143).

The Lingbao dialect (Yang and Ching 1971) is spoken in Henan province, and hence should be a Northern Mandarin dialect. However, it is actually located close to the borders of Shanxi and Shaanxi, and has a phonological system that is closer to the Northwestern subgroup than to the Northern subgroup. Of particular interest to us is Yang and Ching's observation of post-stopping in Lingbao, which provides additional attestation of post-stopped nasals in the modern Northwestern dialect. Yuan (1983:33) also cites Pingyao, Wenshui, Taigu, and Xingxian as places in Shanxi province where post-stopping is found, based, undoubtedly, on Karlgren's monumental work (1915-1926).

With respect to Northwestern Mandarin spoken by the Chinese-speaking people in Gansu, the sources surveyed do not reveal post-stopping in the modern dialects (e.g., Karlgren 1915-1926, Yuan 1983, Liu 1986). It is significant, however, that although Liu (1986), for example, does not describe post-stopped nasals in the modern Dunhuang dialect in Gansu, Chinese-Tibetan interlinear texts of the eighth to eleventh centuries of Chinese materials from Shazhou, which is the area around and to the west of modern-day Dunhuang, attest to post-stopped nasals in premodern Dunhuang speech (Coblin 1986, and works cited therein). Gong's (1981) study of a late twelfth century Northwestern Mandarin dialect based on Chinese-Tangut transcriptions of a source provides further evidence of post-stopped nasals in the premodern Northwestern Mandarin dialect.

For the Northwestern Mandarin dialects that are spoken in the more remote regions of Xinjiang, Qinghai, and the western part of Inner Mongolia, further investigation is needed to determine if the nasals in those dialects are pronounced with a homorganic stop.

2.1.3. Southeastern Mandarin

Of the Mandarin dialect subgroups, the smallest is Southeastern Mandarin. Speakers of Southeastern Mandarin are located in a relatively small region: in central Jiangsu and Anhui provinces, northern Jiangxi and the southeastern corner of Hubei province. No post-stopping is recorded in the general surveys (Zhan 1981, Yuan 1983) consulted here. Additional sources, however, remain to be investigated. The only evidence of post-stopped nasals in this subdialect group is in the Hefei dialect, based on the examples given earlier (from Forke, cited in Karlgren 1940:355) for the homophonous words 寧 'rather' and 伶 'actor', which are pronounced with a post-stopped nasal: [ndin].

2.1.4. Southwestern Mandarin

Southwestern Mandarin is spoken in Sichuan, Guizhou, Yunnan, the greater part of Hubei, and the northwestern part of Hunan and Guangxi provinces. Post-stopped nasals have been reported in Southwestern Mandarin, and in particular in the subvarieties spoken in Sichuan (Malmqvist 1959, Yang 1951, Yang 1956, Yang 1984, Yuan 1983). An important source of information is the major dialect survey conducted in Sichuan province, edited by Yang (1984). Of the 97 sites that are given individual descriptions in the survey, 78 have post-stopped nasals. One additional site not recorded in Yang (1984) is Chongqing, which was reported to have post-stopped nasals by Yuan (1983).

In the Sichuan survey and similar surveys of this type conducted in China, one or two speakers are recorded to represent each location. It is, therefore, important to add that, although no post-stopping is reported for a given site, it is not necessarily absent in that speech community. A case in point is the Chengdu dialect spoken in Sichuan. Although no post-stopping is recorded in the large survey (Yang 1984), it is, nonetheless, reported in the Chengdu speech recorded by Malmqvist (1959) and Yang (1951), the latter of whom is the editor of the Sichuan dialect survey. Similarly, although no post-stopping is reported by Chao, Ting, Yang, Wu and Tung (1948) on the Southwestern Mandarin dialect of Hanyang, spoken in Hubei province, post-stopped nasals are transcribed in the dialect by Yuan (1983:33). Hence, the observation of post-stopped nasals is significant, but the absence of such reports in a speech community, typically based on the recording of one or two speakers, may not necessarily indicate no post-stopped nasals in that speech community.

Up to this point, all the descriptions of post-stopped nasals treat the stop component as quite weak, or at least weaker than the nasal component. Among the Mandarin dialects, there is one exception. Scott (1973:290) describes the Northwestern Mandarin dialect of Yibin, spoken in Sichuan, as having strong plosive release. In fact, he notes that "they might, indeed, be classified as plosives with nasalization." No similar comments have been made by linguists concerning any of the northern Chinese dialects examined in this study.

We turn now to Yunnan, another province in which Northwestern Mandarin is spoken. A more limited number of cases surveyed in Yunnan (Yang 1969b) have post-stopped nasals. These nasals occur in only 19 of the 101 surveyed sites.

Even more restricted cases of post-stopped nasals are found in the Hubei dialect survey (Chao et al. 1948): of 64 sites in the province, post-stopped nasals are observed in only 3 of them. A fourth location can be added from Yuan (1983:33), namely, Hanyang, mentioned above.

The general studies (Yuan 1983, Zhan 1981) did not note post-stopping of nasals in the other provinces where Southwestern Mandarin is spoken. Descriptions of individual dialects such as Guilin (Yang 1964) made no mention of plosive release on the nasals.

2.2. Gan Dialect Group

The Gan dialect group is a relatively minor one which has previously been combined with Kejia to form the Gan-Kejia group. Gan speakers are located in Jiangxi, southern Anhui, and the southeastern corner of Hubei. No post-stopping of nasals is reported in Yuan (1983) or Zhan (1981), nor in the southeastern corner of Hubei in the Hubei dialect survey (Chao et al. 1948). Post-stopped nasals are also absent in the description of two Gan dialects spoken in Jiangxi, where the Gan dialect predominates. In neither Linchuan, recorded by Luo (1940), nor Longyan, recorded by Condax (1973), is the post-stopping of nasals recorded. Nonetheless, post-stopped nasals have been noted in the speech of Nanchang, the provincial capital of Jiangxi province (Yang 1969a).

2.3. Kejia Dialect Group

The Kejia (Hakka) people are the Chinese correspondences to the Jewish population in Europe in being scattered in various parts of the country, with no specific place they can consider their own. Furthermore, in the Pearl River Delta region in Guangdong, and particularly in Taishan district, they were treated as outcasts. Violent clashes lasting a decade arose in the mid-nineteenth century between the Taishan, or "Punti" ('local' settlers), and the Kejia (the 'guest' people), who came later.[5] By the end of that period, the Kejia were decimated. They had been recruited from eastern Guangdong province by the authorities in the latter part of the seventh century to the Pearl River Delta region. Until the so-called "Hakka-Punti Wars", the Kejia had grown in population to the extent that they comprised a third of the population of Taishan district.

The Kejia stronghold is in northeastern Guangdong province. The representative dialect for Kejia is Meixian, spoken in Meixian city, located in northerneastern Guangdong province. Some Kejia-speaking communities can be found in other parts of Guangdong province. In addition, Kejia speakers, who had emigrated from Guangdong province, form a sizeable minority in Taiwan, constituting about 12 percent of the population on that island (Kubler 1985:156). (As in the Pearl River Delta region, the Kejia group in Taiwan has traditionally been treated as social outcasts also.) Kejia is also spoken in the eastern and southwestern part of Guangxi province. Small pockets of Kejia-speaking communities are scattered in other provinces of China.

To my knowledge, no large-scale dialect surveys have yet been conducted on the Kejia dialect group. A study of several individual works indicate fairly regular occurrences of post-stopping in the nasals in Kejia. In Guangdong provine, post-stopped nasals are recorded in the Kejia dialect of Meixian city (Hashimoto 1973), and in Zhongshan district's fifth *qu* ('subdistrict') by Egerod (1959). Kejia predominates in both places.

Post-stopped nasals have also been reported in Kejia-speaking communites in other provinces; for example, in the Meinong (Yang 1971) and Taoyuan (Yang 1957) dialects of Kejia in Taiwan; and in the Kejia dialect spoken in Liangshuijing, Huayang district, Sichuan province (Tung 1956). Concerning the Kejia dialect spoken in other provinces, investigation of additional sources is needed.

2.4. Yue Dialect Group

The Yue dialect group is commonly referred to as 'Cantonese', the standard of which is spoken in Canton City and Hong Kong. Although it is spoken by only five percent of the Chinese-speaking population in China, it occupies a far more important status historically, due in part to Western trade with China, where the ports of call include Canton, Macao and Hong Kong. Moreover, in North America, the original immigrants from China were primarily Yue-speaking. That dialect group continues to be the dominant one in the traditional Chinatowns today. In addition, although the Yue dialect group is spoken in both Guangdong and Guangxi province, virtually all of the Yue speakers in North America were originally from Guangdong province.

In the case of the Yue dialect group, while no large-scale dialect survey exists, Yuen Ren Chao did conduct a survey of this dialect group during 1928 and 1929. However, only his study of Zhongshan (1948) and Taishan (1951), in Guangdong province, have been published. He notes post-stopping of nasals in both dialects. Some information concerning other dialect areas surveyed by Chao are included in Hashimoto (1972); such phonetic details as plosive release on nasals, however, are absent in Hashimoto's study.

Nevertheless, the post-stopping of nasals is commonly observed among the individual reports of various Yue dialects, both in Guangdong and Guangxi provinces. The optionality of post-stopping, or the tendency to produce nasals with plosive release, has also been noted in some sources (e.g., Egerod (1956) for Zhongshan, and Tsuji (1980) for several dialects in Guangxi). Among the early published studies of the dialects in Guangdong is Wang and Qian's (1950) survey of the Yue dialects — in particular, Taishan, Kaiping, Xinhui, Heshan and Zhongshan — all located in the Pearl River Delta region, to the south and southwest of Canton city. Post-stopping of nasals is reported to a greater or lesser extent in these dialects by Wang and Qian.

Wang and Qian's study also includes further details concerning the post-stopped nasals. They describe the stop component in both the Duanfen dialect of Taishan district and the Kaiping dialect as being produced with some voiced aspiration. This has not been observed elsewhere. Moreover, unlike the dialect groups mentioned earlier in which the stop component is regularly regarded as relatively weak (the only genuine exception being Scott's (1973) description of Yibin in Sichuan, the same is not always true among the Yue dialects. Wang and Qian, who treat the post-stopped nasals as consonant clusters phonetically, observe that the relative strength of the nasal versus stop component in these dialects is not consistent: the nasal may be stronger sometimes, or the stop component may be stronger; sometimes, the nasal and stop components are perceived as equally strong. One possible acoustic cue to the perception of relative strength of the two components is the relative timing of the nasal and stop components. A reduction in the duration of the nasal murmur, for instance, could give the impression that the stop component is relatively strong. With regard to the velar nasal in Kaiping in the environment before /u/, for example, as in the word 言 [ŋgun] 'speech', Wang and Qian (1950:61) note that the plosive release is particularly strong, so that the the cluster almost simplifies to a single segment, becoming [gun], where the nasal murmur practically disappears.[6]

Another important later source on post-stopped nasals in the Yue dialect group is McCoy's (1966) dissertation, containing field data on the Yue dialects spoken in Siyi (or "Szeyap"). Siyi, literally, the "Four Districts", is composed of Taishan, Kaiping, Enping, and Xinhui. The prestige dialect of that locality is Standard Taishan, spoken in Taishan city, in the district of Taishan. McCoy collected data on Standard Taishan and ten other varieties of Yue spoken in Taishan district. The syllable-initial nasals are accompanied by homorganic stops in all eleven subvarieties of the Taishan dialect. McCoy also collected data on six localities in Kaiping district, five of which have post-stopped nasals. For the other two districts, Enping and Xinhui, only one subvariety of Yue was collected from each of these districts. Homorganic stops accompany the nasals in Xinhui, but not in Enping.

Although post-stopping is prevalent in the nasals of a number of Yue dialects in Guangdong, the phenomenon is absent in the standard variety of Cantonese spoken in Canton and Hong Kong. Wang and Qian (1950) also note that nasals are not accompanied by homorganic stops in the area immediately surrounding Canton city, which includes Nanhai, Sanshui, Shunde, and Dongguan. This is also true of the neighbouring Panyu district (based on my acoustical study of a small set of data from one Panyu speaker.)

Post-stopped nasals are also observed in Guangxi province. Of the eight Yue dialects investigated by Tsuji (1980), three show post-stopping: Rongxian, Binyang, and Sihe. Rongxian and Binyang are spoken in their respective districts in Guangxi province, while Sihe, whose phonological system is similar to the Guangxi Yue dialects, is actually spoken in Guangdong province near the Guangdong-Guangxi border. No post-stopping is reported in Yue's (1979) study of Tengxian, in Guangxi province. An early source on a Yue dialect spoken in Guangxi is Wang's (1932) instrumental study. Its phonological system differs from neighbouring Yue dialects, such as Rongxian. Tsuji (1980:7) regards Bobai as having admixtures of Kejia speech. In any case, Wang examines his own production of nasals in Bobai with respect to places of articulation using an artificial palate, and notes the fortis nature of /m/; however, he makes no comments concerning any plosive release on the nasals.

2.5. Min Dialect Group

The Min dialect group is primarily spoken in Fujian, and is commonly divided into Northern and Southern Min, although, as noted earlier, an even more important east/west split exists. The original north/south division was made when little was known about the eastern dialects of Fujian province. The division was based on treating Fuzhou (in northeastern Fujian) as the representative dialect of Northern Min, and Xiamen (commonly known as 'Amoy', in southeastern Fujian) as the representative dialect of Southern Min. According to that subclassification, Northern and Southern Min divides in half the coastal belt that extends from southern Zhejiang province, past Fujian province into northeastern Guangdong. Some Min-speaking communities are also located elsewhere in Guangdong (e.g., in Zhongshan district, Hainan Island, and Leizhou Peninsula). In Taiwan, Southern Min, popularly referred to as "Taiwanese", is spoken by about 70 percent of the population. (Kubler 1985:156). (Most of those under fifty can also speak Mandarin, the standard imposed in the school system since the end of World War II when Chiang Kai-shek established his government there.)

2.5.1. Northern Min

Post-stopping is not commonly noted in the literature on Northern Min. In Fujian province, explicit mention of post-stopped nasals have been made for Fuan and Ningde (Norman 1977-1978).

In Guangdong province, a few studies of Northern Min have been conducted in Zhongshan district. Post-stopped nasals are observed in the Longdu dialect, originally analyzed by Egerod (1956) as a Southern Min dialect, but has since been treated by others such as Jerry Norman (personal communication) and Nicholas Bodman (1981) as a Northern (or Northeastern) Min dialect. Post-stopped nasals are also reported in a more restricted environment (i.e., prominent only before high vowels) in Bodman's (1981) study on the Nanlang dialect, also spoken in Zhongshan district.

2.5.2. Southern Min

For Southern Min, some background informatioon will be presented here. Southern Min presents a unique case among the Chinese dialects with respect to the topic of post-stopped nasals. In other Chinese dialects, what are plain or post-stopped nasals were plain nasals, at least phonemically, in the earlier phonology of those dialects, and can continue to be treated as plain nasals in their respective phonological system. This is not true in all cases with respect to the Southern Min dialects. In Xiamen (or Amoy), which is commonly used to represent Southern Min, besides plain nasals in its phonetic inventory, it also has voiced stops which are prenasalized. The two phonetic series alternate in phonologically-conditioned environments. The Xiamen case is then contrasted with another variety of Southern Min, represented by Chaozhou. In the Chaozhou dialect, the two series have split and are now contrastive, albeit in a very limited set of environments. Thus, in Southern Min, what were 'nasal + stop' syllable onsets had evolved into segments that are conventionally treated in the literature as voiced stops. Vestiges of the nasal component remains, nonetheless, in the prenasalization of the stop.

The prenasalization is not always noted in the published sources, and voiceless nasal onset is noted in only one of the sources consulted (Zhang 1983). If voiceless nasal onset is produced in the speech of the three Taiwan subjects in Iwata, Sawashima, Hirose and Niimi's (1979) fiberoptic study of laryngeal control in the voiced and voiceless stops in Southern Min, for example, it is not taken into account in their measurements of voice onset time (VOT). They simply observe that the voiced stops are "voiced through"; that is, "the duration of the voicing lead for the voiced type corresponds to the closure duration" (p.68).

To summarize, a series of plain nasals and a (prenasalized) voiced stop series characterize the Southern Min dialects on the whole. Whether the two series are in complementary distribution or have become contrastive is then dependent upon the particular subvariety of Southern Min.[7] Given the unique situation in Southern Min, the following section is devoted to a study of the distribution of these two series, together with some phonetic details.

3. Plain Nasals and Voiced Stops in Southern Min

In this section, the customary treatment of the voiced stops in Southern Min as simply voiced stops is adopted here for ease of exposition. Remarks concerning prenasalization or voiceless nasal onset are treated as further phonetic detail.

The two phonetic series, plain nasals and voiced stops, in Southern Min yield at least three different distributional patterns which pivot on whether plain nasals and/or voiced stops occur in syllables closed by a nasal consonant. The three distributional patterns are identified here as Patterns A, B, and C for convenience. Pattern A is exemplified by the varieties of Quanzhou and Zhuangzhou dialects spoken in Taiwan (Zhang 1983). (Quanzhou and Zhuangzhou districts in Fujian were the ancestral homes of these people.) The subvarieties of the Quanzhou and Zhuangzhou spoken in Taiwan (hereafter, simply referred to as Quanzhou and Zhuangzhou dialects) have [m], [n], and [ŋ], and the corresponding voiced stop series, [b], [d], [g]. The two series are in complementary distribution, as summarized in (2). For the sake of simplicity, syllabic nasals occurring in the final (or rhyme) are subsumed under nasalized vowels in the present discussion. According to Zhang (1983:7), the voiced stops are described as being preceded by a homorganic, voiceless nasal: [m̥b], [n̥d], and [ŋ̊g] in narrower phonetic transcription. Moreover, a voiced dental stop in the two dialects is produced in the speech of older speakers; younger speakers typically produce the lateral, [l], more narrowly transcribed as [n̥l].

(2) Pattern A. Phonological Conditioning of Nasals versus Voiced Stops.

a. Nasals occur before nasal vowels and syllables closed by a nasal consonant.

b. Voiced stops occur before oral vowels, and syllables closed by a glide or stop ([p], [t], [k], [ʔ]).

It is important to note that Pattern A does not occur in Tung's (1958) description of Jinjiang and Longqi, representing Quanzhou and Zhuangzhou respectively, Tung notes that some free variation exists in Jinjiang where [bin nĩ], for example, alternates with [min nĩ] for 'next year'. Longqi, on the other hand, patterns similarly to Xiamen, to be discussed next.

Pattern B is exemplified by Xiamen (Amoy), spoken in southern Fujian (Tung 1957, 1958). Xiamen also has two series: nasals — [m], [n], [ŋ] — and voiced stops or lateral — [b], [l], [g] — which are in complementary distribution. The voiced stop/lateral series has been described as being sometimes slightly prenasalized (e.g., Tung 1957:233). Moreover, the lateral is sometimes pronounced more stop-like, so that Southern Min speakers learning English often find it difficult to distinguish late and date (Tung 1957:233). Tay (1968:31) describes the sound as being produced by a rapid flap of the tongue tip, and finds it difficult to determine whether the sound would be more accurately represented as a [d] or [l]. For descriptive purposes, treating the series as voiced stops is more expedient, and will be done in the remainder of the study. Moreover, recall that the Xiamen data given in Figure 6d earlier shows a stop-like segment, with a burst transient. The treatment of all the segments as voiced stops not only simplifies the description, but it also has a phonetic basis. The distribution of the two series is summarized in (3). (The Pingyang dialect in Zhejiang province also exhibits Pattern B (Yuan 1983:240.)

(3) Pattern B. Phonological Conditioning of Nasals Versus Voiced Stops.

a. Nasals only occur before nasal vowels.

b. Voiced stops occur elsewhere (viz., before oral vowels, which are optionally followed by a nasal or non-nasal segment).

From Patterns A and B, one can observe that the Jinjiang dialect described by Tung (1958) has Patterns A and B in free variation. Other dialects that pattern similarly to Xiamen include the seven Penghu dialects of Southern Min, spoken on the Penghu Islands ("the Pescadores") between Taiwan and mainland China (Kubler 1986).

A third set of situations is exemplified by Chaozhou, spoken in northeastern Guangdong province. The plain nasal and voiced stop series are no longer in complementry distribution, but have developed into two contrastive series. This is described by Tung (1958) in his analysis of Jieyang, to represent this group of Southern Min dialects. The result is Pattern C, given in (3) below. Minimal pairs are actually very limited, but exist nonetheless. A pair with identical tone is 蜜 /bak/ 'honey' contrasting with 目 /mak/ 'eye' (cf. Amoy /bit/ and /bak/ respectively).

(3) Pattern C. Distribution of Nasals and Voiced Stops.

a. Nasals occur before nasal vowels, and before oral vowels closed by a nasal consonant.

b. Voiced stops occur before oral vowels, which are optionally followed by a glide, stop, or nasal consonant.

As in the other Southern Min dialects, some prenasalization is noted before the voiced stops in Jieyang (Choy 1976:6). Chao'an (Li 1959), another subvariety of Chaozhou, also fits into Pattern C. And, like Jieyang, the voiced stops are also slightly prenasalized. Li (1959:7) further notes that, in consequence, outsiders often confuse the voiced bilabial stop with the bilabial nasal.

A somewhat similar pattern is also found in the young generation of Wanyao speakers, whose ancestors had moved from the Quanzhou region to Wanyao, Ningde district, in northeastern Fujian province (Li and Chen 1982). Older speakers exhibit Pattern B. There is insufficient information and examples to determine the extent to which the young Wanyao speakers exhibit Pattern C. Due undoubtedly to influence from standard Mandarin, which has no nasal vowels, young Wanyao speakers produce oral vowels followed by final nasals corresponding to nasal vowel endings in older speakers; for example, 命 'life' is [miaŋ] for the young generation, and [miã] for the mid and old generations. And, in some contexts (the phonologically-conditioning of which cannot be determined due to the paucity of examples), initial plain nasals in young Wanyao speakers correspond to voiced stops in the older speakers; for example, 幕 'curtain' is [mɔʔ] for young speakers versus [bɔʔ]

for older speakers. Nonetheless, a voiced stop series is still found in the young Wanyao people (e.g., 米 'rice' [bi]).

The distribution of nasals and voiced stops in the three patterns are given in (4). The canonical shapes of the syllables are summarized in Columns I, II, and III, where uppercase 'C' represents a initial voiced stop, lower case 'c' a non-nasal consonant in coda position, 'N' a nasal consonant', 'V' an oral vowel, and 'Ṽ' a nasal vowel. The syllables may optionally include a prevocalic glide, which is omitted in (4) for simplicity's sake.

(4)

Pattern	I		II		III		Example
	CVc	NVc	CV	NṼ	CVN	NVN	
A	X		X	X		X	Quanzhou
B	X		X	X	X		Xiamen
C	X	X	X	X	X	X	Chaozhou

Studying Columns I, II, and III above in turn, observe, first of all, that for Patterns A and B, syllables consisting of 'voiced stop + vowel + non-nasal consonant' (CVc) and those consisting of 'nasal consonant + vowel + non-nasal consonant' (NVc) in Column I are in complemenary distribution. For Pattern C, however, the two types of syllable structure yield contrastive pair; for example, 蜜 /bek/ 'honey' contrasts with 密 /mek/ 'dense' in Jieyang (Choy 1976).

Regarding Column II, open CV and NṼ syllables differ both with respect to initial oral-nasal consonant and with respect to oral-nasal vowel. There is some redundancy: for dialects with Pattern A or B, either the nasalization on the vowel can be predicted on the basis of the preceding nasal consonant, or the nasal initial can be predicted on the basis of following nasal vowel. For dialects with Pattern C, since nasals and voiced stops form two separate series, the nasalization on the vowel can be predicted on the basis of the nasal initial. For example, in Jieyang, 米 /bi/ 'rice', is phonetically [bi], and 靡 /mi/ 'disperse', phonetically [mĩ].

Column III pertains to syllables closed by a final nasal. The initial consonant is either a voiced stop or a nasal consonant. Pattern A permits only a voiced stop as syllable onset, while Pattern B permits only a plain nasal in that environment. Thus, the stop and nasal series in these two patterns are in complementary distribution. Pattern C, however, permits both voiced stops and nasals to occur as onsets in syllables with final nasal, resulting in contrastive pairs. In Jieyang, for example, 望 /buaŋ/ 'hope' and 漫 /muaŋ/ 'overflow' form a minimal pair (Choy 1976).

Pattern C for the Chaozhou dialects results in part from multiple readings, or a literary-colloquial distinction, as a consequence of the chronological stratification of the lexicon. In the Hainan dialect (Woon 1979), for instance, the literary reading of 萬 'ten thousand' is distinguished from the colloquial reading of the word: /man/ is the literary reading, and /ban/ the colloquial reading. The two forms contrast only with respect to the initial consonant.

The above summarizes the main patterns for the distribution of the nasal and voiced stops series in Southern Min. The next section deals with non-Southern Min dialects with respect to the phonological conditioning of post-stopped nasals.

4. On the phonological conditioning of plosive release on nasals

Plosive release (including cases of burst release without stop closure) does not necessarily occur in all environments in dialects which do possess post-stopped nasals. Most studies mention the post-stopping of certain nasals, but provide no further information concerning whether the post-stopping is limited to syllables with a high vowel or glide, syllables with oral vowels, or syllables optionally closed by an obstruent. One major exception is McCoy's (1966) description of the Siyi ("Four Districts" — viz., Taishan, Kaiping, Enping, Xinhui) subgroup of Yue dialects. McCoy's dissertation includes information on the environments in which post-stopped nasals occur. Another valuable source of information is Karlgren's (1915-1926) lexicon in which he transcribed post-stopped nasals for the words in the dialects with that phenomenon, thereby enabling us to see the phonological environments in which plosive release occurred. In this section, the main objective is to report on some of the limited descriptions available in the literature concerning contextually-conditioned plosive release on syllable-initial nasals. Other sources provide more scanty information. McCoy, Karlgren and other sources will be used in this section to study the phonological conditioning of post-stopped nasals. The remainder of this sectin is organized as follows. Section 4.1 describes the phonological conditioning of post-stopped nasals with respect to height and backness of the following vowel, section 4.2 the interaction of post-stopped nasals and nasal vowels/nasal codas, and section 4.3 post-stopped nasals and their places of articulation.

4.1. Post-stopped nasals and vowel height/backness

One of the early sources with data on the phonological environments in which post-stopped nasals occur is Karlgren's (1915-1926) lexicon. Four of the dialects in the lexicon have post-stopped nasals, namely, Guihua, Taigu, Wenshui, and Xingxian. All four are Northwestern Mandarin dialects spoken in Shanxi province. In Guihua and Taigu, only the velar nasals have plosive release, which occur in all environments — that is, before non-high vowels specifically, since the velar nasals do not precede high vowels in either dialect. In the Wenshui and Xingxian dialects, plosive release occurs on the nasals in all four places of articulation: bilabial, dental, alveopalatal, and velar positions. Of particular interest to this subsection is that the post-stopping of the nasals surfaces in all environments, regardless of the height or backness of the following vowel. Similarly, M. Hashimoto (1973) and Egerod (1956) treat Kejia and Longdu (Northern Min) respectively as having post-stopped nasals in all environments.

For the Yue dialect group, and more specifically, for the dialects in the Siyi districts of Guangdong province, McCoy (1966) provides information on his eighteen Yue dialects, which are predominantly varieties of Taishan and Kaiping. Two of the dialects have no description concerning syllable-initial nasals. One can assume that they do not exhibit post-stopping of nasals. Thirteen of the dialects have post-stopping in all contexts. For the remaining three dialects -- Standard Taishan, "Kwong Hoi", and "Tai Ling" -- all spoken in Taishan district, syllable-initial nasals are pronounced with homorganic stops only in certain phonological environments. In Standard Taishan, the bilabial nasal occurs with a homorganic stop before back vowels /u,o/. Before other vowels, post-stopped nasals occur in free variation with the plain bilabial nasal. With respect to /n/, the plain nasal variant is in free variation with the post-stopped nasal variant before back vowels. Regarding the velar nasal, the third and last nasal in the phonology of Taishan, the plain nasal occurs in free variation with its corresponding post-stopped nasal variant before back vowels. In the Kwong Hoi dialect, nasals are pronounced with homorganic stops except before front vowels /i,e/, while in the Tai Ling dialect, nasals are pronounced with weak homorganic stops except before /a/, where only plain nasals surface. The Tai Ling case is similar to the observation made by Wang and Qian (1950) concerning the Duanfen variety of Taishan.

Wang and Qian (1950) also make observations concerning the relative strength or weakness of the post-stopped nasals in Kaiping with respect to the height or backness of the following vowel. As stated earlier, they note (p. 61), for instance, greater prominence of the plosive release before high back vowels, giving as their example, 言 [ŋgun] 'speech', in which the plosive release is so strong that the nasal-stop component almost becomes a single stop segment, creating [gun]. They further observe that the plosive release on initial nasals is particularly weak before the low vowel, /a/.[8]

Aside from the above sources, the height or backness of the vowel following the syllable-initial nasal is often not noted. When phonological conditioning is included in the descriptions, as in the Sichuan and Yunnan dialect surveys, it is always with respect to plosive release on nasals before high vowels or glides only; or sometimes, mention is made of greater prominence of the plosive release in that context. This is reported for /n/ in the Pengshan dialect in Sichuan province, for example (Site 77, Yang 1984).

In some other cases, specific reference is made to post-stopping only before high front vowels or glides. For example, in the Longchang dialect in Sichuan (Site 115, Yang 1984), and the Suijiang dialect in Yunnan (Site 99, Yang 1969b), /n/ has plosive release before /i/ and /y/. In the Rongchang dialect (Site 116, Yang 1984), plosive release on the dental and alveopalatal nasals is particularly prominent before the /i/ and /y/ glides. With regard to the initial nasals of the Nanlang dialect (Northern Min), Bodman (1981) states that plosive release is prominent only before /i/, and provides examples containing bilabial and velar nasal initials.

Alternatively, plosive release is noted only before high back vowels or glides. This is true for /m/ in the Tao'an dialect in Yunnan (Site 72, Yang 1969b). Plosive release noted for /m/ before the high back vowel is also observed in Sichuan province (Yang 1984), in both the Santai (Site 22) and Changshou (Site 20) dialects.

To summarize, from the above descriptions, no conclusion can be reached concerning which phonological criterion, height or backness of a vowel, is more crucial in conditioning plosive release on the nasals. The overall pattern that does emerge is that high vowels (or glides) tend to condition the post-stopping of nasals, and that low vowels tend to inhibit the phenomenon. Furthermore, post-stopping of dental nasals tends to be more prevalent before high front vowels, while post-stopping of bilabial nasals tends to be more common before high back vowels. With the exception of the brief comment above concerning the post-stopped velar nasal before /u/ in Kaiping, no general observation can be made concerning the phonological conditioning of plosive release on velar nasals.[9]

A caveat needs to be added at this point. In some sources, such as Egerod (1956) on Standard Zhongshan, it is simply stated that the initials tend to be followed in pronunciation by homorganic stops. Hence, stop closure is not obligatory, serving no phonological function in the dialect. In a similar way, Tsuji (1980) treats the plain nasals and their post-stopped counterparts in Rongxian, Binyang, and Sihe as occurring in free variation. A more systematic study of these dialects, however, is needed to to determine if plain and post-stopped nasals truly occur in free variation.

4.2. Post-stopped nasals and vowel nasalization/nasal coda

In this subsection, the first issue to be addressed is the correlation of post-stopped nasals and vowel nasalization. Plosive release on nasals, thereby terminating the nasal murmur, is an effective means to reduce or completely eliminate nasalizataion on the following vowel. For this reason, various linguists (e.g., M. Hashimoto 1973, Chen and Clumeck 1975) have used the term "denasalization" to describe the phenomenon. In a number of languages in the world, including Kaingáng (Wiesemann (1972), Amahuaca, Apinaye and other languages cited in Kawasaki (1986:85), a nasal is accompanied by an intrusive stop next to an oral vowel, while a plain nasal occurs next to nasal vowels.[10] Thus, pre- or post-stopped nasals and plain nasals are in complementary distribution, serving to maximize an oral-nasal vowel opposition in those languages. A further development is exemplified by the Southern Min dialects discussed earlier, where complete or almost complete denasalization has occurred before oral vowels. In Akan (Dolphyne, forthcoming), which has an oral-nasal vowel contrast, complete denasalization has taken place: the voiced stop series is in complementary distribution with the plain nasal series in CV stems. Voiced stops occur before oral vowels, while plain nasals occur before nasalized vowels (e.g., [ba] 'come' versus [mã] 'give', and [du] 'arrive' versus [nũ] 'stir').

With respect to Chinese, Southern Min and some dialects within the Mandarin, Wu, Gan and Xiang dialect groups have an oral-nasal vowel contrast. Among the Chinese dialects, Xiamen is exemplary in behaving as one expects: plain nasals precede nasal vowels, while voiced (and optionally prenasalized) stops occur before oral vowels. What is particularly interesting in Chinese, however, is that nasals may be accompanied by plosive release even in dialects without an oral-nasal vowel contrast. The phenomenon occurs in Northern Min, Yue and Kejia, as well as in dialects from other dialect groups with only a series of oral vowels. Synchronically, there are no reasons for the post-stopping of the nasals in these dialects.

From the above discussion, and from the study of Southern Min in section 3, one would naturally assume that, in Chinese dialects with an oral and a nasal series of vowels, nasals would not have plosive release if they are followed by a nasal vowel. No statements are made concerning this topic in the literature surveyed here. Only Karlgren's lexicon (1915-1926) with field data on Guihua, Taigu, Wenshui, and Xingxian provide any evidence to support or refute that assumption. Surprisingly, Karlgren records both oral and nasal vowels following the post-stopped nasals in all four dialects. In other sources, such as the dialect surveys, plosive release on nasals is such a low-level phonetic concern that no information is available on whether there are any co-occurrence restrictions on the post-stopping of nasals when the initial nasal is followed by a nasal vowel.

In the Chinese dialects, nasal vowels regularly came from finals (i.e., a syllable minus the initial consonant) that originally contained a nasal coda. Hence, regarding dialects that have oral vowels only, a relevant question to ask is whether or not plosive release occurs in syllables closed by a nasal ending. My field data on Zhongshan and Changsha Kaiping show that nasals have plosive release even in syllables with a final nasal. Examples are given in the expanded amplitude displays in Figure 7. The displays, from top to bottom are: Kaiping 腩 [ndam] 'sirloin', Kaiping 銀 [ŋgin] 'silver', and Zhongshan 頑 [ŋga:n] 'stubborn'. (The stop component is superscripted in the figure.) Note also that Figure 5b presented earlier shows a burst transient in Zhongshan for the word 農 [ndUŋ] 'agriculture', even though the syllable ends in a nasal consonant. Post-stopping of nasals occurring in syllables with a nasal coda is also found in Longdu (Egerod), Kejia (Hashimoto 1973), and the Siyi dialects recorded by McCoy (1966). In these dialects, post-stopped nasals are transcribed in all environments. Attested cases can also be found in the lexicon for Rongxian (Tsuji 1980).

Thus, among the modern Chinese dialects for which information is known, even if the nuclear vowel is fully nasalized or only somewhat nasalized (preceding a nasal coda), the syllable-initial nasal may still be produced with plosive release. Furthermore, recall from section 3 that in Xiamen and Chaozhou, voiced stops, accompanied by slight prenasalization, may occur in syllables closed by a nasal. The voiced stops are derived historically from the nasal series. Hence, these dialects also reflect the co-occurrence of post-stopping of earlier nasals in syllables with final nasals. In Southern Min, only in Quanzhou and Zhuangzhou spoken in Taiwan (Zhang 1983) are syllable-initial nasals inhibited from having plosive release when the syllables are closed by a nasal. In the Jiahe variety of the Xiang dialect group (Tsuji 1987), post-stopping is inhibited in syllables with final nasals. In Chaozhou, some of the syllable-initial nasals also lack plosive release in similar contexts. In conclusion, among the Chinese dialects, one finds cases of plain or post-stopped nasals occurring before nasal vowels, as well as cases of plain or post-stopped nasals in syllables with a final nasal.

4.3. Post-stopped nasals and places of articulation

In a number of dialects, the syllable-initial nasals may be produced with plosive release without regard to the place of articulation of these nasals. Examples include Taishan, Kaiping and Xinhui (McCoy 1966); Longdu (Egerod 1956); Zhongshan (my field data); Wenshui and Xingxian (Karlgren 1915-1926); Kejia (Hashimoto 1973), as well as Fuan and Ningde (Norman 1977-1978).

Dialects may differ, however, with regard to the relative duration of these segments. As noted earlier in section 1.1, in Changsha Kaiping, post-stopped velar nasals are shorter than those in other places of articulation, and have some tendency to almost denasalize. In Zhongshan, it is the bilabial post-stopped nasals that are sometimes shorter in duration than those in other places of articulation. Currently, there is no acoustical measurements of post-stopped nasals in other Chinese dialects. What information we have on the post-stopped nasals in other dialects pertains only to their confinement to certain places of articulation.

Focussing first on the study of individual dialects, as opposed to the major dialect surveys, no consistent pattern emerges. In the case of the Yue dialects in Guangxi province (Tsuji 1980), for example, there are four places of articulation for the syllable-initial nasals: bilabial, dental, alveopalatal, and velar. Optional plosive release on the nasals only apply to those in bilabial and dental positions. In the case of Rongxian, in addition to a plain nasal series which is produced with optional plosive release, the dialect has a contrastive series of nasals with murmured release, which may also be accompanied by stop closure (e.g., 門 [mbɦun] 'door').

A different situation obtains for the Northwestern dialects of Taigu and Guihua, spoken in Shanxi province (Karlgren 1915-1926). Taigu has four places of articulation for the nasals, and Guihua only three, lacking the alveopalatal series. In both dialects, plosive release is recorded consistently for the velar nasal. No post-stopping is recorded for the other nasals in either dialect.

Yet another situation has developed in the Nanchang (Gan) dialect (Yang 1969a). There are three nasals: a bilabial, an alveopalatal, and a velar nasal. Only the bilabial and velar nasals have stop closure. (The historical dental and retroflex nasals have become an alveopalatal before high front vowels, and a lateral in other contexts.)

Post-stopping of nasals with respect to places of articulation is, furthermore, not absolute. Some cases may reflect varying degrees of strength in the plosive release with respect to place of articulation. A case in point is Suixi, spoken on Leizhou Peninsula in Guangdong province (Yue-Hashimoto 1985). Strong stop closure often accompanies bilabial nasals, but the phenomenon is less commonly observed in the dental and velar nasals.

The above descriptions provide no overall pattern of which nasals tend to be produced with plosive release. We turn now to the major dialect surveys on Sichuan, Yunnan, and Hubei provinces. The distribution of post-stopped nasals in Sichuan (Yang 1984) is discussed first. Of the 134 sites in the survey, 16 sites have no reports of post-stopped nasals. Another 37 sites are not described independently, but are subsumed under other dialects with identical or virtually identical phonological systems.[11] Since post-stopping of nasals is of phonetic concern only, whether the nasals in these 37 sites are produced with plosive release cannot be ascertained, and are excluded from consideration in the present study. Post-stopped nasals are reported in the remaining 81 sites. Sixty-one of these sites have four places of articulation for the nasals. The four nasals are placed across the top of Table 2.

Table 2. Sichuan Dialect Survey: Post-stopping of Nasals in Four Places of Articulation.

Number of Places of Articulation with Post-stopping	[mb]	[nd]	[ɲd]	[ŋg]	Number of Sites
All places	+	+	+	+	6
3 places	+	+	+	−	5
	+	+	−	+	11
2 places	+	+	−	−	10
	−	+	+	−	3
	−	+	−	+	1
1 place	+	−	−	−	9
	−	+	−	−	6
	−	−	−	+	2
Total No. of Sites	49	50	14	20	61

In Table 2, the plus sign (+) represents presence of post-stopping, and a minus sign (-) its absence. As the first row shows, post-stopped nasals are reported for all four places of articulation, hence a plus sign under each column. The last column provides statistics on the number of sites reported to have the particular distribution of post-stopped nasals. In the case of the first row, there are six sites in the survey with post-stopping on all four nasals. The rest of the table proceeds in a similar way. The last row in the table provides information on the number of sites with post-stopping for the particular nasal. For [mb], for instance, 49 sites have plosive release on the bilabial nasal. (The sum is obtained by adding the number of sites with a plus sign under the [mb] column (i.e., 6 + 5 + 11 + 18 + 9 = 49).) Studying the last column in the table, one can observe that only 6 out of 61 sites, or about 10 percent of the sites, have post-stopping in all four places of articulation. Most common are sites with post-stopping on the bilabial and dental nasals, and next in frequency are sites with post-stopping in three places of articulation, with the alveopalatal nasal excluded. In sites with only one place of articulation, the most common situation is for the bilabial nasal to be produced with plosive release, with the dental, velar and alveopalatal following in descending order of frequency. Observe that none of the dialects mentioned earlier have plosive release limited to the dental nasal only. It is also significant that one never finds post-stopping restricted only to the alveopalatal nasal. In general, the alveopalatal tends to be produced without plosive release.

The last row in the table provides statistics on the individual nasals. From that set of statistics, there is no major difference in bilabial versus dental nasal with respect to frequency of occurrence in the 61 sites: the bilabial nasal has plosive release in 49 sites, while the dental nasal has plosive release in 50 sites. The significant difference is in the paucity of cases involving the alveopalatal and velar nasals. Why alveopalatal nasals tend to resist being produced with plosive release is not clear. A simiilar situation obtains in the Jiahe Xiang dialect (Tsuji 1987) where plosive release occurs with the bilabial and dental nasals, but not with the alveopalatal one. (The dialect lacks a velar nasal.) In the case of the velar nasals in the Sichuan survey, in virtually all cases, the following vowel is non-high. From the observations in section 4.1, one finds that post-stopping of nasals tend to occur more often if the following vowel is a high vowel. The restriction of the velar nasal to an environment only before non-high vowels may account for the low frequency of post-stopping in these dialects.

For completeness of coverage, Table 3 shows the 20 sites in the Sichuan survey with only three places of articulation. The same format as Table 2 is used. In this table, one finds, again, that the bilabial nasal occurs more frequently as the only nasal with plosive release. In this table, there is some slight difference with respect to the frequency that the post-stopped bilabial nasal versus the post-stopped dental nasal occur in the dialects. The bilabial nasal has post-stopping in 17 dialect sites, whereas only 12 sites have post-stopped dental nasals. It may be relevant to note that /n/ in these dialects often has one or more phonetic variants besides the dental nasal. In a number of these dialects *l- and *n- are no longer contrastive, so that [l] and [n] form allophones of the same phoneme. While having an [n]/[l] alternation does not preclude the post-stopping on the dental nasal, there is a definite correlation between the absence of post-stopping in the dental nasal and dialects with the nasal-lateral variants of /n/: in every case where post-stopping of /n/ is absent, one also finds that the /n/ has an [n]/[l] alternation.

Table 3. Sichuan Dialect Survey: Post-stopping of Nasals in Three Places of Articulation.

Number of Places of Articulation with Post-stopping	[mb]	[nd]	[ŋg]	Number of Sites
All places	+	+	+	4
2 places	+	+	–	6
1 place	+	–	–	7
	–	+	–	2
	–	–	+	1
Total No. of Sites	17	12	5	20

Turning now to the Yunnan dialect survey (Yang 1969b), there are 101 sites in the survey, but only 19 of them are reported to have plosive release on the nasals. These sites have two to four places of articulation for the nasals. Given the paucity of cases, all 19 sites are tabulated in Table 4. Zero (0) is used to indicate the absence of a given nasal in the dialect sites. For example, there are 7 sites with only three places of articulation, of which 6 lack the alveopalatal nasal, and one lack the velar nasal. There are 10 sites with only two places of articulation for the nasals, restricted to the bilabial and dental positions. In the Yunnan data, the bilabial nasal occurs significantly more frequently with post-stopping than the dental nasal.

Table 4. Yunnan Dialect Survey: Post-stopping of Nasals in Two to Four Places of Articulation.

Number of Places of Articulation	[mb]	[nd]	[ɲȡ]	[ŋg]	Number of Sites
4 places	+	+	—	—	1
	+	—	—	—	1
3 places	+	+	0	+	2
	+	+	0	—	2
	+	—	0	—	2
	+	—	—	0	1
2 places	+	+	0	0	1
	+	—	0	0	8
	—	+	0	0	1
Total No. of Sites with Post-stopping	18	7	0	2	19

As in the Sichuan survey, a number of the dialects in Yunnan have a dental nasal in which [l] and [n] occur as free or phonologically-conditioned variants. (The lateral is never produced with stop closure.) In addition, before a high front vowel, there is often a tendency for the nasal to be fronted to the alveopalatal position, a position which tends to inhibit plosive release. Thus, synchronically, there are at least a couple of factors that can account for the lower frequency of the dental nasal to have plosive release. In the case of the velar nasal, it occurs before non-high vowels, as in the Sichuan case, but in addition, the nasal is very unstable: in various Yunnan sites, it tends to be weak, and often spirantizes, and almost disappears. In contrast, the bilabial nasal is completely stable, with only the plain nasal or the post-stopped nasal as phonetic variants. Moreover, the bilabial nasal occurs in all environments with respect to the height and backness of the following vowel.

Proceeding to the third major dialect survey, on Hubei province (Chao et al. 1948), there are even fewer sites with post-stopped nasals. Plosive release on nasals is limited to three sites in the 64-site survey. The statistics are given in Table 5. Again, one finds the bilabial nasal occurring most frequently with plosive release. One reason is that it is the only nasal which occurs in the phonology of the dialects in all three sites. *n has merged with the alveopalatal nasal before high front vowels, and with the lateral in other contexts. The alveopalatal only surfaces in one dialect site, and the velar nasal in two. The velar nasal only precedes non-high vowels; moreover, in one of the two sites, the velar nasal is weak, and is sometimes spirantized.

Table 5. Hubei Dialect Survey: Post-stopping of Nasals in Two to Three Places of Articulation.

Number of Places of Articulation	[mb]	[nd]	[ɲɖ]	[ŋg]	Number of Sites
3 places	+	—	0	—	1
	+	0	—	—	1
2 places	+	+	0	0	1
Total No. of Sites with Post-stopping	3	1	0	0	3

To summarize, in general, post-stopped nasals are found in all places of articulation in a number of dialects, with loss or weakening before low vowels in some cases. Absence of plosive release on the velar nasals in the major dialect surveys of Sichuan, Yunnan, and Hubei is regularly correlated with spirantization and weakening of the velar nasal. Whether this implies that, historically, loss of stop closure on the velar nasal resulted eventually in spirantization and ultimate loss in many Mandarin dialects can only be speculative. A somewhat comparable situation obtains in the case of /n/ in a number of the dialects in the surveys. A dialect without plosive release on /n/ is typically also a dialect in which *l and *n have merged, resulting in [l] and [n] as phoneetic variants. The choice of /n/ as the phoneme in those dialects is based in part on frequency of occurrence of the two variants. In the case of /m/, there is no spirantization or phonetic alternation in any of the dialects. As a consequence, it is very stable.

There are, therefore, extrinsic factors to be considered before one can claim that of the three places of articulation — bilabial, dental, and velar — bilabial nasals have the greatest tendency to be produced with plosive release, while velar nasals have the least. The reason for the paucity of cases in which alveopalatal nasals are produced with stop closure is less clear. Alveopalatal nasals generally occur less frequently in languages of the world, while alveopalatal stops tend to affricate. The reason for the infrequency of alveopalatal nasals to have plosive release in the Mandarin dialects is linked somehow to these observations, although the precise nature of the connection remains to be determined .

With these remarks, we proceed to the fifth and final section of this study, tracing and speculating on the historical bases for the post-stopped nasals in Chinese.

5. Historical bases for the post-stopped nasals in Chinese

An appropriate place to begin our discussion is Henri Maspero's 1920 classic study of Chang'an (modern Xi'an), the capital of the Tang dynasty (618-907 A.D.). Maspero divides the standard speech during the Tang dynasty into two periods, the first encompassing the seventh century, and the second the eighth and ninth centuries. The division is based on observations of major changes in the pronunciation of Chinese in Chang'an, as reflected in the changes in the transcription of Sanskrit into Chinese in the Buddhist texts.

In the first period (seventh century), Sanskrit nasals were transcribed with nasals in Chinese, while voiced stops and voiced aspirates in Sanskrit were both transcribed with voiced stops. In the second period (eighth and ninth centuries), although Sanskrit nasals were still transcribed with nasals in Chinese, the characters chosen were usually those ending in a nasal (or more specifically, a velar nasal (Pulleyblank 1983:89)), Chinese nasals were also used to transcribe Sanskrit voiced stops during that period. Chinese voiced stops, in turn, were used to transcribe the Sanskrit voiced aspirates. From these changes, Masper infers that the nasals in Chang'an had become "nasales à détente orale" (nd, mb, ŋg) — or nasals with oral stop release — while the voiced stops had become voiced aspirates.

Maspero then provides further corroboration of oral stop closure on the Chang'an nasals. The evidence comes from two additional sources: (1) written Tibetan, in a Chinese-Tibetan, interlinear, manuscript of that period found in the famous hidden library in modern Dunhuang, in Gansu province, and (2) the so-called "Kan'on" pronunciation ('pronunciation of Han (— China)') of Chinese loan words in Japanese during the Tang dynasty. Regarding, first, the written Tibetan evidence, Maspero shows that the Chinese syllable-initial nasals were transcribed with Tibetan nasals when the syllables in Chinese were closed by a nasal; in other environments, the Chinese nasals were transcribed by a voiced stop preceded by the marker of prenasalization before obstruents, the "a-chung" letter in Tibetan orthography. This manuscript, together with other Chinese-Tibetan manuscripts discovered in Dunhuang, were originally intended for Tibetans learning Chinese, and hence are particularly valuable sources for determining the language of that period in northwestern China.

In the Kan'on readings, Chinese initial nasals in open syllables were borrowed in Japanese as voiced obstruents. This is contrasted with "Go'on" ('pronciation of Wu'), Sino-Japanese based on standard Chinese of the preceding period, in Wu, the ancient name for the Shanghai region and Zhejiang province. In Go'on, Chinese nasals were plain nasals, the only exception being that of the Chinese velar nasal, which was rendered by a voiced velar stop, since Japanese lacked a velar nasal in syllable/word-initial position.

Observe that even in the modern Wu dialect group today, spoken in the Shanghai and Zhejiang area, nasals are not pronounced with plosive release. Go'on readings provide invaluable evidence that the Wu dialect region maintained a pronunciation of syllable-initial nasals as plain nasals, without oral stop closure. In the case of Kan'on, Chinese syllables with a final nasal (or final velar nasal) are pronounced with a plain nasal or the corresponding voiced stop. Pulleyblank (1983:89) suggests that final velar nasals in the local Chang'an dialect may have tended to be replaced by nasalization of the vowel, so that plain nasals occurred only before nasalized vowels, similar to the distribution of the nasal series in modern Xiamen (Southern Min). In his summary of eighth and ninth century Chang'an speech, Maspero simply posits a post-stopped nasal series which alternates with plain nasals in those syllables that end in a nasal consonant.

In the above contrast between Kan'on and Go'on readings, although Maspero utilizes the two sets of Sino-Japanese pronunciations for demonstrating sound changes which had occurred between the first and second part of the Tang dynasty in the national standard, he does not question the reasons for the abrupt changes in the Tang standard in Chang'an in the eighth century, which is reflected in the Kan'on readings. Pulleyblank (1984), however, divides Middle Chinese into two periods, Early Middle Chinese and Late Middle Chinese, to account not only for a different period, but also for a different dialect base that is reflected in the Kan'on versus Go'on readings. Pulleyblank regards the Go'on readings as being based on Early Middle Chinese, and the Kan'on readings as being based on Late Middle Chinese. In his reconstruction schema, Early Middle Chinese (EMC) is based on the language of the well-known Qie Yun rhyme dictionary of 601 A.D. Although the Qie Yun was completed in Chang'an, he regards the language to be based on the standard Mandarin of the Northern and Southern Dynasties, probably reflecting the educated speech of the sixth century court, Nanjing ('southern capital'), located south of the Yangzi River, in what was the ancient state of Wu (whence the term, Go'on, 'pronunciation of Wu'). Thus, even though Chang'an became the Tang dynasty capital, the educated elite were originally drawn from the east and south.

By the eighth century, however, the local Chang'an dialect had emerged as the new prestigious dialect, supplanting the older standard. The changes observed in the eighth and ninth century Chang'an dialect hence reflect a change in dialect base. The new standard, based on the local Chang'an dialect of the eighth and ninth century, marks the beginning of Late Middle Chinese, which is the source of the Kan'on readings.

Maspero simply treats the two periods of the Tang dynasty speech in Chang'an as changes within the Chang'an dialect. For the earlier period, he posits a single, plain nasal series, and for the later period, he posits a post-stopped nasal series which alternates with the plain nasal series in syllables with nasal finals.

Since Maspero's classic article, Luo (1933) has made a further study of the Northwestern dialects of the Tang and Five Dynasties (tenth century) using three additional Chinese-Tibetan manuscripts from Dunhuang, and a Tang dynasty stone monument. From these sources, he finds that the Chinese bilabial and dental nasals, for example, are transcribed in written Tibetan as plain nasals in syllables ending in a nasal, and as voiced stops with nasal prefixation in other contexts. The Chinese velar nasal is transcribed in all environments by a voiced velar stop with nasal prefixation. Besides these premodern sources, Luo also utilizes the modern Northwestern Mandarin dialects from Karlgren (1915-1926), including Wenshui, Xingxian, and Pingyang (modern-day Linfen), which have been reported by Karlgren to have nasals that are closed by an homorganic oral stop. Based on the four Chinese-Tibetan manuscripts, the stone monument, and the modern Northwestern Mandarin dialects, Luo reconstructs the sounds of eighth century Northwestern diaelcts of Chinese. Regarding nasals in particular, Luo reconstructs plain and post-stopped nasals for all the Chinese nasals (including in labiodental and alveopalatal position). The only exception is the Chinese velar nasal, for which he only reconstructs a post-stopped velar nasal, which occurs in all environments in the ninth and tenth century sources. The velar position excepting, two phonetic series, plain and post-stopped nasals, are reconstructed by Luo for eighth century Northwestern Mandarin.

Another recent reconstruction of a Tang dynasty Northwestern Mandarin dialect is that by Coblin (1986) on the initials in Shazhou, spoken in the area around modern Dunhuang. On the basis of Chinese loangraph substitutions, Tibetan transcriptions, and the modern Northwestern dialects, Coblin reconstructs plain nasals phonemically, but includes, in the phonetic inventory, plain and "prenasalized stops" in complementary distribution. (Plain nasals occur in syllables ending in a nasal.)

Post-stopped nasals have also been taken into consideration by Gong (1981) in his reconstruction of a Northwestern Mandarin dialect at the end of the twelfth century, based, in this case, on a Chinese-Tangut source. Both plain and post-stopped variants of the nasal series are included in the reconstructed system.

All the above studies, however, are restricted to the Northwestern Mandarin group. The widespread distribution of the phenomenon among the modern Chinese dialect groups -- the only major exception being the Wu dialect group -- suggests that post-stopped nasals should also be reconstructed for the other Chinese dialect groups: Proto-Kejia, Proto-Min, Proto-Yue, and so forth. In Proto-Yue, for example, post-stopped nasals are often found in all environments. A single series of post-stopped nasals could be posited, with subsequent weakening or loss of post-stopping before low vowels in some dialects.

"Prenasalized stops" have been posited by Norman (1985) for Proto-Min, based on related words in the Miao-Yao language. His prenasalized stops correspond to 'nasal + homorganic voiceless obstruent' initials in Miao (Petchabun) and to voiced obstruents in Yao (Chiengrai). These initials have been reconstructed as prenasalized stops in Proto-Miao-Yao. Norman's prenasalized stops for Proto-Min correspond to a subset of stops in the modern Min dialects, and not to the nasal series, which continue to be treated as nasals in the proto-language.[12]

Historical evidence shows that post-stoppped nasals in the modern dialects can be traced back at least as early as the eighth century, in the standard of the Tang dynasty in Chang'an. For the Min dialect group, which broke off from the rest of the Chinese language previous to that time, the existence of a plain and (prenasalized) voiced stop series in the modern Southern Min dialects argues for post-stopped nasals existing even earlier in the Chinese language. The dating of the phenemonon, however, remains to be worked out.

For dialect groups such as Kejia and Yue, there is also the question of whether post-stopped nasals were introduced into the language from the Tang standard, or whether they existed prior to the Chang'an standard. If nasal vowels were in the Chang'an speech, as Pulleyblank (1983) suggests, then it is unlikely that eighth century Chang'an speech was the source of the post-stopped nasals in Kejia and Yue, which only have oral vowels. This conclusion is further corroborated by the absence of allophonic variation in many Yue and Kejia dialects; post-stopped nasals are found in all contexts, or at most, weakened or lost before low vowels. Crucially, the phonological conditioning is different, with the loss of plosive release due to vowel height and not to a tautosyllabic nasal. Hence, the phenomenon pre-dates Late Middle Chinese, even though much of the phonology of modern Yue and Kejia dialects can be traced to LMC. The widespread distribution of post-stopped nasals, especially in all environments, provide evidence to argue for some kind of 'nasal + stop' segment in Proto-Yue and Proto-Kejia. Whether they are single segments, post-stopped nasals, or two segments, 'nasal prefix + stop', remains speculative at this point, and will not be pursued further in this paper.

In the case of Chang'an, whether the dialect had post-stopped nasals much earlier in its history cannot be ascertained. Karlgren (1940:435) rejects the possibility that the nasal/voiced stop phonetic series in Southern Min have developed independently, arguing, instead, for an historical relationship between those two series in Southern Min and the post-stopped nasals in the Northwestern Mandarin dialects (e.g., Wenshui, Xingxian). With more knowledge of post-stopped nasals in the other modern dialects and some understanding of the acoustical nature of post-stopped nasals, there is little doubt that the Southern Min plain and (prenasalized) voiced stops could have developed independently. A comparison of the prenasalized voiced stops in Southern Min with the post-stopped nasals in Zhongshan, for example, shows that prenasalization and the production of a burst release for the 'stop' component in Southern Min do not differ substantially from that in Zhongshan. A major difference is in the voiceless nasal onset in Southern Min, which is absent in Zhongshan. The vast geographical spread of nasal-stop segments in China makes viable the proposal of a common origin for the post-stopped nasals in Chinese pre-dating the phenomenon in eighth century Chang'an.

Notes

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Conference on Sino-Tibetan Languages and Linguistics (21–23 August 1987), Vancouver, Canada. The current study includes acoustical data on the post-stopped nasals in Zhongshan and Kaiping Chinese, as part of the research for Chan and Ren (1987). To the best of our knowledge, that was the first acoustical investigation into the phenomenon in the Chinese dialects. The examples in this paper are from one Zhongshan and one Kaiping speaker. The Zhongshan speaker is Dennis Chan, born in Kuchong, near Shiqi, the county seat of Zhongshan county in Guangdong province. The study of Zhongshan in Chan (1980) was based on his speech, recorded in Vancouver, Canada, in 1977 and 1978 when he was in his early fifties. David Leong, thirty-five years old, is the speaker from Changsha, Kaiping district, also in Guangdong province. His speech was recorded in 1987 in Los Angeles. An early study of some aspects of the present topic is included in Chen and Clumeck (1975) as part of their study of denasalization of the nasals in Korean.

[1]The speaker is Bill Dolan, a graduate student in the Linguistics Department at UCLA. The Malagasy example to be given later is from a tape that is part of U.C. Berkeley's series of tapes on "The Sounds of Languages."

[2]The tokens are from a tape recorded by an undergraduate student, John Ritchie, in 1985, and is part of the tape collection at UCLA Phonetics Laboratory. The informant is Phil Wang, a twenty-one year old originally from Taiwan.

[3]Population figures for the subgrouping within the Mandarin dialect group are not given in Yuan (1960). They are based on the figures from Chen (1975:84), who had projected Yuan's figures for the various dialect groups onto a population of 741 million, compared to Yuan's 547 million. Chen's source for the number of speakers of the subdialects of Mandarin is not known; they do not appear in Yuan (1960, 1983). The figures for the subgrouping within Min is given in Yuan (1960), but not in the more recent edition (1983).

[4]In these large-scale dialect surveys, for each location, one or two speakers are recorded. For each location, a brief description is given of the sounds in the dialect, with some phonetic details noted.

It should be noted that in all the cases of post-stopped nasals, these nasals were historically nasals (or the lateral which had merged with its corresponding nasal). Only in one case, to my knowledge, has nasal-stop components arisen from the historically voiced stop seriaes. This occurred in Hunan province, in the Lin Xiang dialect (Site 17 in Yang's (1974) survey): the voiced stop series was sometimes pronounced with prenasalization. While this is probably an isolated case of dialect-internal innovation, it is worth noting that a subset of Middle Chinese voiced stop series were recorded as prenasalized stops by Norman (1985) for Proto-Min.

[5]Background on the Hakka-Punti wars is commonly known to Chinese historians. The particular details here are based on Lai (1980).

[6]Note that in the acoustical study of Kaiping (Chan and Ren 1987), the post-stopped velar nasals, as a whole, were noticeably shorter than the

corresponding labial and dental counterparts, as shown in (i). The duration measurement (in milliseconds) is the measurement from syllable onset to vowel onset, and thus includes both the nasal and stop component. For typographic convenience, the stop component is not superscripted.

(i) Duration of Post-Stopped Nasal (nasal + stop component).

Post-stopped Nasal	Mean Duration	Number of Tokens	Standard Deviation
[mb]	105.7 ms.	15	19.8 ms.
[nd]	107.3 ms.	15	23.5 ms.
[ŋg]	69.5 ms.	15	25.4 ms.

The mean duration of the stop components by themselves, however, shows no significant difference with respect to the place of articulation. This is shown in (iii). The duration of the stop component is determined by the duration of amplitude drop, measured from the beginning of amplitude drop in the syllable onset to vowel onset.

(ii) Duration of Amplitude Drop (the stop component) in Post-Stopped Nasals.

Post-stopped Nasal	Mean Duration	Number of Tokens	Standard Deviation
[mb]	23.7 ms.	15	22.6 ms.
[nd]	25.5 ms.	15	7.1 ms.
[ŋg]	23.7 ms.	15	10.9 ms.

[7]The Southern Min dialect of Suixi, spoken in Leizhou Peninsula, at the southwestern tip of Guangdong province (Yue-Hashimoto 1985:4-5) is an exception. It has neither nasal vowels nor a split series of nasals contrasting with voiced stops. Post-stopped nasals, and sometimes simply voiced stops, occur sporadically in open syllables, or in syllables closed by a non-nasal segment. The phenomenon does not occur in syllables with a nasal coda. Data was recorded from one informant in Hong Kong whose ancestral home was Putian, northern Fujian province.

Putian and neighbouring dialects in Putian and Xianyou districts in Fujian are described by Chang (1972) as transitional both linguistically and geographically with respect to Northern Min, represented by Fuzhou, and Southern Min, represented by Xiamen. What are voiced stops in Southern Min have merged with the voiceless stop series in Putian and the other dialects in its vicinity. In the case of Putian, the loss of nasalizaion on the vowels resulted in the dialect having only oral vowels.

[8]In David Leong's Changsha Kaiping speech, the duration of the nasal component in the post-stopped velar nasal is very short before all vowels, and is not restricted to the environment before /u/. See, for example, the short duration of the velar post-stopped nasal in Figure 3b, displaying the syllable, [ŋga]. Moreover, with respect to the stop release before low vowels, it is not noticeably weaker than before other vowels in the informant's speech.

[9]Not related to either height or backness of the vowel following the nasal is Norman's (1977–1978:329) observation on Fuan and Ningde (both Northern Min dialects) with respect to phonologically-conditioned plosive release on the nasals: "the nasals are pronounced as prenasalized voiced when articulated in isolation or after a pause: [mb, nd, ŋg]; intervocalically they are pure nasals".

[10]It is likely that a similar process of partial denasalization has occurred in Acehnese (Durie 1985) with respect to the nasals before oral vowels.

[11]The pages describing Site 28 are missing in the UCLA copy of the survey. As a result, Site 28 is temporarily treated as having no phonetic description of its own.

[12]Note that a reconstruction of "prenasalized stops" for Proto-Chinese, corresonding to the nasal series in modern Chinese has been proposed by Chang and Chang (1976), based primarily on Chinese doublets and comparative evidence in the Tibeto-Burman and Miao-Yao languages.

Bibliography

Due to confusion in the existence of several romanization systems to refer to the various Chinese dialects (Pinyin, Wade-Giles, idiosyncratic romanization systems for Cantonese, etc.), three additional pieces of information are included at the end of each source concerning Chinese dialects: (1) name of the dialect group in uppercase letters, (2) name of the dialect optionally included in parentheses, and (3) the province in which the dialect is spoken. For example, "YUE: (Zhongshan) Guangdong" specifies "YUE" as the dialect group, "(Zhongshan)" as the dialect within that dialect group, and "Guangdong" as the province in which Zhongshan is spoken. In addition, the following abbreviations are used:

BIHP	Bulletin of the Institute of History and Philology
CAAAL	Computational Analyses of Asian and African Languages
JCL	Journal of Chinese Linguistics
ZGYW	Zhongguo Yuwen

Bodman, Nicholas C. (1981). "A Sketch of Two Min Dialects of Zhongshan Xian." Paper presented at the XIVth International Conference on Sino-Tibetan Languages and Linguistics, Gainesville, Florida. [N MIN: (Nanlang) Guangdong]

Chan, Marjorie K.M. (1980). Zhong-shan Phonology: A Synchronic and Diachronic Analysis of a Yue (Cantonese) Dialect. Masters thesis, University of British Columbia, Vancouver, Canada. [YUE: (Zhongshan) Guangdong]

__________ and Hongmo Ren. (1987) "Post-stopped Nasals: An Acoustic Investigation." Paper presented in May 1987 at the 113th meeting of the Acoustical Society of America, Indianapolis, Indiana. UCLA Working Papers in Phonetics 68. [YUE: (Kaiping, Zhongshan) Guangdong]

Chang, Yü-hung. (1972). The Hinghwa Dialects of Fukien: A Descriptive Linguistic Study. Ph.D. dissertation, Cornell Unversity. [N/S MIN: (Xinghua) Fujian]

Chang, Betty Shefts and Kun Chang. (1976). "The Prenasalized Stop Initials of Miao-Yao, Tibeto-Burman, and Chinese: A Result of Diffusion or Evidence of a Genetic Relationship?" In: Mantaro Hashimoto (Ed.). Genetic Relationship, Diffusion and Typological Similarities of East and Southeast Asian Languages. Tokyo: The Japan Society for the Promotion of Sciences. Pg. 315-358.

Chao, Yuen Ren. (1928). Xiandai Wuyude Yanjiu. [Studies in the modern Wu dialects] Monograph Number 4, Tsing Hua College Research Institute. [WU: Jiangsu, Zhejiang]

__________. (1948). "Zhongshan Fangyan." [Zhongshan dialect] BIHP 21:49-73. [YUE: (Zhongshan) Guangdong]

__________. (1951). "Taishan Yuliao." [Taishan linguistic materials] BIHP 23:25-76. [YUE: (Taishan) Guangdong]

__________, Sheng-shu Ting, Shih-feng Yang, Tsung-chi Wu, and T'ung-ho Tung. (1948). Hubei Fangyan Diaocha Baogao. [Report on a survey of the dialects of Hubei] Special Publication Number 18, Institute of History and Philology, Academia Sinica. [SE & SW MANDARIN: Hubei]

Chen, Matthew. (1975). "An Areal Study of Nasalization in Chinese." In Ferguson et al. (eds.), pp. 81-123.

__________ and Harold Clumeck. (1975). "Denasalization in Korean: A Search for Universals." In Ferguson et al. (eds.), pp. 125-131.

Choy, Chun-ming. (1976). Chaoyu Cidian. [A dictionary of the Chaozhou dialect] Taipei: Dongya Zhibensuo. [S MIN: (Jieyang variety of Chaozhou) Guangdong]

Coblin, W. South (1986). "Notes on the Initials of a Northwest Dialect of Tang Times". Paper presented at the Second International Conference on Sinology, Taipei, Taiwan. [NW MANDARIN: Gansu]

Condax, Iovanna Delano. (1973). Phonology of Lung-Yen Chinese: A Synchronic and Diachronic Analysis of a Kiangsi Dialect Based on 3,700 Character Readings and Selected Colloquial Forms. Ph.D., Princeton University. (Also in: Working Papers in Linguistics, University of Hawaii (1974) 6.1:1-169.) [GAN: (Longyan) Jiangsu]

Dolphyne, Florence. (Forthcoming). The Akan Language: Its Sound Systems and Tonal Structure. University of Ghana Press.

Durie, Mark. (1985). A Grammar of Acehnese: On the Basis of a Dialect of North Aceh. Dordrecht: Foris Publications.

Egerod, Søren. (1956). The Lungtu Dialect: A Descriptive and Historical Study of a Southern Chinese Idiom. Copenhagen: Ejnar Munksgaard. [N MIN: (Longdu) Guangdong]

__________. (1959). "A sampling of Chungshan Hakka." In Egerod and Glahn, (eds.), pp. 36–54. [KEJIA: (Zhongshan Kejia) Guangdong]

__________ and Glahn, Else, Editors. (1959) Studia Serica Bernhard Karlgren Dedicata. Copenhagen: Ejnar Munksgaard.

Ferguson, Charles A., Larry M. Hyman, and John J. Ohala, Editors. (1975) Nasalfest: Papers from a Symposium on Nasals and Nasalization. Stanford: Department of Linguistics, Stanford University.

Forke, A. (1903). "A Comparative Study of Northern Chinese Dialects." China Review 21.

Gong, Hwang-cherng. (1981). "Shi'er Shijimo Hangyude Xibei Fangyan (Shengmu Bufen)." [A Northwestern Chinese dialect at the end of the 12th century] (English abstract) BIHP 52.1:37–78.

Hashimoto, Oi-kan Yue. (1972). Phonology of Cantonese. Cambridge: Cambridge University Press. [YUE: (Standard Cantonese) Guangdong]

Hashimoto, Mantaro J. (1973). The Hakka Dialect: A Linguistic Study of Its Phonology, Syntax and Lexicon. London: Cambridge University Press. [KEJIA: (Meixian Kejia) Guandong]

Hebei Beijing Shifan Xueyuan & Zhongguo Kexueyuan Hebeisheng Fenyuan, Editors. (1961) Hebei Fangyan Gaikuang. [Survey of the Hebei dialect] Tianjin: Hebei Renmin Chubanshe. [N MANDARIN: Hebei]

Hebeisheng Changlixian Xianzhi Bianzuan Weiyuanhui & Zhongguo kexueyuan Yuyan Yanjiuso, Editors. (1960). Changli Fangyanzhi. [Record of the Changli dialect] Beijing: Kexue Chubanshe. [N MANDARIN: Hebei]

Hyman, Larry M. (1975). "Nasal States and Nasal Processes." In Ferguson et al. (1975). Pages 249–264.

Iwata, Ray, Masayuki Sawashima, Hajime Hirose and Seiji Niimi. (1979). "Laryngeal Adjustment of Fukienese Stops." Annual Bulletin, Research Institute of Logopedics and Phoniatrics (RILP) 13:61–81. [S MIN: Taiwan]

Karlgren, Bernhard. (1915–1926). Etudes sur la Phonologie Chinoise. Uppsala: K.W. Appelberg & Leiden.

__________. (1940). Zhongguo Yinyun Xue Yenjiu. [Studies in Chinese phonology] Translation of Karlgren (1915–1926), with phonetic transcriptions by Changpei Luo, Yuen Ren Chao and Fang-kuei Li. Shanghai: Shangwu. (The 1940 Chinese translation is cited where page reference is given. A 1962 reprint (Taipei: Shangwu Yinshuguan) is used here.)

Kawasaki, Haruko. (1986). "Phonetic Explanations for Phonological Universals: The Case of Distinctive Vowel Nasalization." In Ohala and Jaeger (eds.), pp. 81–103.

Kratochvil, Paul. (1968). The Chinese Language Today. London: Hutchinson University Library.

Kubler, Cornelius C. (1985). "The Influence of Southern Min on the Mandarin of Taiwan." Anthropological Linguistics 27.2:156–176.

__________. (1986). "A Dialect Survey of the Penghu Islands." JCL 14.2:292–305. [S MIN: Taiwan]

Ladefoged, Peter and Ian Maddieson. (1986). Some of the Sounds of the World's Languages. UCLA Working Papers in Phonetics 64.

Lan, Ching-han. (1980). The Yilan Dialect of Chinese. (In Japanese) CAAAL Monograph Series, Number 14. [S MIN: Taiwan]

Lai, Him Mark. (1980). "Roots and Linkages: A Journey Through the Pearl River Delta." Part IV: Taishan. East/West (25 June 1980):8. (An eight-part article published in the East/West newspaper in separate installments from 19 March 1980 to 4 February 1981.)

Li, Rulong and Zhangtai Chen. (1982). "Wanyao Minnan Fangyan Dao Erbaiduo Nianjiande Bianhua." [Linguistic changes in Wanyao, an isolated South Min dialect in the east of Fujian, during the past two centuries] ZGYW (1982)5:354-364. [S MIN: (Wanyan) Fujian]

Li, Rong. (1966). "Wenling Fangyan Yuyin Fenxi." [Phonetic analysis of the Wenling dialect] ZGYW (1966) 1:1–9. [WU: Zhejiang]

Li, Yongming. (1959). Chaozhou Fangyan. [The Chaozhou dialect] Beijing: Zhonghua. [S MIN: (Chao'an variety of Chaozhou) Guangdong]

Liu, Ling. (1986). "Gansu Dunhuang Fangyin Yu 'Guangyun' Yinxi." [Dunhuang dialect of Gansu and the Guangyun sound system] Journal of Asian and African Studies 32:127–142.

Luo, Changpei. (1933). Tang Wuxdai Xibei Fangyin. [The Northwestern dialects of the Tang and Five Dynasties] Shanghai: Academia Sinica (Includes a 7-page preface in English.) [NW MANDARIN: Shanxi, Shaanxi]

__________. (1940). Linchuan Yinxi. [Phonetics and phonology of the Linchuan dialect] Changsha: Shangwu. [GAN: Jiangxi]

Maddieson, Ian and Karen Emmorey. (1984). "Is There a Valid Distinction Between Voiceless Lateral Approximants and Fricatives?" Phonetica 41:181–190.

Malmqvist, Goran. (1959). "A Note on Two Szech'uanese Dialects". In Egerod and Glahn (eds.), pp. 92–97. [SW MANDARIN: Sichuan]

Maspero, Henri. (1920). "Le Dialecte de Tch'ang-Ngan Sous les T'ang." Bulletin de l'Ecole Française d'Extrême-Orient 20.2:1-124. [NW MANDARIN: (Chang'an (modern Xi'an)) Shaanxi]

McCoy, William John, Jr. (1966). Szeyap Data for a First Approximation of Proto-Cantonese [with] Appendix. Ph.D. Dissertation, Cornell University. [YUE: (Taishan, Kaiping, Enping, Xinhui) Guangdong]

Nakajima, Motoki. (1977). A Study of the Basic Vocabulary of the Min Dialect in the Tung Shan Island. (In Japanese) Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies. [S MIN: Fujian]

__________. (1983a). Studies in Wu Dialects. (In Japanese) Tokyo: Fuji Publishing Co. Ltd. [WU: (Shanghai) Jiangsu]

__________. (1983b). The Southern Chekiang Dialect: A Linguistic Study of Its Phonology and Lexicon. (= Asian and African Lexicon, Number 14). Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo Foreign University. [WU: (Wenzhou, Leqing) Zhejiang]

Norman, Jerry. (1970). "A Characterization of the Min Dialects." Qilin 6:19-34.

__________. (1977-78). "A Preliminary Report on the Dialects of Mintung." Monumenta Serica 33:326-348. [N MIN: Fujian]

__________. (1985). "The Origin of the Proto-Min Softened Stops." In: John McCoy and Timothy Light (Eds.) Contributions to Sino-Tibetan Studies. Leiden: E.J. Brill. Pg. 375-384.

Ohala, John J. and Jeri J. Jaeger, Editors. (1986). Experimental Phonology. New York: Academic Press.

Pan, Maoding. (1963). "Fujian Hanyu Fangyan Fenqu Lueshuo." [A short discussion on divisions of the Chinese dialects of Fujian] ZGYW (1963) 6:475-495.

Pulleyblank, Edwin G. (1983). "Stages in the Transcription of Indian Words in Chinese from Han to Tang." In: Klaus Röhrborn and Wolfgang Veenker (Eds.) Sprachen des Buddhismus in Zentralasien. Wiesbaden: Otto Harrassowitz. Pp. 73-102.

__________. (1984). Middle Chinese: A Study in Historical Phonology. Vancouver: University of British Columbia Press.

Scott, N.C. (1973). "The Monosyllable in Szechuanese." In: W.E. Jones and J. Laver (Eds.) Phonetics in Linguistics: A Book of Readings. London: Longman. Pp. 278-298. [SW MANDARIN: Sichuan]

Tay, Mary Wan Joo. (1968). A Phonological Study of Hokkien. Ph.D. dissertation, University of Edinburgh. [S MIN: (Malayan variety of Yongchun) Fujian]

Tsuji, Nobuhisa. (1980). Comparative Phonology of Guangxi Yue Dialects. Tokyo: Kazama Shobo Publishing Co. [YUE: Guangxi]

__________. (1987). Lexicon of a Chinese Dialect in South Hunan, China: Classified Data From Longtan-xu, Jiahe County. (= Asian and African Lexicon, Number 17). Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies. [XIANG: (Longtan) Hunan]

Tung, T'ung-ho. (1956). "Huayang Shuijing Kejiahua Jiyin." [The phonetic system of Kejia dialect spoken in Liangshuijing, Huayang district] Beijing: Kexue Chubanshe. [KEJIA: (Huayang Shuijing Kejia) Sichuan]

__________. (1958). "Sige Minnan Yangyan." [Four Southern Min dialects] BIHP 30.2:729—1042. [S MIN: Fujian, Guangdong]

__________, Yung-lang Chao, and Ya-shiu Lan. (1967). Ji Taiwande Yizhong Minnanhua. [A Southern Min dialect of Taiwan (spoken in Taipei)] Monograph Series A, Number 24, Institute of History and Philology.

Wang, Li. (1932). Une Prononciation Chinoise de Po-Pei (Province de Kouang- si) Etudiée à l'aide de la Phonétique Expérimentale. Paris: Librairie Ernest Leroux. [YUE/KEJIA: (Bobai) Guangxi]

__________ and Songsheng Qian. (1949). "Dongguan Fangyin." [The sounds in the Dongguan dialect] Lingnan Xuebao 10.1:119—150. [YUE: (Dongguan) Guangdong]

__________. (1950a). "Taishan Fangyin." [The sounds in the Taishan dialect] Lingnan Xuebao 10.2:67—104. [YUE: (Taishan) Guangdong]

__________. (1950b). "Zhujiang Sanjiaozhou Fangyin Zonglun." [General introduction to the study of the sounds (in the Yue dialect) in the Pearl River Delta] Lingnan 10.2:57—66. [YUE: (Taishan, Kaiping, Zhongshan, Heshan, Shunde, Dongguan, Nanhai, etc.) Guangdong]

Wang, Shihua. (1959) Yangzhouhua Yinxi. [Phonetics of Yangzhou] Beijing: Kexue Chubanshe. [N MANDARIN: Jiangsu]

Woon, Wee-Lee. (1979). "A Synchronic Phonology of Hainan Dialect." JCL 7.1:65—100, 7.2:268—302. [S MIN: Guangdong]

Wiesemann, Ursula. (1972). Die Phonologische und Grammatische Struktur der Kaingáng-sprache. (English summary) The Hague: Mouton.

Yang, Huandian. (1964). "Guilin Yuyin." [Phonetics of Guilin] ZGYW (1964) 6:454—462. [SW MANDARIN: Guangxi]

Yang, Shih-feng. (1951). "Chengdu Yinxi Lueji." [A brief description of the phonetics of the Chengdu dialect] BIHP 23.1:289—302. [SW MANDARIN: Sichuan]

__________. (1956). "Sichuan Lizhuang Fangyan Lueji." [A brief description of the Lizhuang dialect, Sichuan] BIHP 28.1:283—317. [SW

MANDARIN: (Lizhuang) Sichuan]

__________. (1957). "Taiwan Taoyuan Kejia Fangyan." [The Kejia dialect of Taoyuan, Taiwan] BIHP 22:1–451. [KEJIA: (Taoyuan Kejia) Taiwan]

__________. (1969a) "Nanchang Yinxi." [The phonetic system of Nanchang] BIHP 39.1:125–204. [GAN: (Nanchang) Jiangxi]

__________, Editor. (1969b). Yunnan Fangyan Diaocha Baogao. [Report on the dialects of Yunnan] 2 volumes. Special Publication Number 56, Institute of History and Philology, Academia Sinica. SW MANDARIN: Yunnan]

__________. (1971). "Taiwan Meinong Kejia Fangyan." [The Kejia dialect of Meinong, Taiwan] BIHP 42.3:405–466. [KEJIA: (Meinong Kejia) Taiwan]

__________, Editor. (1974). Hunan Fangyan Diaocha Baogao. [Report on a survey of the dialects of Hunan] Special Publication Number 66, Institute of History and Philology, Academia Sinica. [XIANG: Hunan]

__________, Editor. (1984). Sichuan Fangyan Diaocha Baogao. [Report on a survey of the dialects of Sichuan] 2 volumes. Special Publication Number 82, Institute of History and Philology, Academia Sinica. [SW MANDARIN: Sichuan]

__________ and Eugene Ching. (1971). "Lingbao Fangyan." [Lingbao dialect] Tsinghua Journal of Chinese Studies 9.1–2:106–147. [N (NW) MANDARIN: (Lingbao) Henan]

Yue, Anne O. (1979). The Teng-Xian Dialect of Chinese: Its Phonology, Lexicon and Texts with Grammatical Notes. CAAAL 12:1–357. (– CAAAL Monograph Series, Number 3.) [YUE: (Tengxian) Guangxi]

Yue-Hashimoto Anne O. (1985). The Suixi Dialect of Leizhou: A Study of Its Phonological, Lexical and Syntactic Structure. Hong Kong: Institute of Chinese Studies, Chinese University of Hong Kong. (S MIN: (Suixi) Leizhou Peninsula, Guangdong]

Yuan, Jiahua. (1960). Hanyu Fangyan Gaiyao. [Outline of Chinese dialects] Beijing: Wenzi Gaige Chubanshe. (Second edition published in 1983.)

Zhan, Bohui. (1981). Xiandai Hanyu Fangyan. [Modern Chinese dialects] Qianjiang County: Hubei Renmin Chubanshe.

Zhang, Zhenxing. (1983). Taiwan Minnan Fangyan Jilue. [A brief description of the Southern Min dialects in Taiwan] Fuzhou: Fujian Renmin Chubanshe. [S MIN: Taiwan]

Zheng, Zhang Shangfang. (1964). "Wenzhou Yinxi." [The phonetic system of Wenzhou] ZGYW (1964) 1:28–60. [WU: Zhejiang]

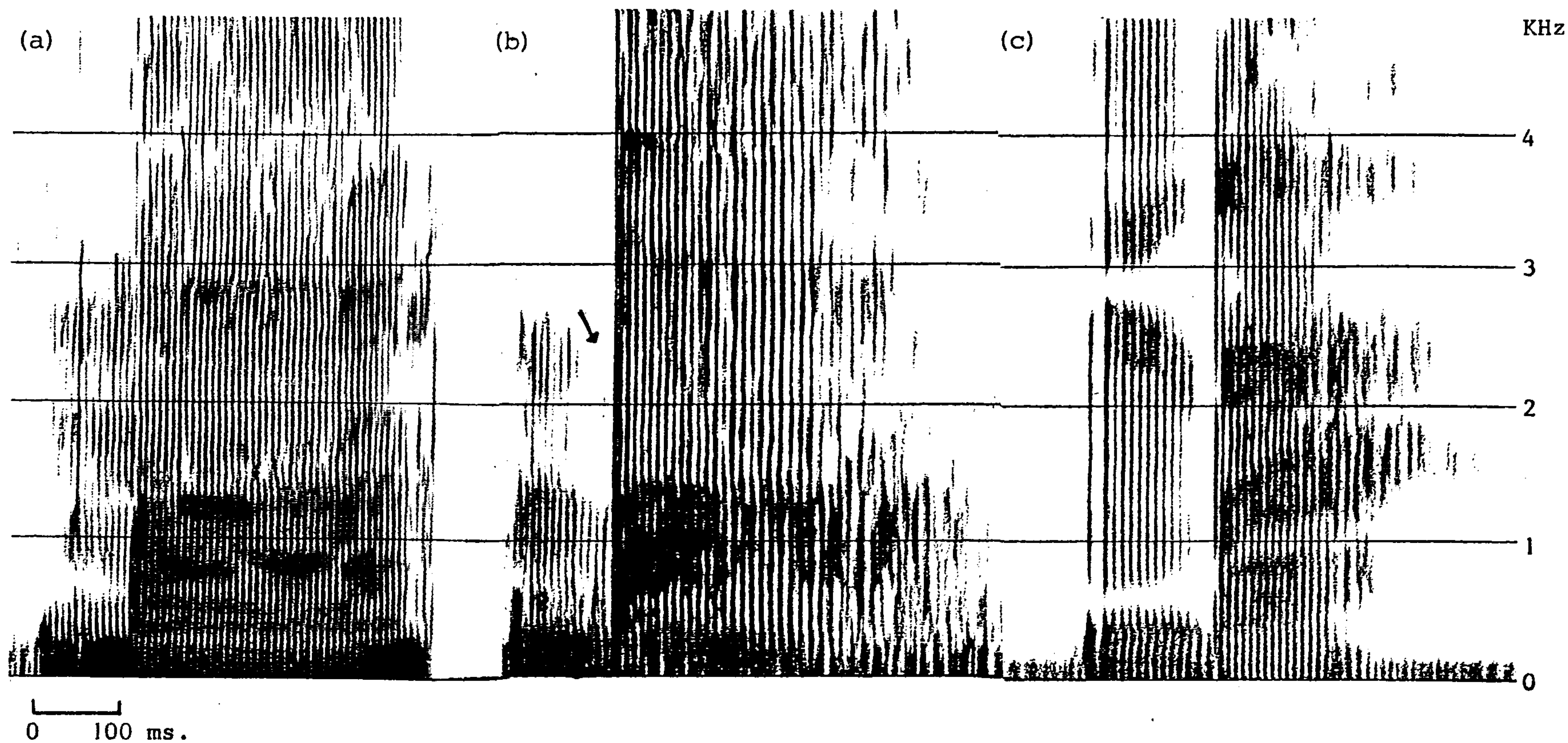


FIG. 1. Spectrograms of (a) English [ma], (b) Kaiping [m^{b}a], and (c) Malagasy [^{m}ba].

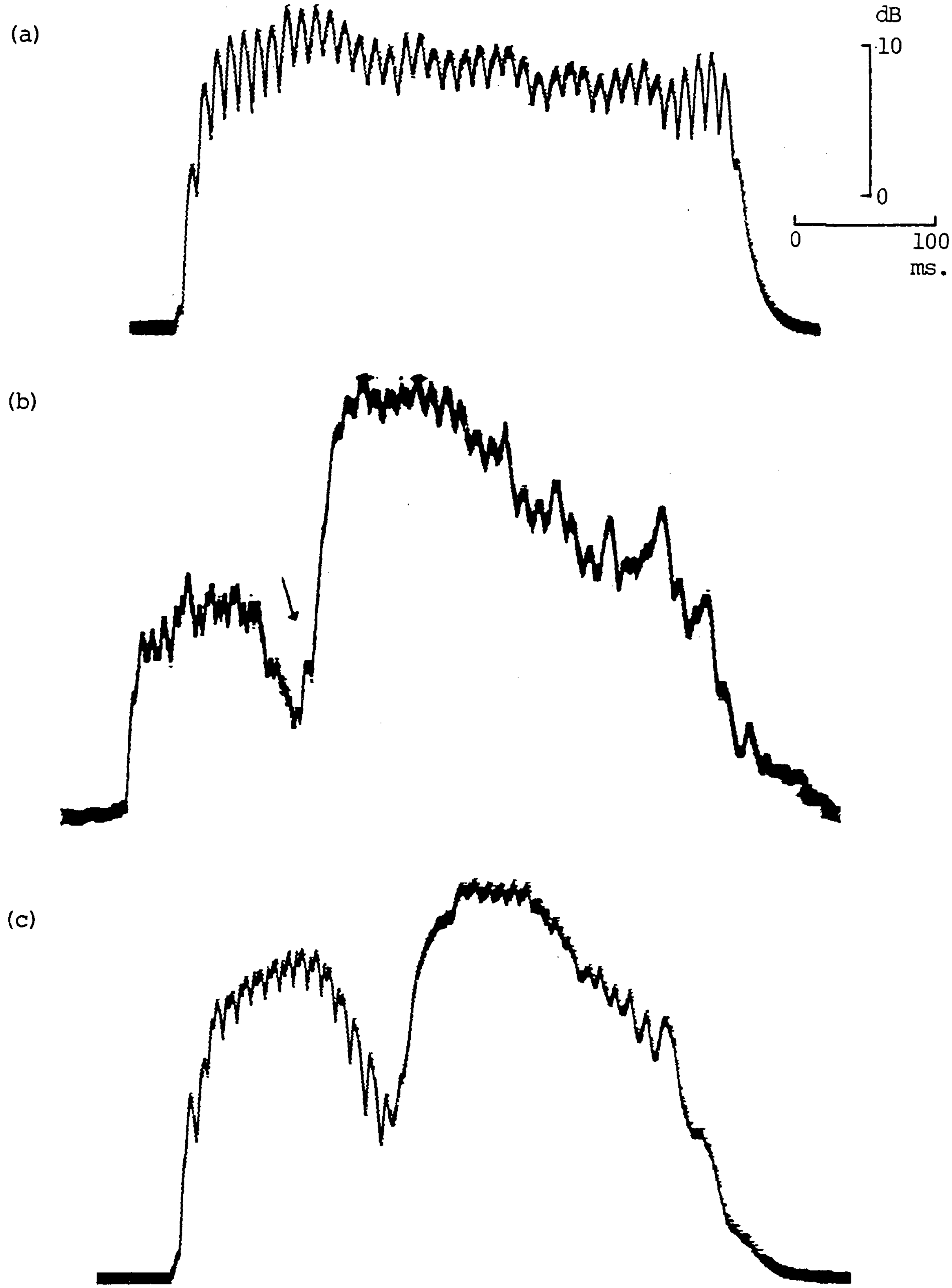


FIG. 2. Expanded amplitude envelope displays of (a) English [ma], (b) Kaiping [m^ba], and (c) Malagasy [^{m}ba] in FIG. 1.

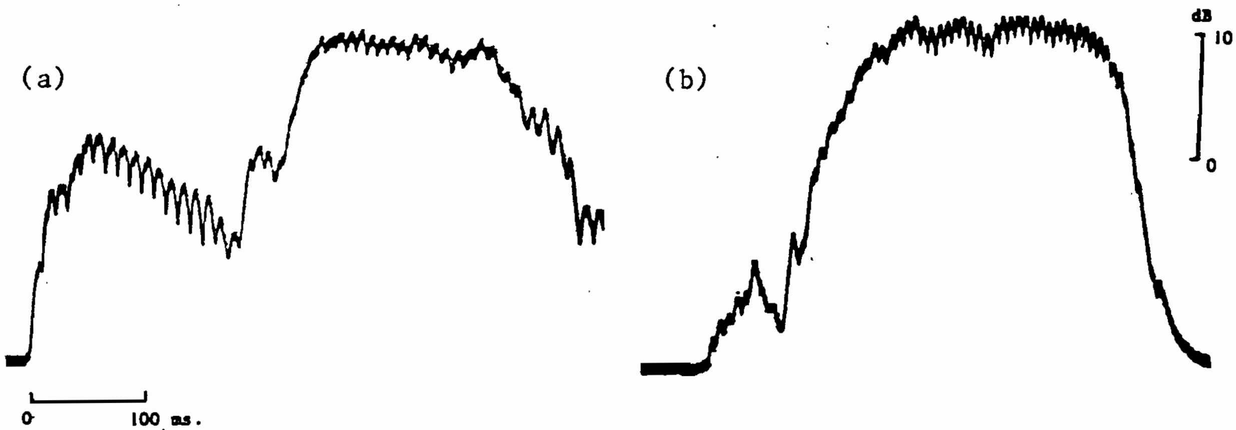


FIG. 3. Expanded amplitude envelope displays of (a) Malagasy [ᵑgali], and (b) Kaiping [ŋᵍa].

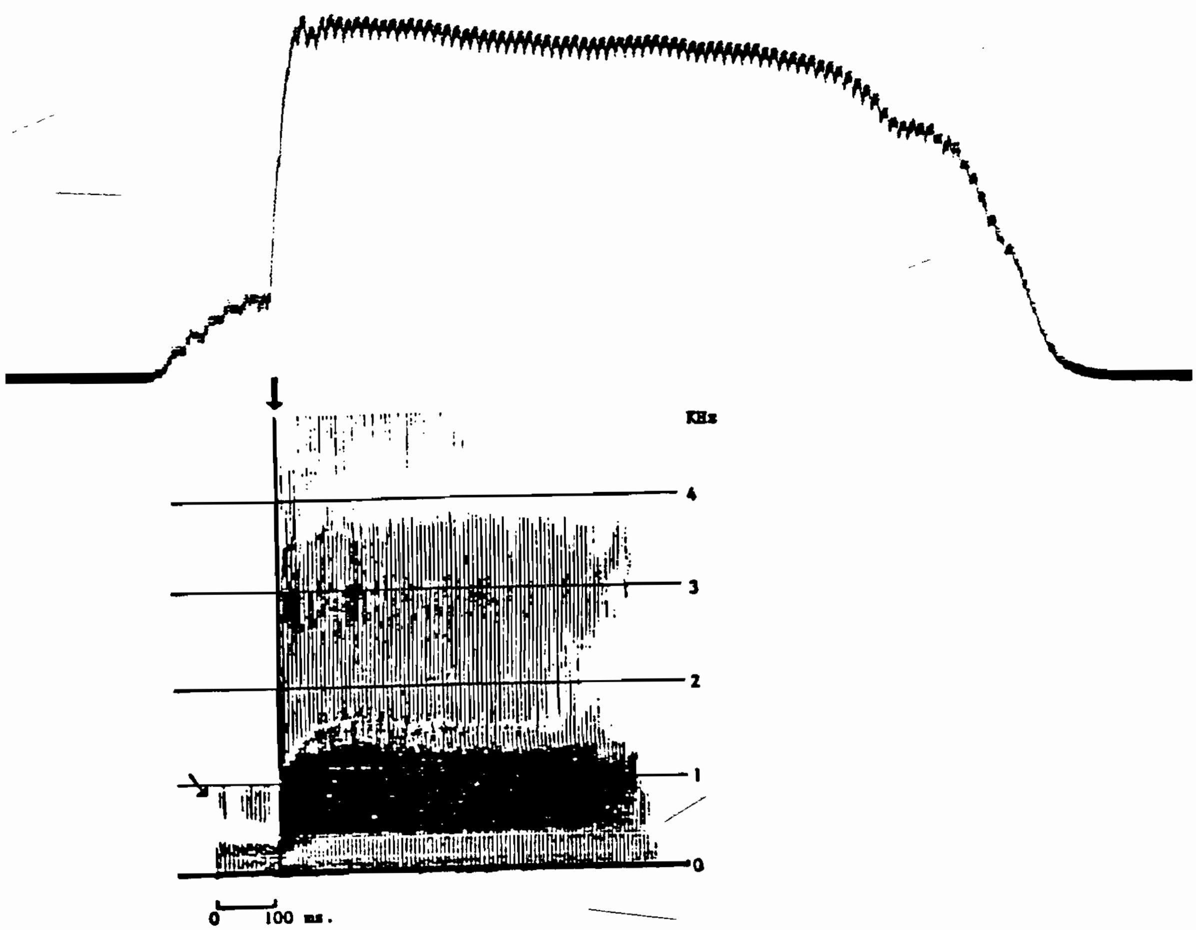


FIG. 4. Expanded amplitude envelope display and spectrogram of Zhongshan [mᵇa].

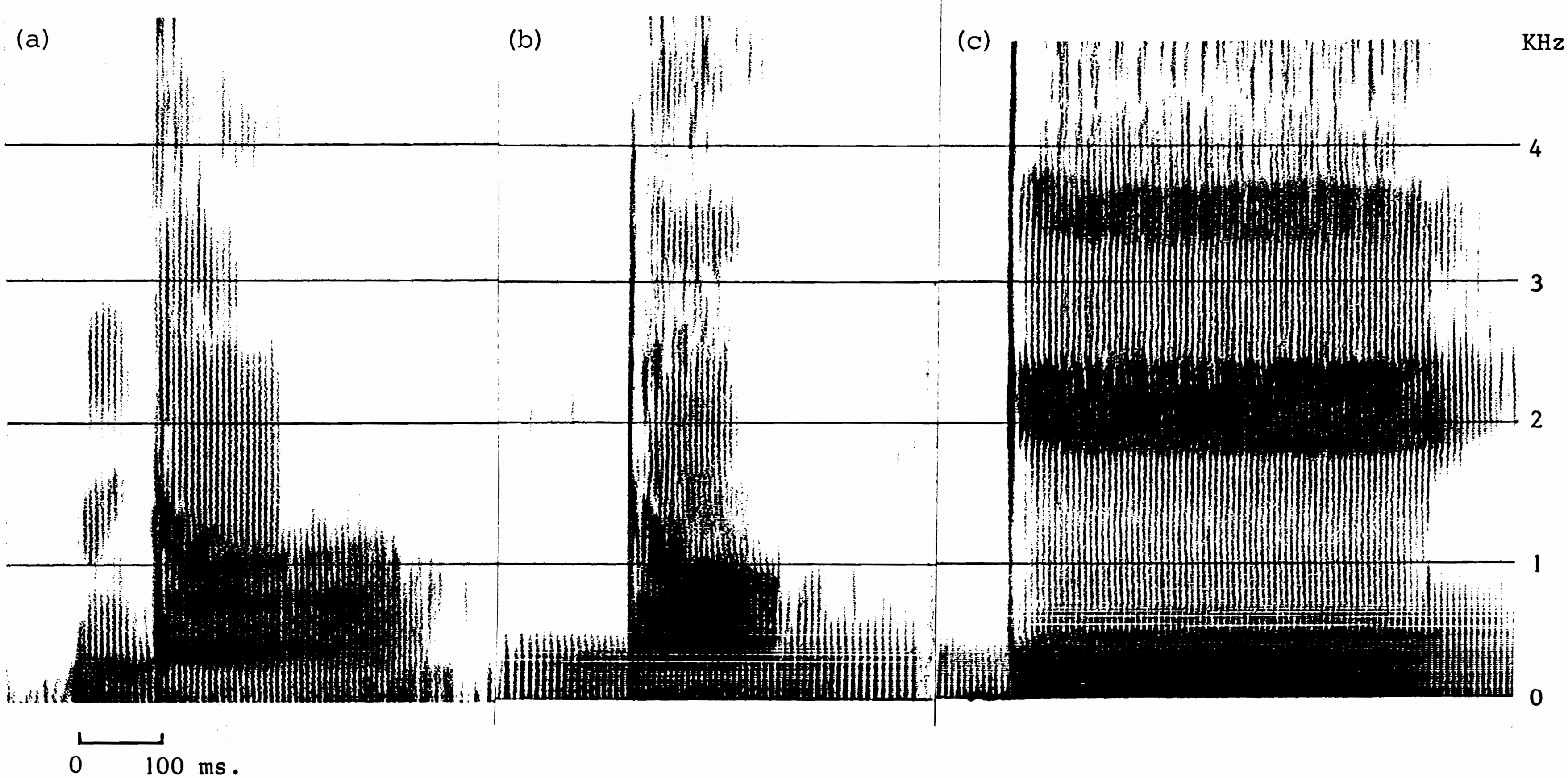


FIG. 5. Spectrograms of (a) Kaiping [nᵈɔ], (b) Zhongshan [nᵈʊŋ], and (c) Zhongshan [ŋᵍy].

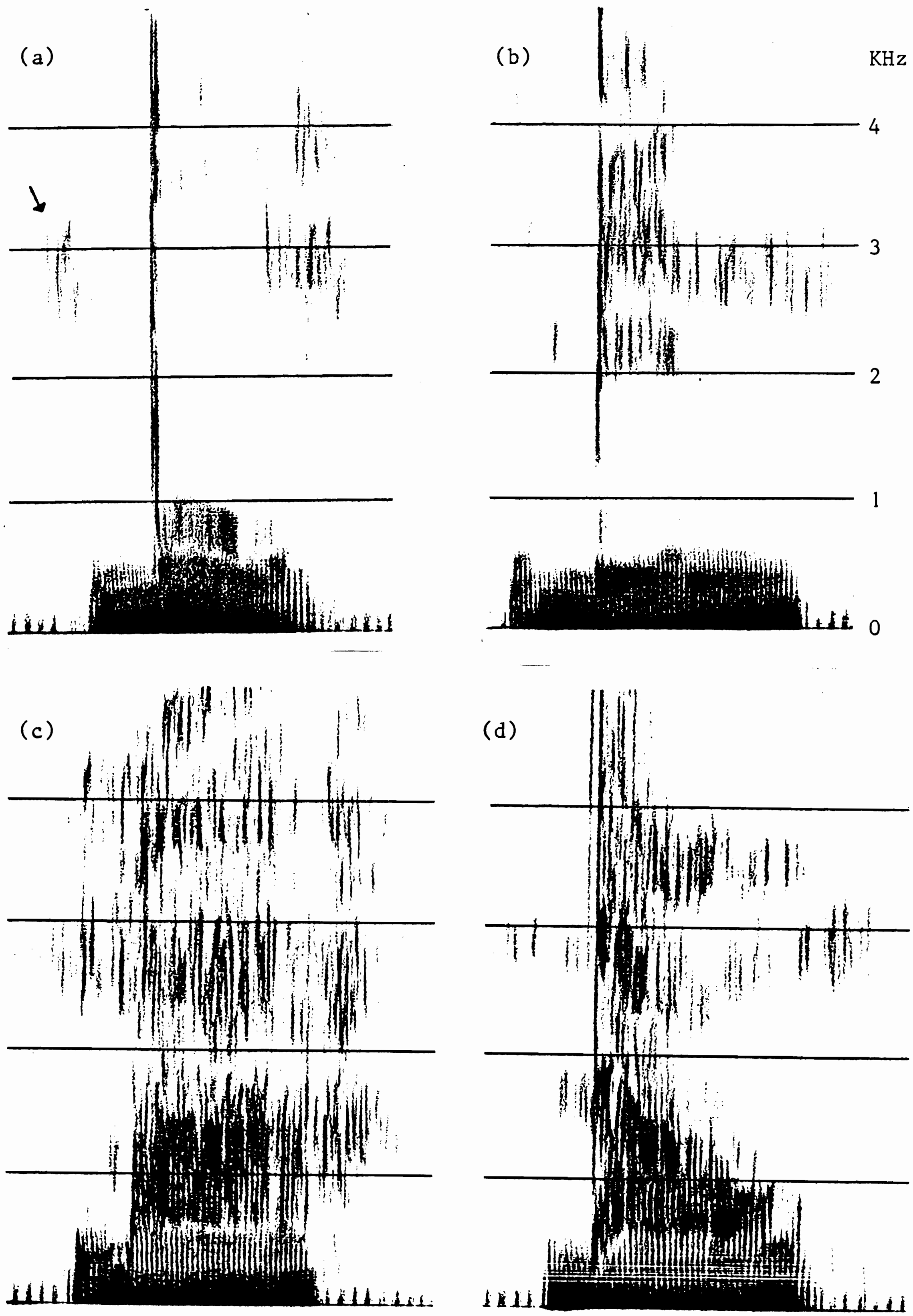


FIG. 6. Spectrograms of Xiamen (a) [bu], (b) [bin], (c) [mã], and (d) [dau]. (Broad phonetic transcription without indication of prenasalization)

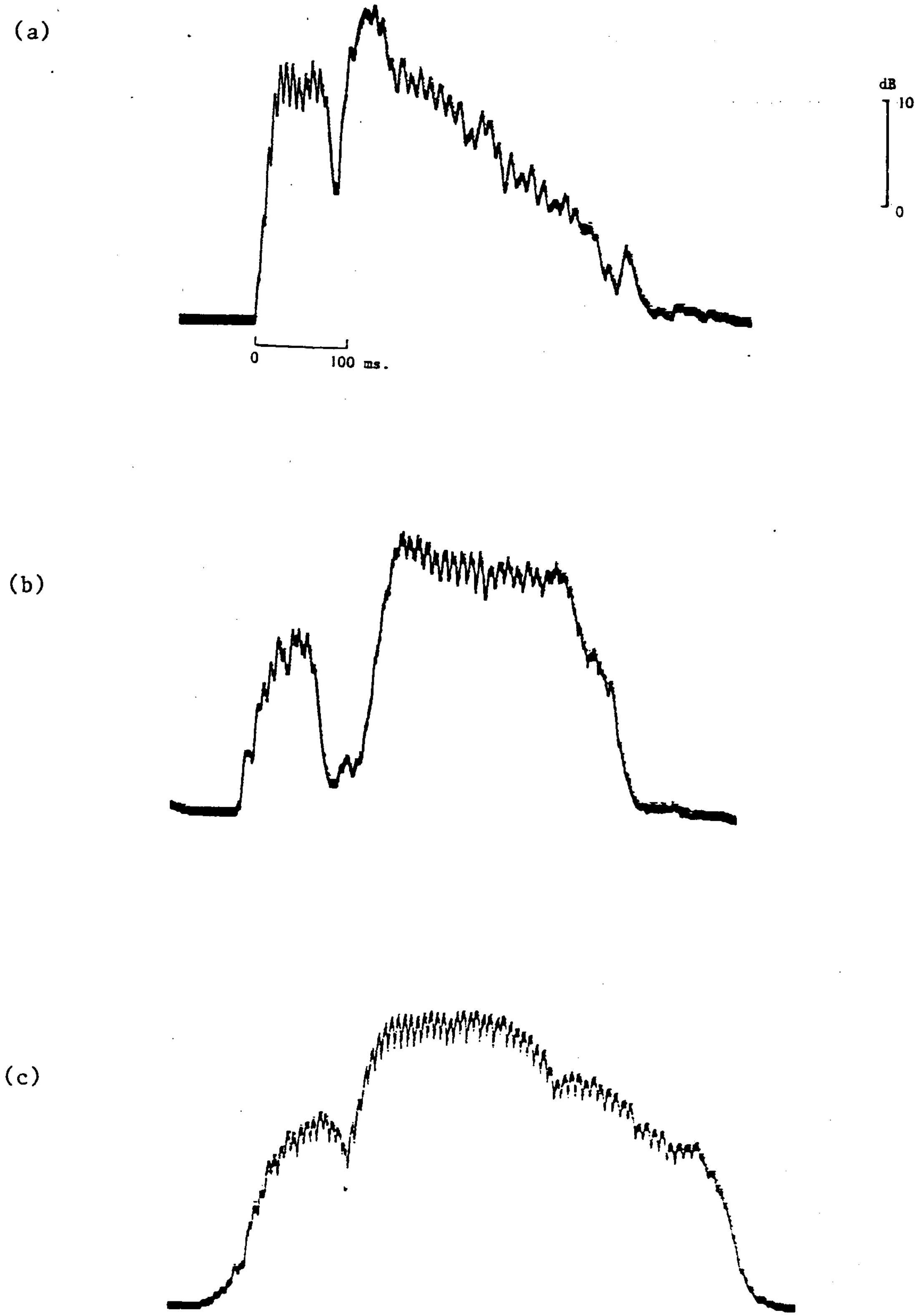
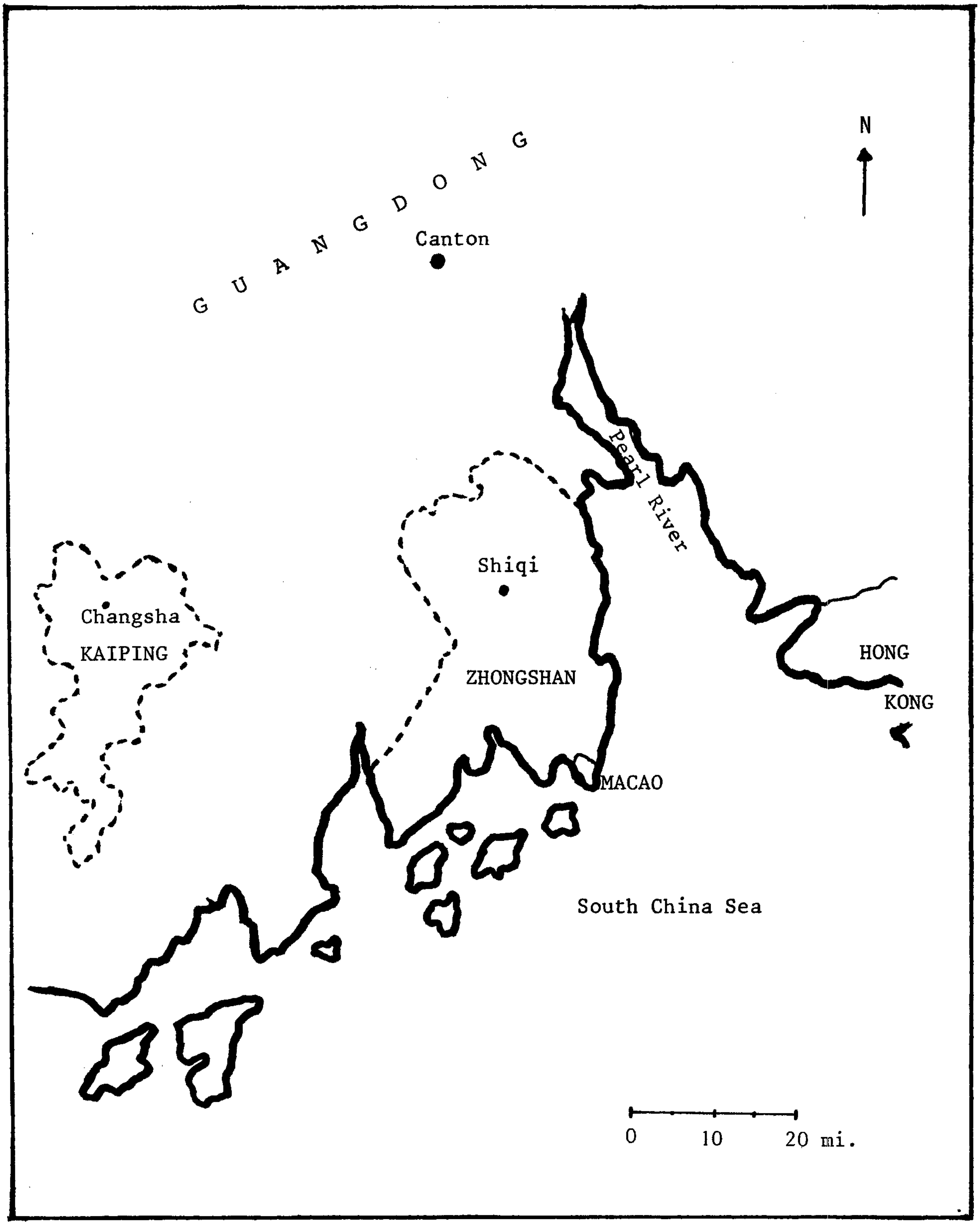


FIG. 7. Expanded amplitude envelope displays of (a) Kaiping [n^{d}am], (b) Kaiping [ŋ^{g}in], and (c) Zhongshan [ŋ^{g}a:n].

Map 1. Zhongshan and Kaiping districts, Guangdong Province.



Post-stopped nasals: an acoustic investigation*

Marjorie K.M. Chan and Hongmo Ren

0. Introduction

In a number of dialects of Chinese (and to a much lesser extent in Miao-Yao[1], although the nasals in syllable-final position are plain nasals, those in syllable-initial position have been noted as being accompanied by a homorganic stop. Based on auditory impressions, some of the sources further describe the stop portion as being relatively weak or short in duration. As a result, Chinese linguists sometimes superscript the stop component to emphasize the transient status of the stop. There is an underlying assumption that these post-stopped nasals differ phonetically from prenasalized stops, which are often transcribed in the linguistic literature with the nasal component superscripted.

Thus far, no attempt has been made to determine whether there is indeed a phonetic distinction between post-stopped nasals, as recorded for some Chinese dialects, and the prenasalized stops that have been posited for various languages in the world. In this study, a preliminary acoustical investigation is made of the post-stopped nasals in Chinese to determine whether a valid distinction can be made between post-stopped nasals and prenasalized stops. The nasals in Zhongshan and Kaiping, two varieties of the Cantonese dialect, are examined here. (See Map 1 for the Zhongshan and Kaiping districts where these two dialects are spoken.)

This study is divided into two main parts. The first part examines the acoustic nature of the syllable-initial nasals in Zhongshan and Kaiping. Both dialects are reported to have post-stopped nasals. Data is based on tape-recordings of one principal speaker for each dialect. A few tokens obtained from four other Zhongshan speakers, and three other Kaiping speakers are also examined.[2]

The second part of the study addresses the central question of whether the post-stopped nasals in Zhongshan and Kaiping are phonetically distinct from prenasalized stops. Toward an answer to that question, one language is selected for comparison, Malagasy. The Malagasy data is part of the University of Berkeley's series of language tapes on "The Sounds of Language".

1. Post-stopped nasals in Zhongshan and Kaiping

We focus first on Zhongshan. Two representative samples of post-stopped nasals in Zhongshan are given in the spectrograms in Figure 1. (All figures are placed at the end of the paper. The words are [m^{b}a] 'mother' and [ŋ^{ɡ}y] 'fish'. Observe that the nasal murmur, indicated by the single-bar arrows (⟶) is weak in both tokens. The nasal is within the normal duration for nasals in English, which is about 100 msec. (Pickett 1980:123).

What is perceived as a "stop" component in the Zhongshan post-stopped nasals is simply a strong burst, indicated by the double-bar arrows (⟹). There is no closure duration preceding the burst. The burst occurs simultaneous with oral release. This is shown on the corresponding amplitude envelope display of 'mother' on Figure 2. (This display and others presented here are all expanded to twice the duration of that on the spectrograms.) Note the low amplitude for the nasal component, indicated by the single-bar arrow. The display suggests the precise synchronization of velic closure with oral release. This is not a regular feature of English nasals. The amplitude display presented here is, however, characteristic of the post-stopped nasals in Zhongshan. The bursts may vary in strength. Clear, strong bursts occur in at least 75% of the data (about 150 tokens). Only a conservative estimate is provided, since there is no formal, measurable criterion to establish what constitutes a strong burst. The amplitude display also suggests that strong stop closure may not be needed to form the equivalent of a burst. It could be that the same effect was caused by a very rapid change in area (P. Ladefoged, personal communication).

Only in a small subset of the Zhongshan tokens is there actual stop closure following the nasal component. This is shown in Figure 3, for the word 'stubborn', [ŋ^{g}an]. The stop closure results in an amplitude drop at the end of the nasal portion, indicated by the dashed arrow.

In Kaiping, the post-stopped nasals are not produced with a strong burst. Instead, they are regularly produced with genuine stop closure. As in Zhongshan, the nasal murmur is relatively weak. Again, the nasals (from onset of nasal murmur to oral release) are roughly 100 msec. long. Only the velar nasals produced by our principal Kaiping speaker are shorter, averaging about 70 msec.

2. Post-stopped nasals and prenasalized stops: a comparison

We proceed now to the prenasalized stops in Malagasy. An example is given in the amplitude display in Figure 4. The word is [^{ŋ}gali] 'jet black'. Observe that the duration of the nasal murmur, terminating at the double-bar arrow, is longer than 100 msec., the normal duration for English nasals. The prenasalized stop sounds like an unstressed syllabic nasal followed by a stop. The nasal amplitude is also relatively strong.

The prenasalized stops in Malagasy differ from the typical post-stopped nasals in Zhongshan in having an amplitude drop. And unlike Zhongshan, none of the Malagasy tokens (a total of 36) exhibit strong burst at oral release. The nasal component in Malagasy is simply followed by stop closure, with concomitant amplitude drop.

Since both Malagasy and Kaiping have nasals accompanied by stop closure, a short study was conducted of the two languages. Three measurements were made, as shown in Figure 5:

A. Duration of the post-stopped nasals/prenasalized stops (i.e., duration from nasal onset to vowel onset)

B. Duration of the amplitude drop

C. Nasal-vowel amplitude difference

The results of these three measurements are summarized in Table 1. A more comprehensive set of measurements, together with the tokens used in Kaiping and Malagasy are given in the appendices.

	Mean Duration	Standard Deviation	Number of Tokens
A. Duration of Post-stopped Nasal/Prenasalized Stop (msec)			
Kaiping	94.2	28.6	45
Malagasy	128.5	27.1	36
B. Duration of Amplitude Drop (msec)			
Kaiping	24.3	14.8	45
Malagasy	31.9	14.4	36
C. Nasal-Vowel Amplitude Difference (dB)			
Kaiping	11.87	4.35	45
Malagasy	3.52	3.14	36

Table 1. Comparison between Kaiping and Malagasy.

The mean values of the three measurements in Table 1 show some general tendencies. Regarding measurement A, the duration of the post-stopped nasals in Kaiping is relatively shorter than that of the prenasalized stops in Malagasy.

Regarding measurement B, the duration of amplitude drop is slightly greater in Malagasy, but the difference may be due, in part, to the small sampling in the study.

Regarding measurement C, the amplitude difference between the nasal and the following vowel is greater for Kaiping than for Malagasy. Although the standard deviation is quite large in the Malagasy case (3.14 dB), the mean values -- 11.87 dB for Kaiping, and 3.52 dB for Malagasy -- still point to a relevant difference between the two languages: the nasal murmur is relatively weak in Kaiping, accounting for the relatively large nasal-vowel amplitude difference. In Malagasy, the nasal murmur is relatively strong, resulting in a small nasal-vowel amplitude difference.

3. Summary and remarks

To summarize, in some of the Chinese linguistic literature, there exists an underlying assumption that, phonetically, there are two types of 'nasal + stop' segments: post-stopped nasals and prenasalized stops. On the basis of a small acoustical study of Zhongshan, Kaiping, and Malagasy, the main difference between post-stopped nasals and prenasalized stops are given in Table 2.

Post-stopped Nasals	Prenasalized Stops
1. Burst and/or amplitude drop following nasal.	Amplitude drop following nasal.
2. Relatively weak nasal murmur.	Relatively strong nasal murmur.
3. Relatively shorter duration.	Relatively longer duration.

Table 2. Comparison between post-stopped nasals and prenasalized stops.

Only two of the three criteria in Table 2 can be considered to distinguish post-stopped nasals from prenasalized stops, namely, relative strength of the nasal murmur, and relative duration of the segment. Whether these two criteria can be used to distinguish post-stopped nasals from prenasalized stops when more languages are considered must await further study.

The problem of post-stopped nasals and prenasalized stops is actually complicated by a more fundamental problem, namely the wide phonetic differences within the category of "prenasalized stops". A hint of the complexity can be gleaned in Figure 6. The prenasalized stop in Malagasy is compared with its counterparts in Fijian and Fula.[3] With respect to nasal duration -- measured against the duration of English nasals -- the three languages form a continuum: the nasal portion in Malagasy is extra long, average in Fijian, and extra short in Fula. The three languages also do not share a common characteristic with respect to nasal-vowel amplitude differences. Thus, a better understanding of prenasalized stops is paramount to addressing the question of whether or not post-stopped nasals are phonetically different from prenasalized stops.

Notes

*Except for a few minor changes included here, this paper was presented at the 113th meeting of the Acoustical Society of America in Indianapolis (11-15 May 1987). Research for this project was funded in part by a Social Sciences and Humanities Research Council of Canada Post-doctoral Fellowship. Thanks go to David Leong and the Historical Society of Southern California for their assistance in obtaining Kaiping and Zhongshan data. The authors also benefited from conversations with David Strecker, Edwin G. Pulleyblank, Michel Jackson, Marie Huffman, Peter Ladefoged, and Ian Maddieson, as well as other members of the UCLA Phonetics Laboratory. Special appreciation is extended to Ian Maddieson for his technical assistance. The measurement of amplitude difference in the study follows the method used in Maddieson and Emmorey (1984) for a different phonetic problem.

1. The She language, belonging to the Miao-Yao language group, has nasals followed by voiceless, homorganic stops, which are transcribed by Chen (1982) with superscripts (e.g., [m^p]). These post-stopped nasals occur as syllable onsets, and are in complementary distribution with plain nasals occurring in syllable-final position. The post-stopped nasals in She correspond to the plain nasal series, and not the prenasalized stop series, of the Miao languages.

2. The principal Zhongshan speaker, Dennis Chan, was from Kuchong, near Shiqi, the county seat of Zhongshan. His speech, which is representative of standard Zhongshan, was recorded in Vancouver, Canada, in 1977, and analyzed in Chan (1980). The principal Kaiping speaker was David Leong, born in Changsha, one of the three towns in Kaiping which form Sanbu, the county seat of Kaiping. Not enough is known about Kaiping to determine if his speech is considered standard Kaiping. The Kaiping district is part of the "Four Districts", which include Taishan. The speech of Taishan City serves as the standard for the Four Districts as a whole. Kaiping data from David Leong was recorded in Los Angeles in the spring of 1987. Additional tokens with open syllables, [m^ba], [n^da] and [$ŋ^g$a], were tape-recorded in Los Angeles from male and female speakers of various subvarieties of Zhongshan and Kaiping. The informants were in their forties or older; some were born in China and others in the United States. Two of the Zhongshan speakers exhibited the same post-stopping phenomena as our primary Zhongshan informant, while the other two produced their post-stopped nasals in a manner similar to the Kaiping speakers. (The tape also included tokens elicited from two older Taishan speakers. They had the same type of post-stopped nasals as the Kaiping speakers.)

3. The Fijian token is extracted from a tape recorded by Ian Maddieson. The Fula token is taken from a short Fula tape at the UCLA Phonetics Laboratory which contains a few examples with prenasalized stops.

Bibliography

Barale, Catherine, Mae-chu Chang, Marjorie Chan, John D'Andrea, David Strecker, and Moira Yip. (1977). "Aspects of the Kaiping vernacular: a field study report." Ms. (LSA Linguistic Institute, U. of Hawaii, 1977)

Chan, Marjorie K.M. (1980). Zhong-shan phonology: a synchronic and diachronic analysis of a Yue (Cantonese) dialect. Masters thesis, University of British Columbia, Vancouver, Canada.

Chao, Yuen Ren. (1948). "Zhongshan fangyan." (Zhongshan dialect) Bulletin of the Institute of History and Philology 21:49-73.

——————. (1951). "Taishan Yuliao." (Taishan materials) Bulletin of the Institute of History and Philology 23:25-76.

Chen Qiguang. (1982). "Sheyu zai Miao-Yao yulide liwei." Paper circulated at the Fifteenth International Conference on Sino-Tibetan Languages and Linguistics, Beijing.

Egerod, Søren. (1956). The Lungtu dialect: a descriptive and historical study of a Southern Chinese idiom. Copenhagen: Ejnar Munksgaard.

Ladefoged, Peter and Ian Maddieson. (1986). Some of the Sounds of the World's Languages. UCLA Working Papers in Phonetics 64.

Maddieson, Ian and Karen Emmorey. (1984). "Is there a valid distinction between voiceless lateral approximants and fricatives?" Phonetica 41:181-190.

Mao Zongwu and Chaoji Meng. (1982). "Boluo Sheyu Gaishu." (A brief description of the She language in Boluo district) Minzu Yuwen 1982.

Pickett, J.M. (1980). The Sounds of Speech Communication: A Primer of Acoustic Phonetics and Speech Perception. Baltimore: University Park Press.

Yuan, Jiahua. (1983). Hanyu Fangyan Gaiyao. (A study of Chinese dialects) Second edition. Beijing: Wenzi Gaige Chubanshe.

Appendix A

1. Kaiping Data.

[m^b]: [m^{b}a], [m^{b}ai], [m^{b}ei], [m^{b}ɔ], [m^{b}ɔi]

[n^d]: [n^{d}a], [n^{d}ai], [n^{d}ei], [n^{d}ɔ], [n^{d}ɔi]

[ŋ^g]: [ŋ^{g}a], [ŋ^{g}ai], [ŋ^{g}ei], [ŋ^{g}ɔ], [ŋ^{g}ɔi]

(Three tokens of each syllable were read in different tones -- mid, low (or low-falling), and high rising. All syllables form real words in the language. The informant read the number assigned to each word, and then the Kaiping word once. The set consists of 45 tokens.)

2. Malagasy Data.

[^{m}b]: [^{m}ba], [^{m}ba minni], [^{m}belu]

[^{n}d]: [^{n}diən̥a], [^{n}dzara], [^{n}dzula]

[^{ŋ}g]: [^{ŋ}galli], [^{ŋ}gara], [^{ŋ}gulli]

(Stress falls on the first syllable. The data consists of four tokens of each word read by one speaker. Three repetitions of each word were read after the English gloss was provided. The fourth token of each word was read one after the other without interruption.)

Appendix B

Timing and Amplitude Measurements From Amplitude Envelope Displays.

	A (SD) (msec)	B (SD) (msec)	C (SD) (dB)
KAIPING			
m^b (n=15)	105.7 (19.8)	23.7 (22.6)	10.65 (4.49)
n^d (n=15)	107.3 (23.5)	25.5 (7.1)	9.61 (2.91)
$ŋ^g$ (n=15)	69.5 (25.4)	23.7 (10.9)	15.33 (3.33)
Total: (n=45)	94.2 (28.6)	24.3 (14.8)	11.87 (4.35)
MALAGASY			
${}^mb$ (n=12)	139.6 (31.6)	31.5 (12.7)	2.60 (2.90)
nd (n=12)	117.9 (21.9)	32.3 (11.2)	4.03 (3.99)
${}^ŋg$ (n=12)	138.0 (24.8)	31.8 (19.4)	3.90 (2.42)
Total: (n=36)	128.5 (27.1)	31.9 (14.4)	3.52 (3.14)

A. Duration of post-stopped nasal/prenasalized stop (msec).
B. Duration of amplitude drop (msec).
C. Nasal-Oral amplitude difference (dB).

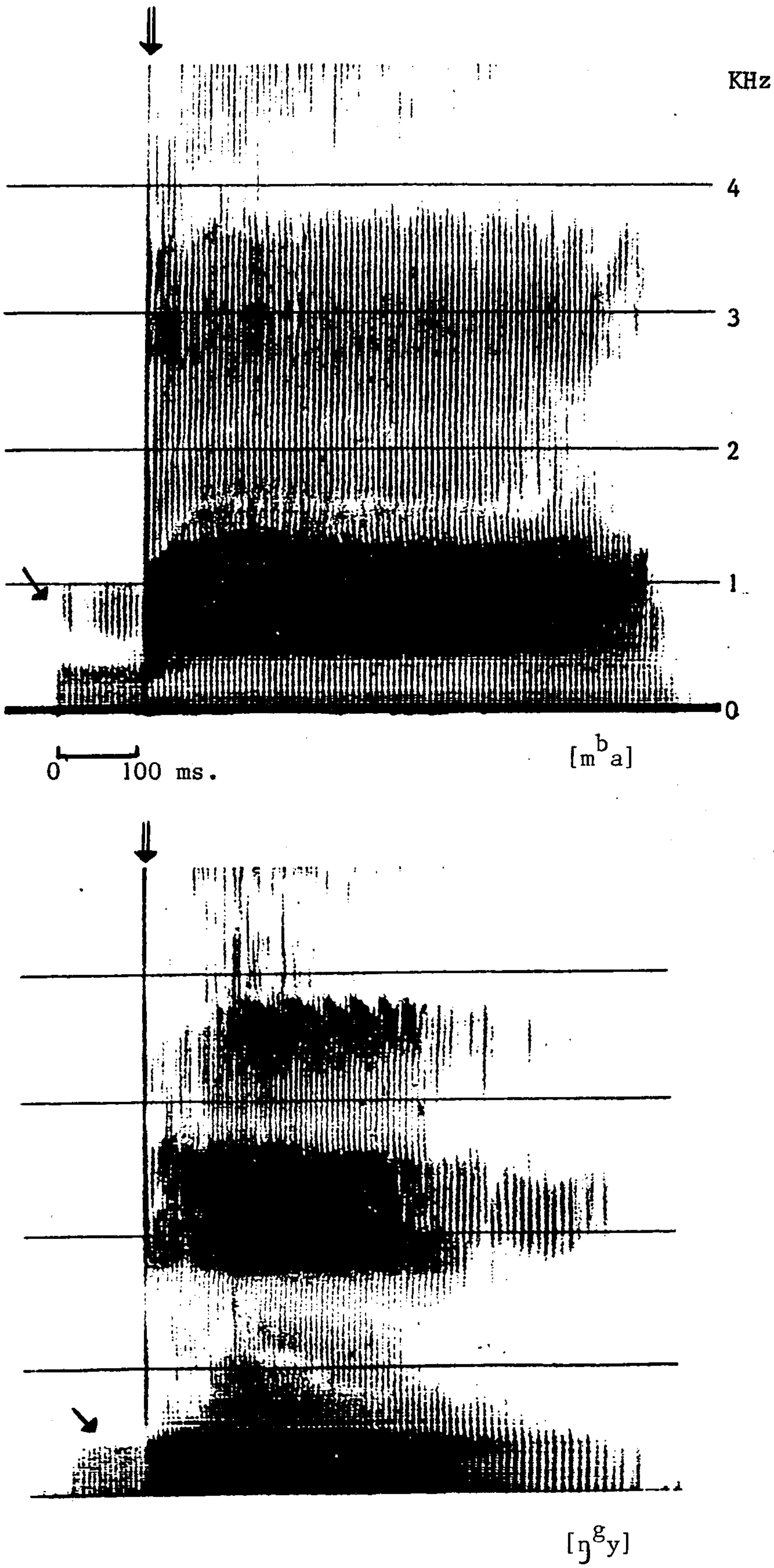


Figure 1. Spectrograms of Zhongshan tokens with post-stopped nasals.

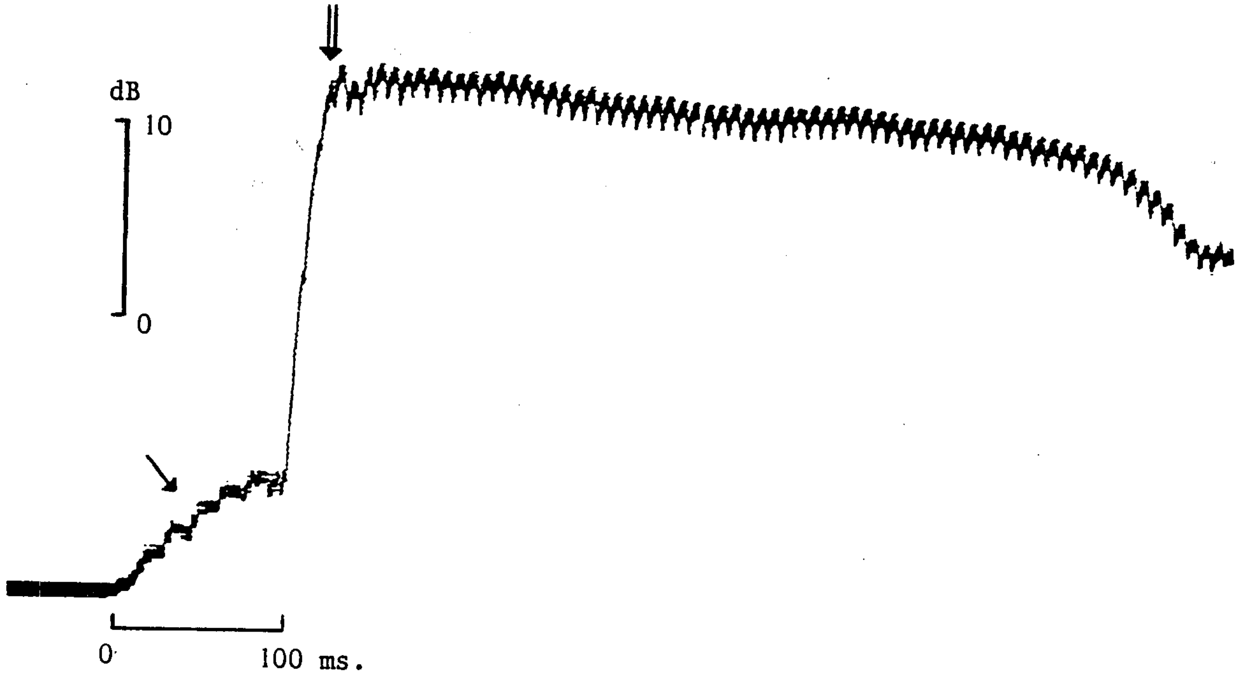


Figure 2. Expanded amplitude envelope display of Zhongshan [m^{b}a].

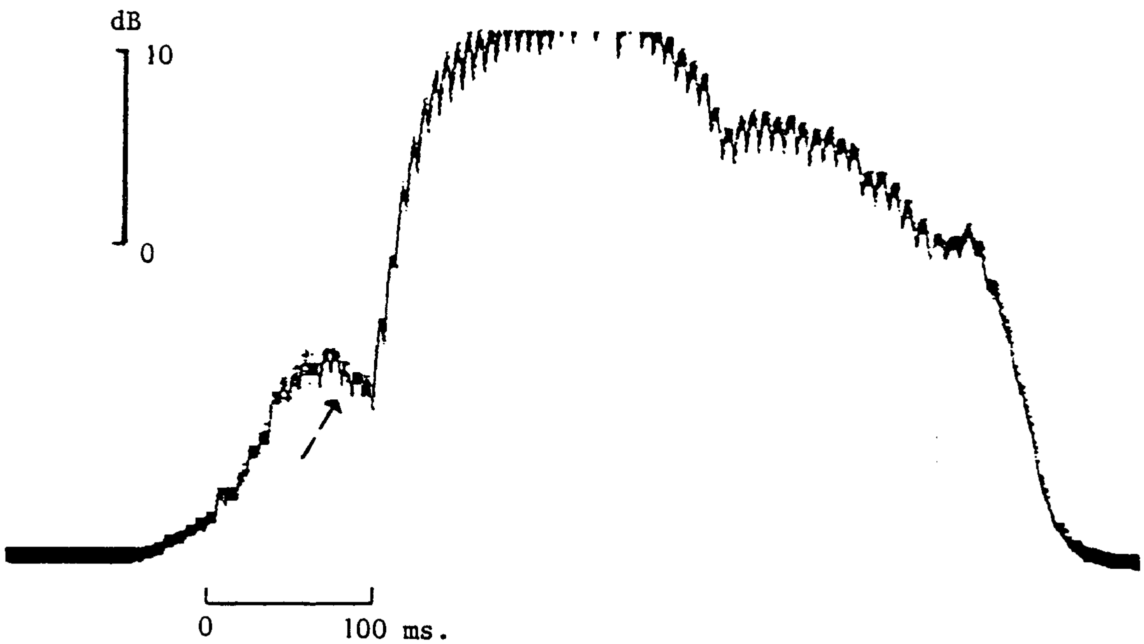


Figure 3. Expanded amplitude envelope display of Zhongshan [ŋ^{g}an].

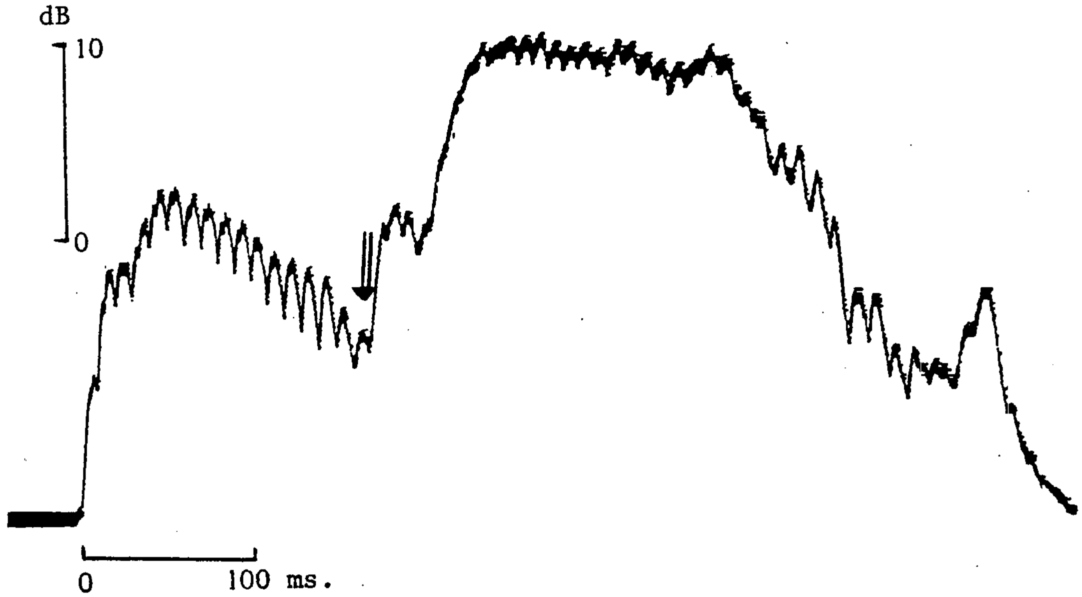
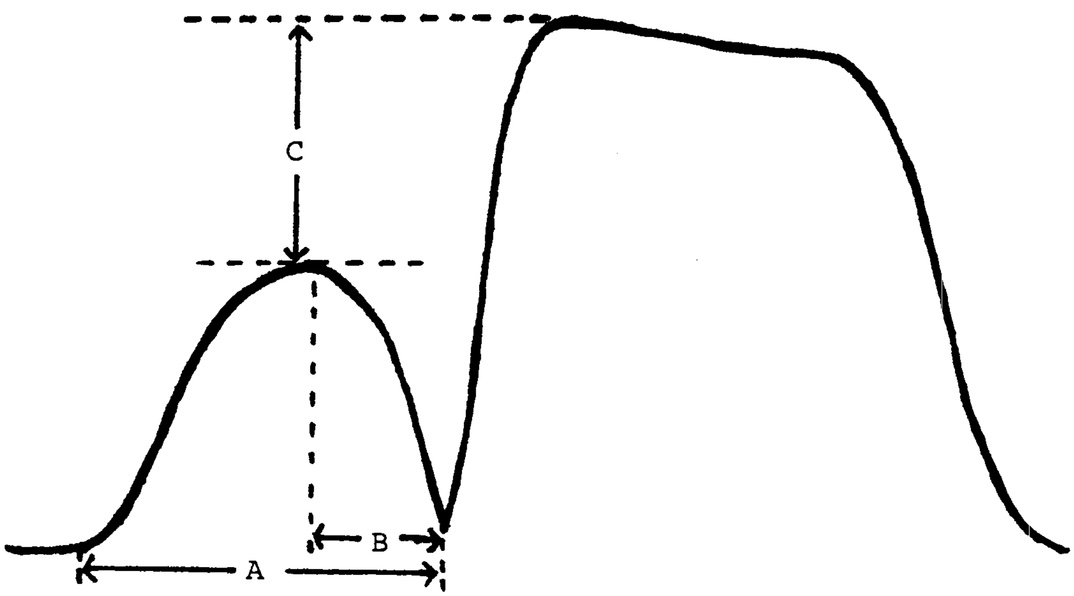


Figure 4. Expanded amplitude envelope display of Malagasy [ᵑgali].



A. Duration of the post-stopped nasal/prenasalized stop (msec.)
B. Duration of the amplitude drop (msec.)
C. Nasal-vowel amplitude difference (dB)

Figure 5. Schematized example of the three measurements made on expanded amplitude envelope displays.

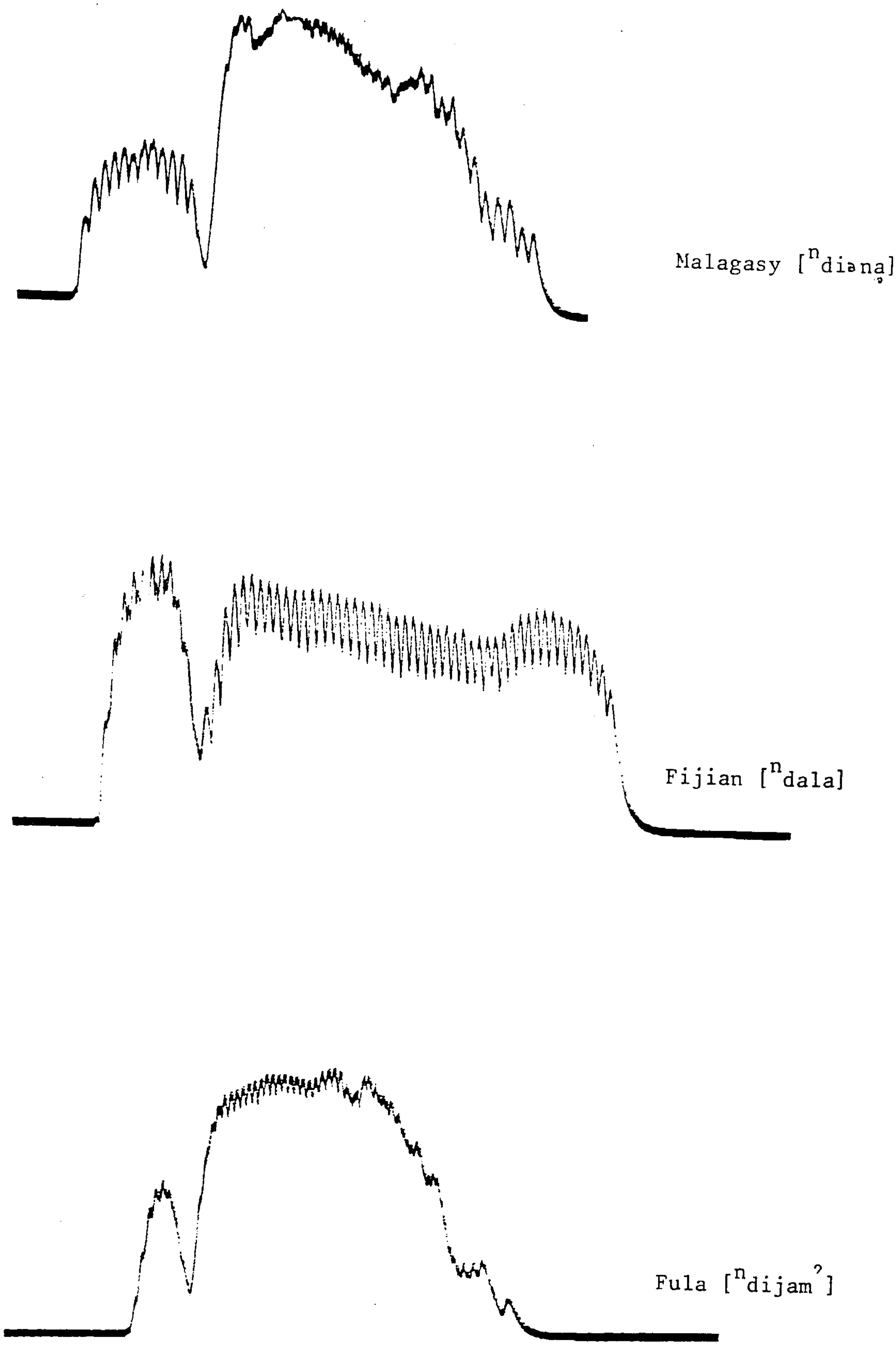


Figure 6. A comparison of prenasalized stops in Malagasy, Fijian, and Fula.

Tone and melody interaction in Cantonese and Mandarin Songs

Marjorie K.M. Chan

0. Introduction

In studying tone languages, one obvious question that a linguist might pose is: what happens to the tones in the language when the words are put to music and sung? For Chinese, modern songs in Mandarin and Cantonese exhibit very different behaviour with respect to how the lexical tones are affected, and the extent to which the tones are affected in the interaction of tone and melody. In modern Mandarin songs, the melodies tend to dominate, so that the original tones on the lyrics may be completely ignored. In Cantonese songs, however, the melodies typically take the lexical tones into consideration and attempt to preserve their pitch contours and relative pitch heights.

This paper reports the investigation into the interaction of tone and melody in Cantonese and Mandarin using commercially-recorded songs on cassette tapes. The initial study was on the interaction of tone and melody in Cantonese, since that dialect poses a particularly interesting case. It has level and contour tones that are intersected by a second dimension -- that of tonal register -- to yield a total of six contrastive tones. The investigation of Cantonese is based on a study of six popular songs sung by a young Hong Kong singer. A comparative study was then conducted on the tone-melody interaction in Mandarin based on six songs in movies for television and theatre produced in China in recent years. The analysis of the Cantonese songs includes instrumental study of the pitch heights and pitch contours, supplemented by transcription of musical notes. In the Mandarin case, six songs were selected from a casette tape because musical notations exist for those songs in a song book published by the Chinese movie industry.[1]

With respect to the study of tone and melody in Cantonese and Mandarin, there are two main tasks to consider. First, one should determine whether the songwriters had intended to compose with the lexical tones in mind. The claim here is that in tonal compositions -- that is, in compositions that pay special attention to the lexical tones -- there would be a close correspondence between tone and melody.

The second major task is to study the actual interaction between the tones in the lyrics, and the melody itself. The aim is to determine the degree of correspondence in the tone and melody interface. More precisely, the aim is to determine the extent to which the pitch contours and the relative pitch heights of the lexical tones are preserved in the melody. The study further attempts to identify the strategies employed in the songs to resolve clashes that arise when there occurs a mismatch between melody and lexical tone.

Furthermore, in the particular case of Cantonese, the study also takes into consideration the various factors that might affect the tone-melody interface -- factors such as melodies imported from abroad, the intrusion of foreign phrases, and the tempo of the songs. These factors are not relevant to the Mandarin songs because the melodies are all locally-produced in China; the lyrics contain no foreign vocabulary, and the songs are all relatively slow.

Given the two main tasks outlined above for the study of Cantonese and Mandarin songs, the paper is divided into two main parts. The Cantonese case is presented frst in section 1, and Mandarin afterwards in section 2. Within each section, background information on the tonal system of the dialect and the data are presented, followed by an analysis of the tonal structure of the lyrics, and then the tone-melody interaction itself.

1. The Cantonese case

1.1. The Tonal System of Cantonese

Cantonese is traditionally described as having nine tones, in which the tones on checked syllables -- those ending in -p, -t, or -k -- are counted separately. As a result, there are only six contrastive tones. Three of these are analyzed here as level, two as rising, and one as falling. The six phonemic tones are presented in (1). The check/non-checked distinction is included for later reference. The aim is to determine whether the tone-melody interface agrees with the phonological analysis. The pitch values are assigned based on Yuen Ren Chao's system of tone numbers, where '1' to '5' represents ascending pitch height.

(1) The tonal system of Cantonese (six contrastive tones).

LEVEL TONES

	Non-checked Syllables	Checked Syllables
High-level:	/55/ (with [53] variant)	/5/
Mid-level:	/33/	/3/
Low-level:	/22/	/2/

FALLING TONE

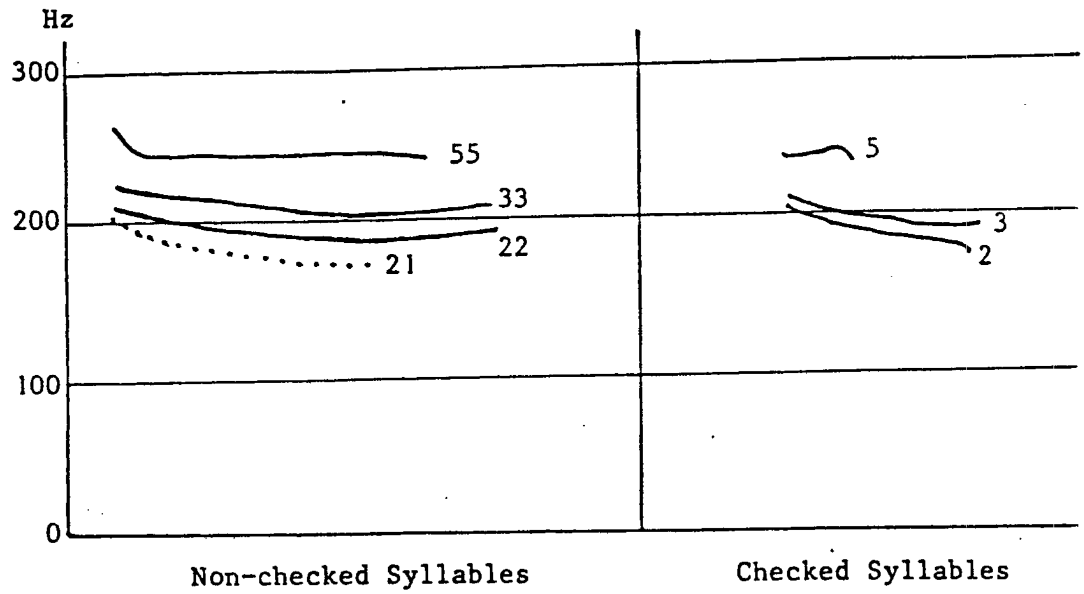
Low-falling: /21/

RISING TONES

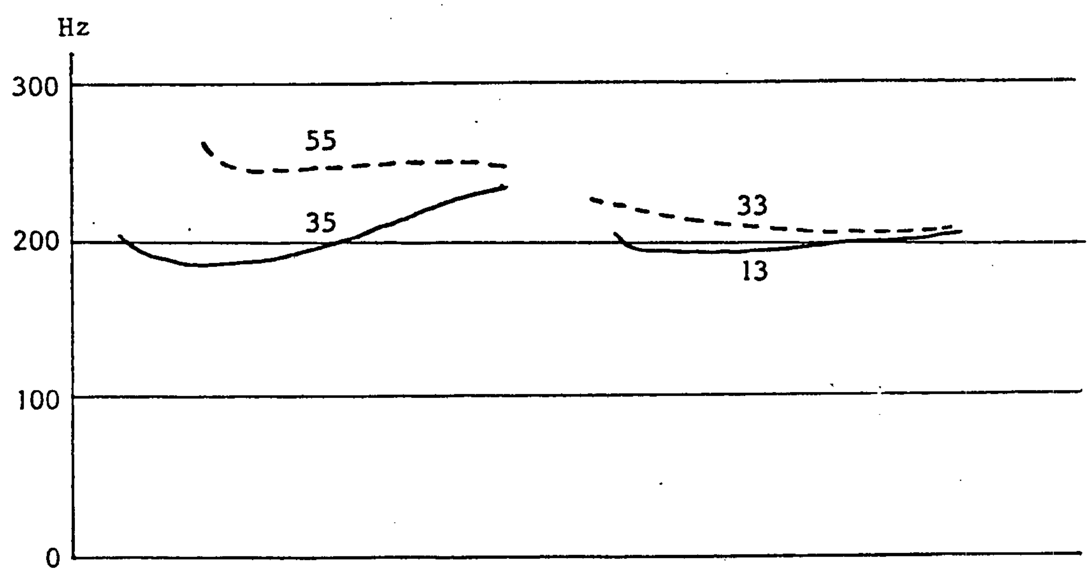
Mid-rising: /35/
Low-rising: /13/

It should be noted that the high tone on non-checked syllables is treated in (1) as basically level, /55/. The falling variant, [53], occurs prepausally and in tone sandhi environment, namely, before a non-high tone. This is not the conventional analysis, which treats [53] as basic. [55] is then treated as the sandhi form, which occurs before another high tone. There are at least two reasons for treating the tone as high level. First of all, in Hong Kong today, a number of young people simply have high level for this tone in all contexts. But more importantly for our study, the high tone behaves like a level tone in the interaction of tone and melody. It patterns similarly to the other level tones, /33/ and /22/. Thus, what is crucial in the pitch shape of the high tone is not that it falls, or that it is high-falling, but simply that it is high, which is captured by treating the tone as /55/. Evidence to support this will be presented in the course of our analysis.

Examples of the six tones in Cantonese are given in (2). For typographical ease, a modified transcription system is adopted here.[2] A period marks the beginning of the tone numbers instead of superscripting them.



a) Level and Falling Tones. (Level: ——, Falling: ·····)



b) Rising Tones (contrasted with corresponding level tones).
(Rising: ——, Level: - - - -)

Figure 1. The tones in Cantonese. (Spoken by UL)

(2) Examples of the six contrastive tones in Cantonese.

LEVEL AND FALLING TONES

Non-checked Syllables		Checked Syllables	
soeng.55	'wound'	huk.5	'cry'
soeng.33	'appearance'	hok.3	'shell'
soeng.22	'above'	hok.2	'study'
soeng.21	'often'		

RISING TONES

soeng.35	'think'
soeng.13	'ascend'

The shapes and pitch levels of the tones in (2) are displayed in Figure 1, based on narrowband tracings of the tenth harmonic from single tokens from one speaker.

The level and falling tones are displayed in the upper portion of Figure 1. Studying first the non-checked syllables, the three level tones are /55/, /33/ and /22/. They are contrastive for the speaker despite very slight differences in pitch height. The Low-falling /21/ is also distinct. It begins at roughly the same pitch height as tone /22/, but falls more, to an extremely low pitch, and is shorter. There is also a drop in amplitude. For some speakers, the tone is also accompanied by creakiness, which is not observed for this speaker. Note that the high level tone is indeed level here. (See also Tse 1978.)

The lower portion of Figure 1 contains the two rising tones. In anticipation of the analysis on the tone-melody interface, these two tones are paired with their corresponding level tones with respect to the end-point, or target. The Mid-rising tone, /35/, is paired with the High-level tone; and the Low-rising tone, /13/, is paired with the Mid-level tone, /33/. In the analysis of the tone-melody interaction, what is crucial in the comparison is the target of the rising tones: for the Mid-rising tone, the target is [5]; for the Low-rising tone, the target is [3]. The significance of these observations will soon be clear.

1.2. The Data: Six Modern Cantonese Songs

We proceed now to the data, which consists of the six Cantonese songs listed in (3). The songs, released in 1984 and 1986, were sung by Cheung Kwok Wing, a popular, young, male Hong Kong singer. The first tape is entitled "Leslie" and the second "Stand Up".

(3) a. Ts'i tsung wui hang wan. (Eventually (I'll) be lucky)
b. Monica.
c. Nung pun to ts'ing. (My desires)
d. Yat tsaan siu ming tang. (A small bright lantern)
e. Stand Up.
f. Haak sik ng ye. (Black midnight)

The six songs were selected, varying in tempo, presence or absence of English phrases in the songs, and whether the melodies were locally-produced or foreign-imported. The information is summarized in (4), arranged according to four tempos: Slow, Medium, Quick, or Fast. The subcategorization of the songs into the four tempos is based on the "average length per syllable", obtained as follows. The length of the first line of each song is calculated from the beginning to the end of the vocal portion. That length is then divided by the number of syllables in the line. Any potential pauses between syllables are, therefore, included in the calculation. This means of calculation yielded the four distinct tempos: Slow, Medium, Quick, and Fast. The year that the songs were released, 1984 or 1986, is indicated after the title of the song.

(4) Summary of information on the six songs.

Tempo	Average Length Per Syll.	Song Title	Foreign Phrases	Foreign Melody
Slow	.84 sec.	Nung-pun to ts'ing ('84)	No	No
Medium	.46 sec.	Ts'i-tsung wui hang wan ('84)	No	No
	.41 sec.	Yat-tsaan siu ming tang ('84)	No	No
Quick	.31 sec.	Stand Up ('86)	Yes	Yes
	.31 sec.	Haak sik ng ye ('86)	Yes	Yes
Fast	.22 sec.	Monica ('84)	Yes	No

1.3. Tonal Structure of the Cantonese Lyrics

Having provided the necessary background information on the tones and the data, we proceed to the first task -- that of determining whether or not the lexical tones were taken into consideration in the composition of the lyrics. This task is accomplished by focussing on stanzas in the lyric that are sung to the same basic melody.[4] For the six songs, there are either two or three stanzas which have repeating melodies. As a result, it is possible to juxtapose the first line of the first stanza with the first line of the second stanza, and with that in the third stanza if there is one. The step is then repeated for the second line of each stanza, and so forth.

An example is presented in (5) from "Ts'i tsung wui hang wan". Only the first line of each stanza is given. For the sake of clarity, the tone numbers are placed on a separate line. ("L." = "Line", "S." = "Stanza".)

(5) Example from "Ts'i tsung wui hang wan."

```
a. Tsoi ts'ing tsoi lei?      Ta   sam   ngo    sam?     (L.1, S.1)
    22    21    22  13        55   55    13     55
   (in   love   in  reason?  his  heart  my    heart)

b. Soen  yyn   soen  yi,     hi  - ha   pun -  sang,     (L.1, S.2)
    22    21    22   33       55   55    33     55
  (obey fate obey desire,    (laugh)   half-of-lifetime)

c. Hap-ts'ing  hap - lei,    hoi - sam  ts'ing - sam,    (L.1, S.3)
    2     21    2    13       55   55    33      55
  (fair (and) reasonable,   happy  (and)  satisfied)
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Even a quick glance at (5) reveals definite tonal correspondences among the lines. The songwriter clearly had the lexical tones in mind in composing the lyrics. For a more systematic study, the tones are isolated in (6), with each column of tones identified with an uppercase letter.

(6) The tones only of the lyrics in (5).

	A	B	C	D	E	F	G	H	
a.	22	21	22	13	55	55	13	55	(L.1, S.1)
b.	22	21	22	33	55	55	33	55	(L.1, S.2)
c.	2	21	2	13	55´	55	33	55	(L.1, S.3)

Let us now study the matching of the members within each set, identified in (6) by column. For the sets in B, E, F, and H, the tones in each set are identical: in Column B, all the syllables are Low-falling; in Column E, all the syllables are High-level, and so forth. The match in those sets are perfect.

In Columns A and C, the tones in both sets are Low-level. The third member of each set, found in Stanza 3, differs from the others only in that the syllable bearing the tone is checked, and hence shorter. The pairing of /2/ with /22/ is consistent in the data. Parallel cases hold for the pairing of /3/ with /33/, and for the pairing of /5/ with /55/. The matching of the tones in song composition, thus, coincides with the phonological treatment of these tones as phonemically non-distinct from the level-tone counterparts in non-checked syllables.

We turn now to the final cases in Columns D and G. At first glance, they appear to contain tonal mismatches, in which the Low-rising tone, /13/, is paired with the Mid-level tone, /33/. However, observe that both /13/ and /33/ end in a mid pitch level. It would seem that it is the end-point, the target, that is relevant, and not the beginning point. The pairing of /13/ with /33/ is not haphazard, but occurs systematically throughout the six songs. Similarly, the other rising tone, /35/, is systematically paired with its corresponding level tone, /55/. Again, it is the target that is relevant in determining the tonal pairings. It is this pairing of /35/ with /55/ that provides arguments for treating the high tone as level, /55/, rather than falling, /53/.

There are further theoretical implications concerning the behaviour and treatment of the rising tones. Digressing briefly, what is crucial in these tonal compositions is not the <u>direction of pitch change</u> (rising or falling), but the <u>end-point</u>, or <u>target</u>, of the tone, mid or high. The end-points of these contour tones are then paired with the level tones in the dialect. As a result, it would be more appropriate to refer to tone /13/ as "rising-to-mid", and tone /35/ as "rising-to-high". Regarding the beginning point of the contour tones, although they do not play a crucial role in tonal compositions, they are nonetheless necessary for distinguishing rising (and falling) tones from level ones in the phonology. Of paramount importance for linguistic theory is that these tonal compositions can provide a primary source of evidence, hitherto overlooked, to argue in favour of treating the lexical tones in Chinese as sequences of level tones.

Returning to the systematic pairing of /13/ with /33/ and that of /35/ with /55/, if they are considered tonal mismatches, then about a third of the sets in the data contain mismatches (that is, 77 out of 248 sets). However, excluding these pairs leads to a dramatic drop in tonal violations to less than one-tenth (23 out of 248 sets). Indisputably, the songwriters intended these pairings as permissible rather than abberant. The permitted tonal pairings are summarized in (7).

(7) Permitted tonal pairings in Cantonese songs.

a. High: /5/, /55/, /35/
b. Mid: /3/, /33/, /13/
c. Low: /2/, /22/

Observe that only the Low-falling tone, /21/, is not included in (7). It is systematically excluded from the tonal pairings in the six songs.[4] This would not be expected if the beginning point of a tone is also relevant in determining tonal pairings. As seen earlier in Figure 1, the Low-falling tone, /21/, and the Low-level tone, /22/, both begin at the same pitch. Tone /21/, however, has an initial fall to an extra low pitch, hence resulting in creakiness for some speakers. Tone /22/, on the other hand, is phonologically level even though it may have a slight, gradual pitch drop prepausally. Thus, the crucial difference between the two tones is their phonological shape: one is falling and the other level.[5]

Sets that conform to the permitted tonal pairings in (7) constitute 90.7 percent of the total sets, or 225 out of a total of 248 sets. Only 23 sets, or 9.3 percent of the data, contain genuine tonal mismatches. The type of tonal violations that one finds include such rare pairings as /35/ with /44/, /13/ with /55/, /22/ with /33/, and /22/ with /35/. The results of this study provide indisputable evidence that the songwriters paid attention to the lexical tones when they composed.

A further examination of the lyrics show that, contrary to what one might expect, a quickening in the tempo of a song, and whether it contains foreign elements, or is sung to a foreign melody do not lead to greater tonal violations. The song "Haak sik ng ye", for example, has a quick tempo, contains English phrases, and has a melody that is Japanese in origin. Nonetheless, the first two stanzas, which contain the same basic melody, have no tonal violations at all. Similarly, the song with the fastest tempo, "Monica", also contains no tonal violations. Together, these two songs contain almost half of the total sets studied. The tonal mismatches are distributed among the remaining four songs. Interestingly, the songs with the most tonal violations are, in fact, the two slower songs, "Nung pun to ts'ing" and "Ts'i tsung wui hang wan", sung in slow and medium tempo, respectively. Neither of them have foreign phrases or foreign melody.

There is another factor which has not yet been considered in the tone-melody interaction, namely, the number of stanzas sung to the same melody. It is significant that 21 of the 23 sets with tonal violations contain three members. The cases with genuine tonal mismatches are tabulated in (8). The table is divided according to whether the sets contain two or three members. Songs with two-member sets include: "Yat tsan siu ming tang", "Haak sik ng ye", and "Monica." Songs with three-member sets consist of "Nung pun to ts'ing", "Ts'i tsung wui hang wan", and "Stand Up". In addition, "Monica" has six sets which contain three members. Within the two basic divisions based on number of members, the songs are arranged with respect to increasing tempo. The six songs are listed below for convenience, referred to by the first letter in the song.

(8) Tonal mismatches in the six songs.

Set	Song	Tempo	Tonal Mismatches	Total Sets	% of Mismatches
2 members	Y	Medium	2	25	8
	H	Quick	0	54	0
	M	Fast	0	53	0
3 members	N	Slow	5	30	17
	T	Medium	10	30	33
	S	Quick	6	50	12
	M	Fast	0	6	0
TOTAL			23	248	9

N = Nung pun to ts'ing. S = Stand Up.
T = Ts'i tsung wui hang wan. H = Haak sik ng ye.
Y = Yat-tsaan siu ming tang. M = Monica.

Observe in (8) the paucity of tonal violations in the quick-tempo song, "Stand up", which contains fifty three-member sets. The songwriter had obviously imposed stringent tonal constraints in writing the lyrics to the melody in order to minimize tonal mismatches. This was accomplished by providing fairly simple lyrics. In the case of the two slower songs, "Nung pun to ts'ing" and "Ts'i tsung wui hang wan", the lyrics were more complex, with greater variation in the number of syllables per line. Despite a number of tonal mismatches, mispronunciation of words with respect to tonal register is, in fact, avoided in the two songs. This is accomplished by locally adjusting the melody to accommodate the lexical tones, a strategy for resolving tone-melody conflicts that will be elaborated upon in the next subsection. The local adjustment of the melody suggests that, in all likelihood, the lyrics for these two songs were written first and set to music later. In the case of the foreign melodies, the lyrics were written in order to conform to an existing melody. One would predict that tonal mismatches in such situations would result in the subordination of lexical tones. The prediction holds for the cases in this study.

1.4. Tone and Melody Interaction in Cantonese

1.4.1. Correspondence between Tone and Melody

We proceed now to the study of the actual interaction between tone and melody in Cantonese. As might be expected from the overwhelming number of cases with appropriately matched tones in the data, there is a close correspondence between lexical tone and melody, otherwise the painstaking efforts of the songwriters would have been in vain. To be precise, there is a strong tendency for the melody to respect the three relative pitch levels, high, mid, and low, and to keep the Low-falling /21/ tone distinct from the other tones. Representative examples are given in Figures 2 and 3. Figure 2 is the tracing of narrowband spectrograms, and Figure 3 the transcription of musical notes showing relative (and not absolute) pitch.[6] Observe in Figure 2 that, in addition to the preservation of relative pitch levels, the rising contours in both the faster tempo and slower tempos are also preserved. The shortening of the syllables in the faster tempo, however, renders the rising contours less perceptible.

In some songs, it is not possible to obtain narrowband tracings due to the strong overlay of music on the tones. This is particularly true for the faster-paced songs with strong beat and loud melody. Recording of musical notes is not sufficiently precise, however, especially for quick pitch changes that are subtle, but linguistically significant. As a result, a statistical account of the degree to which the melodies preserve the pitch shape and relative pitch height in the six songs must await a follow-up study. Nonetheless, although statistical figures cannot be obtained at this time, some generalizations can still be made. First of all, the tempo of the song, and whether it contains foreign phrases, or has an imported melody, do not interfere to any great extent with the maintenance of relative pitch levels. This is expected, given the minimal degree of tonal mismatches. Nonetheless, our study of the six Cantonese songs suggests that when tonal mismatches arise in songs with the quicker, imported melodies, the lexical tones in the lyrics tend to be subordinated by the melody. Whether this holds true generally needs further research.

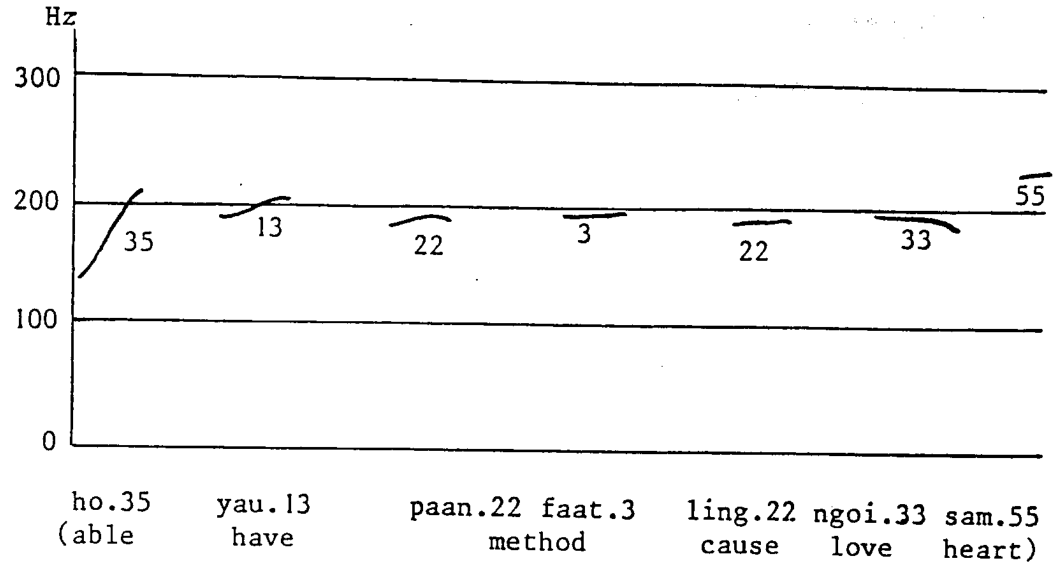
Relative pitch levels are, by and large, preserved in the songs. The same, however, is not true of the tonal contours. The crucial factor involves tempo. In faster-paced songs, the tendency is for the tonal contours to be levelled out. This is accomplished by sacrificing the initial pitch rise when time is short. Thus, tone /13/ would be sung as simply mid, [33], and tone /35/ as simply high, [55].

It is important to note that, despite the tendency toward the levelling of tonal contours in faster tempo, the permissible tonal pairings are still preserved, because the target pitch is preserved. From the general observations made here, it can be seen that the constraint in modern Cantonese songs is against the mixing of pitch levels. The loss of pitch contours is not critical, as long as the target pitch level is attained.

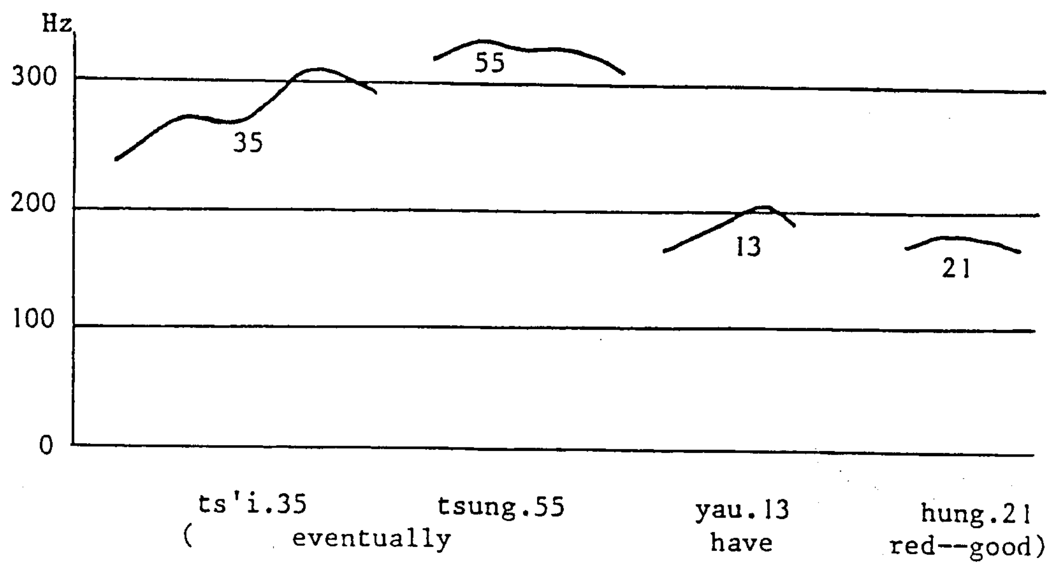
1.4.2. Strategies to Resolve Tone-Melody Clashes in Cantonese

At this point, it is relevant to study what happens in cases of tonal mismatches, where a clash arises between tone and melody in the tone-melody interface. In our Cantonese data, cases involving tonal mismatches are fairly limited. Hence, only some general remarks will be made here. Two opposing strategies can be identified for resolving conflicts that arise from tonal mismatches in the Cantonese songs: (1) melody domination, and (2) lexical tone domination.

In the case of the first strategy, the melody dominates, and the lexical tone is subordinated. Cases of this type are transparent, since they would involve a loss of the original pitch height in the Cantonese songs. The word is sung according to the melody without preserving the lexical tone. An example is given in (9) from "Stand up." For expository convenience, (9) shows only the second half of Line 4 from Stanzas 1, 2 and



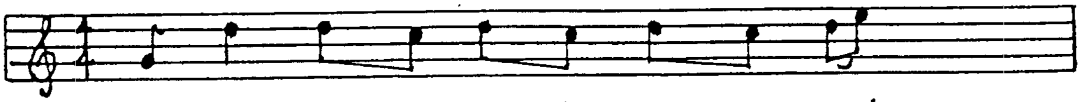
a) Part of a line from "Yat tsaan siu ming tang" (A small bright lantern)



b) Part of a line from "Ts'i tsung wui hang wan" (Eventually I'll be lucky).

Figure 2. Preservation of relative pitch levels.

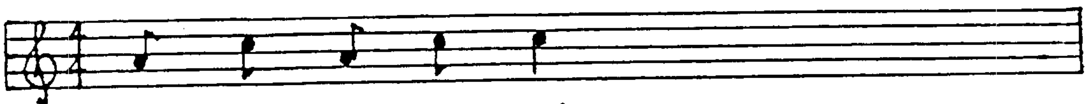
21 35 5 13 5 33 55 33 35



yiu paai tik nei pat yiu taam tang tsai
(sway PRT you NEG need carry small-stool)

a) A line from "Haak sik ng ye" (Black midnight).

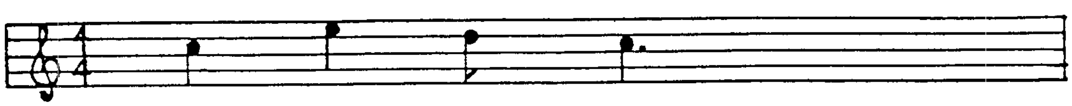
2 33 22 33 33



pit p'ing ming hung tsai
(don't risk-life control)

b) A line from "Haak sik ng ye" (Black midnight).

Figure 3. Preservation of relative pitch levels.



a) tsaak.2 hoi.55 yat.5 - ts'ai.33 (throw open everything)
b) sing.33 yy.55 yat.5 - ts'ai.33 (victory in everything)
c) tsa.33 hoi.55 yat.5 - ts'ai.33 (blast open everything)

(The second half of Line 4 in Stanzas 1, 2, and 3 from "Stand up.")

Figure 4. Melody domination.

3. A transcription of the example in musical notes is provided in Figure 4. As shown in Figure 4, /tsaak.2/ 'throw' is sung at the same pitch as /sing.33/ 'victory' and /tsa.33/ 'blast' even though the tone on /tsaak.2/ is /2/, not /3/, as in the other two words in that same position in the melody.

(9) Example of melody domination (from "Stand up").

a. tsaak.2	hoi.55	yat.5	-	ts'ai.33	(from L.4, S.1)
(throw	open		everything	)	
b. sing.33	yy.55	yat.5	-	ts'ai.33	(from L.4, S.2)
(victory	in		everything	)	
c. tsa.33	hoi.55	yat.5	-	ts'ai.33	(from L.4, S.3)
(blast	open		everything	)	

In the second strategy, tone domination, the converse holds true: the lexical tone takes precedence over the melody. The part of the melody over that particular word or phrase is adjusted in order to accommodate the exceptional tone(s). Thus, there is a divergence in the melody at that particular point in the song. This strategy is employed quite frequently in the Cantonese songs with locally-written melody, suggesting that the lyrics were set to music rather than vice versa. An example of tone domination is presented in (10) from "Ts'i tsung wui hang wan", showing only the first half of Line 4 from Stanzas 1, 2 and 3. The tones in (10) are isolated in (10'), with each set identified by uppercase letters, A to D.

(10) Example of tone domination (from "Ts'i tsung wui hang wan").

a. yat.5	-	ts'ai.33	si.22	-	kon.33	(L.4, S.1)
(	all			affairs	)	
b. tsung.55		ts'i.35			sang.55	(L.4, S.2)
(eventually (in)		this			lifetime)	
c. tsung.55		ts'i.35			sang.55	(L.4, S.3)
(eventually (in)		this			lifetime)	

(10') The tones only of the lyrics in (10).

	A	B	C	D	
	==	==	==	==	
a.	5	33	22	33	(L.4, S.1)
b.	55	35		55	(L.4, S.2)
c.	55	35		55	(L.4, S.3)

Narrowband tracings of the above example is given in the upper portion of Figure 5, with the sets identified with letters A to D, as in (10') for ease of reference. The tracings show that the melody for the first stanza differs substantially from that for the other two stanzas: first of all, the entire pitch level is lower in Stanza 1, and secondly, the second syllable in Stanza 1, /ts'ai.33/, does not have a pitch rise, as is the case for the corresponding syllable, /ts'i.35/ in Stanzas 2 and 3. Thus, the lines in Stanzas 2 and 3 share the same melody, while the line in Stanza 1 has its own melody in order to accommodate the lexical tones in that line.

A second example from "Ts'i tsung wui hang wan" is given in (11), showing the second half of Line 3 from the three stanzas. The tones are isolated in (11'). Narrowband tracings are given in the lower portion of Figure 5. Line 3 in Stanza 1 is sung at a lower pitch level than those in Stanzas 2 and 3. Observe that the unmelodious effect of a long sequence of high level pitches in Stanza 1 was avoided by introducing some undulation in pitch in the lengthened syllable, /k'oey.55/.

(11) Another example of tone domination (from "Ts'i tsung wui hang wan").

a. pat.5 pit.55 k'oey.55 - fan.55 (L.3, S.1)
(don't need to-differentiate)

b. tsi.22 - kei.35 yau.13 tsi.22 - soen.33 (L.3, S.2)
(oneself have self-confidence)

c. sat.2 - tsoi.35 yau.13 tsi.22 - soen.33 (L.3, S.3)
(truly have self-confidence)

(11') The tones only of the lyrics in (11).

	A	B	C	D	E	
	==	==	==	==	==	
a.	5	55	55		55	(L.4, S.1)
b.	22	35	13	22	33	(L.4, S.2)
c.	2	35	13	22	33	(L.4, S.3)

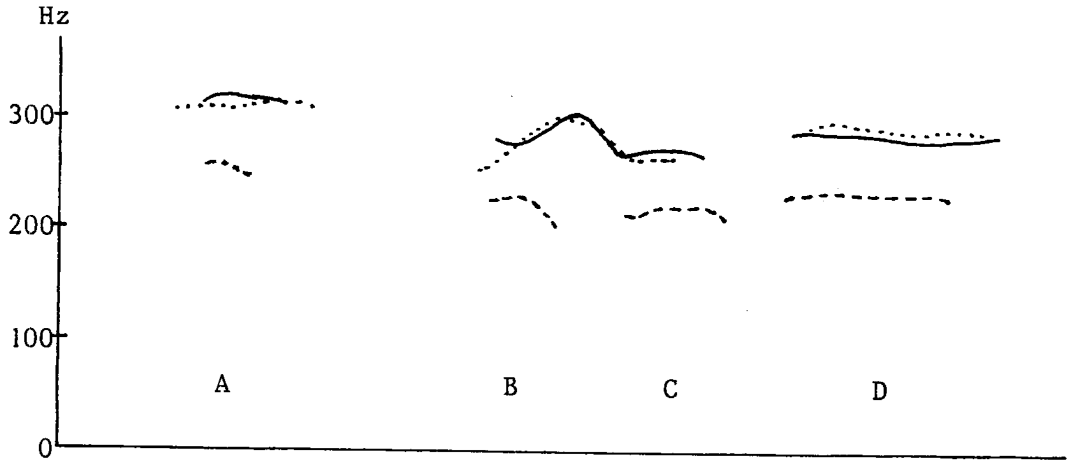
It should be noted that most of the tonal mismatches in "Ts'i tsung wui hang wan", tabulated in (8) earlier, can be traced to Lines 3 and 4 in the first stanza. As the examples above show, the tones dominate over the melody in the song. Thus, despite a fairly large number of tonal mismatches, pitch contour and relative pitch height of the lexical tones have been preserved.

1.5. Summary

To summarize at this point, the impressionistic observation that modern Cantonese songs tend to preserve the relative pitch levels and pitch contours of lexical tones is borne out. Contrary to what one might expect, songs with imported melodies and foreign phrases do not contain a greater number of tonal mismatches. Nonetheless, the present study suggests the possibility that melody domination may be the primary strategy to resolve tone-melody conflicts in songs with imported melodies, while tone domination is preferred for songs with locally-produced melodies, or, at least for those songs in which the lyrics precede the melody and not vice versa.

In the study of the tone-melody interaction in Cantonese, tempo is one of the most important factors affecting that interaction. A loss, or partial loss, of pitch contours occurs on rising tones in faster-paced songs. Nevertheless, crucially, the loss of pitch contours does not result in tonal mismatches.

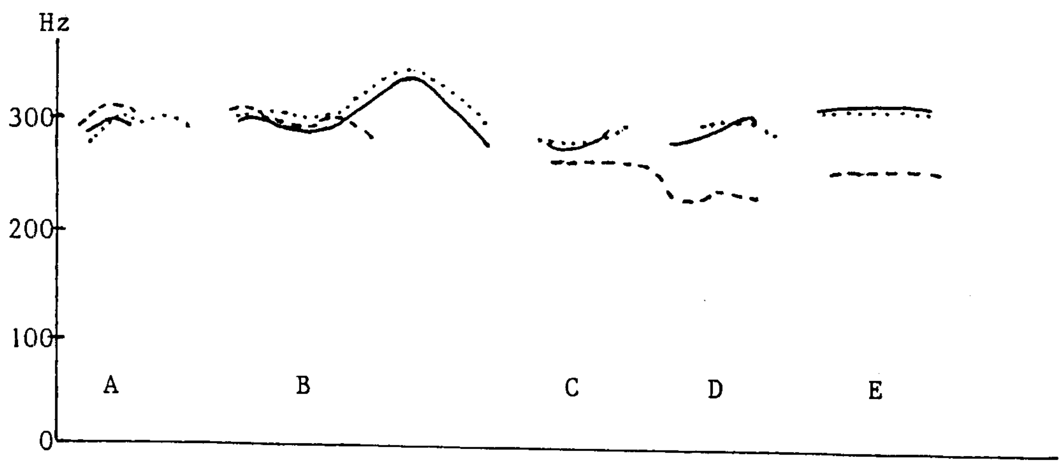
Besides tempo, the number of stanzas that are sung to the same basic melody also affects the tone-melody interface. Songs with two-member sets



a) yat.5 ts'ai.33 si.22 - kon.33 (L.4, S.1)
b) tsung.55 ts'i.35 sang.55 (L.4, S.2)
c) tsung.55 ts'i.35 sang.55 (L.4, S.3)

A B C D

(The first half of Line 4 in Stanzas 1, 2, and 3 from "Ts'i tsung wui hang wan.")



a) pat.5 pit.55 k'oey.55 fan.55 (L.3, S.1)
b) tsi.22 - kei.35 yau.13 tsi.22 - soen.33 (L.3, S.2)
c) sat.2 - tsoi.35 yau.13 tsi.22 - soen.33 (L.3, S.3)

A B C D E

(The second half of Line 3 in Stanzas 1, 2, and 3 from "Ts'i tsung wui hang wan.")

Figure 5. Tone domination.

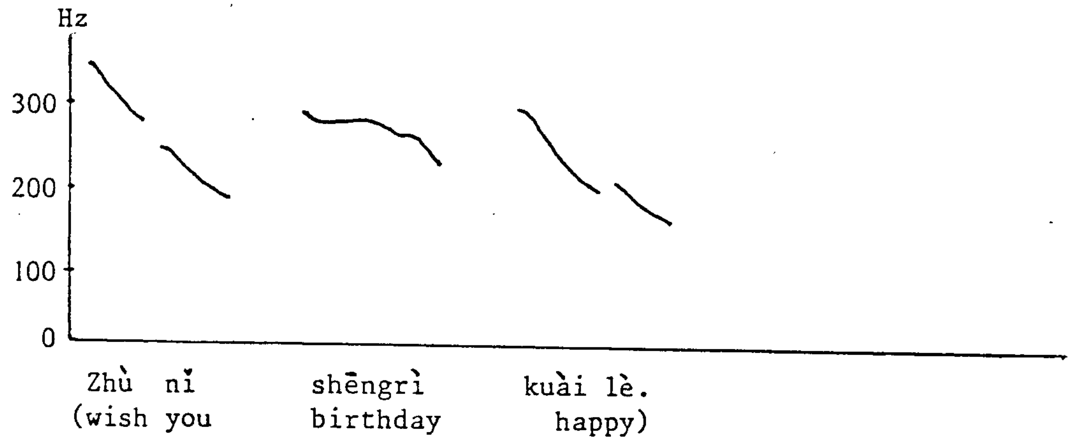
with respect to the tonal pairings contain few, if any, tonal violations, while songs with three-member sets contain noticeably more tonal mismatches.

To conclude, there are also several important ramifications that emerge from the present study of the tone-melody interaction in Cantonese. First of all, the tonal compositions provide evidence for choosing the underlying tones in the dialect. It also yielded our first concrete evidence for treating the lexical tones in Chinese as sequences of level tones. In addition, the results predict that the pitch height dimension would be more critical than the tone contour dimension for Cantonese speakers in tone perception studies, a prediction which has, in fact, been borne out in several studies (Vance 1976, 1977; Gandour 1983, 1984). Moreover, the isolation of the Low-falling tone from permissible tone pairings suggests that the tone would be similarly distinguished in perception studies (as has been demonstrated by Vance's 1977 study). Last but not least, the results of this study suggest that a parallel case would hold in the interaction of tone and intonation in Cantonese, namely, that a faster rate of speech could destroy the initial pitch shape on the rising tones, while greater constraints would exist to minimize the loss of relative pitch height. To my knowledge, no acoustical studies have yet been conducted on the effect of speech tempo on the lexical tones in Cantonese.

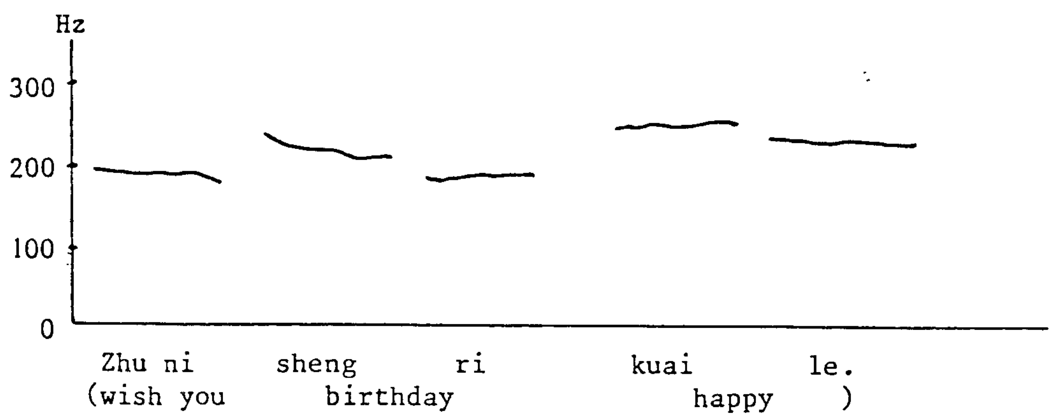
2. The Mandarin Case

The results obtained for the modern Cantonese songs do not generally hold for modern Mandarin songs, where neither relative pitch height nor pitch contours are sacred. This can be demonstrated with a simple example: the first line of a song sung in both China and Taiwan to wish someone a happy birthday. Figure 6 shows the narrowband spectrographic tracings of the first line of the song read in (a). In (b), the words are sung to the familiar English tune, "Happy birthday to you". The pitch contours and relative pitch heights are completely destroyed in (b). Corresponding lyrics do not exist for Cantonese, precisely because the words not only need to convey the desired message simply and naturally, but they must also form a sequence of tones that harmonizes with the melody.

Despite the above example, in listening to Mandarin songs, both from Taiwan and China, it is not strictly true that the lexical tones are completely ignored. In this section, one aim is to determine the extent to which the above observations are true for Mandarin songs, based on a study of six songs from China. The problem of the interaction of tone and melody in Mandarin is actually rather complicated, unlike the relatively straightforward case in Cantonese. Composing of lyrics on the basis of the lexical tones in modern Mandarin is but one option. Other possibilities do not take the modern tones into consideration. For example, songs could be composed on the basis of the artificial tonal system used in Peking operas, or on the basis of the classical Even/Oblique tonal dichotomy which divides the four tones in modern Mandarin into the two tonal categories, Even and Oblique. Details concerning the various options for tonal compositions will be presented in the next subsection, followed by background information on the six Mandarin songs. A study is then conducted on the structure of the lyrics, and ultimately, on the tone-melody interaction in the dialect.

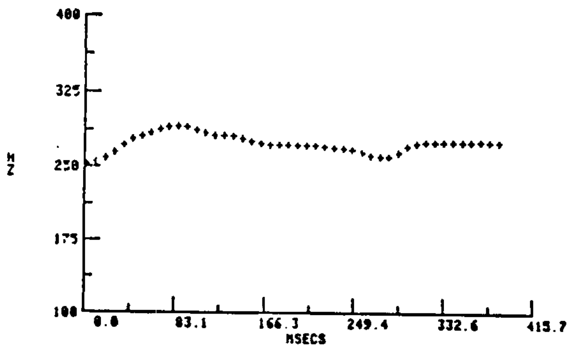


a) 'Happy birthday to you.' (Spoken by RL)

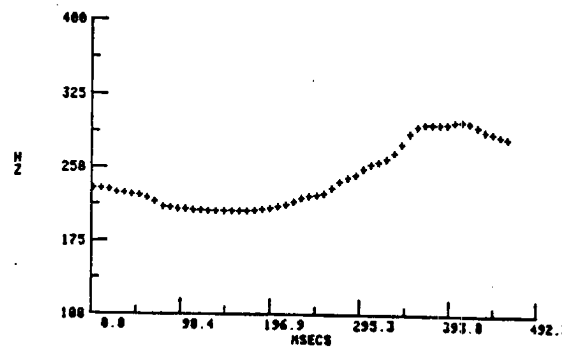


b) 'Happy birthday to you.' (Sung by RL)

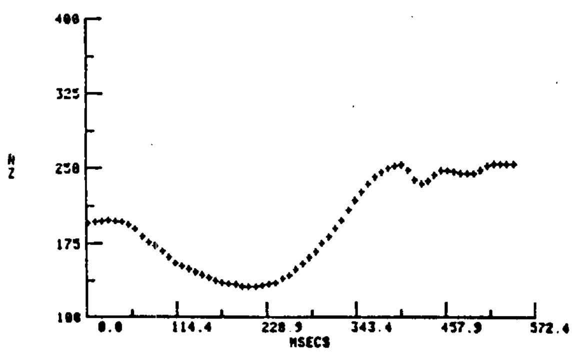
Figure 6. Tone-melody interaction in Mandarin.



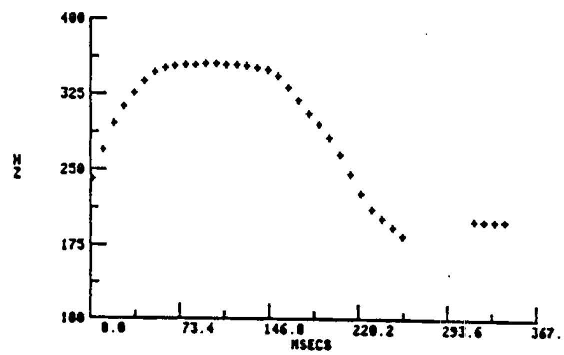
a) Tone 1. (/55/).



b) Tone 2. (/35/).



c) Tone 4. (/214/)



d) Tone 4. (/51/)

Figure 7. The tones in Mandarin. (adapted from Tseng 1981)

2.1. Tonal Systems for Mandarin Songs

Some thirty years ago, Yuen Ren Chao (1956:58) observed that most of the contemporary song writers paid no attention to tone in composing lyrics. After noting a few exceptions of the time, he concluded with the statement: "But by and large, most of contemporary Chinese song composition is independent of tone and only slightly influenced by the composer's dialectal and literary background." Clearly this is not true for Cantonese, but is it true for Mandarin? This is one of the questions which will be addressed here. Chao did concede to some tonal compositions, and made the following statement concerning them:

> (12) When tones are taken into account in the composition of songs, there is still the choice as to whether Mandarin, some other modern dialect, or some more conservative tonal system is to be followed. Because of the low prestige of Mandarin tones in old-style drama, only very recently do composers, when they compose by tone at all, use Mandarin tones and then only occasionally. Consciously or unconsciously, composers follow a more conservative treatment of tones similar to, but not identical with, the treatment of tones in the artificial Central pronunciation.

In taking tones into consideration, the choice of some other modern Chinese dialect is not relevant to this part of the study. Concerning song-writing in Mandarin, Chao essentially outlined four basic options, which are not equal in popularity and usage: (1) atonal composition, in which tones are totally ignored, (2) tonal compositions that pay heed to the modern Mandarin tones, (3) tonal compositions which pay heed to the tones of the "Central" (or Zhongzhou) pronunciation, an artificial dialect that is used in Peking operas, and (4) tonal compositions that pay heed to a more traditional tonal system, namely, the classical division of the tones into Even (or Ping), and Oblique (or Ze).

Ignoring for the present atonal compositions, there are three systems of composing by tone. One is in accordance with the modern Mandarin tones. For ease of reference and comparisons, the tonal system of modern Mandarin will be described first. The basic tonal system of Mandarin, or more precisely, Beijing Mandarin, is well-known. There are four contrastive tones. They are presented in (13) together with a short description of their phonetic value. For ease of description, the citation forms of the tones are given, with no claim made that these are the underlying forms. Some additional information on phonetic variants are included, since they are relevant to the subsequent study of the tonal pairings and the tone-melody interaction (Chao 1968, Connell, Hogan and Rozsypal 1983, Gandour 1983, Tseng 1981). Examples with the four lexical tones using the vowel [i] are given in Figure 7, adapted from Tseng (1981). Besides the four lexical tones, there is also a "neutral tone", which falls on unstressed syllables and lacks its own, inherent phonetic shape. The pitch value of the neutral tone is dependent on the preceding full-toned syllable, the details of which will be omitted here.

(13) The tonal system of Mandarin (four contrastive tones).

Tone 1: /55/	High level [55] or [44], with a slight rise or slight fall at the end of the syllable in citation forms.
Tone 2: /35/	Mid-rising [35], High level [55] in second position of trisyllabic forms if the preceding syllable bears Tone 1 or Tone 2 -- in casual speech only. (The [35] sandhi form of Tone 3 also feeds into this rule.)
Tone 3: /214/	Low-dipping [214] prepausally, Mid-rising [35] before /214/, and Low-falling [21] elsewhere.
Tone 4: /51/	High-falling [51] prepausally, and [53] before /51/.

(Neutral tone: Parasitic on the preceding full tone.)

Lyrics may also be composed based on the Central, or Zhongzhou, pronunciation, which is an artificial dialect used in Peking opera with its own historical origins. The tones for the Central pronunciation are presented in (14), from Chao (1956:57). Modern Mandarin tones are included for comparative purposes.

(14) The tonal system of Mandarin and the "Central" pronunciation.

Tone Class	Mandarin	"Central"
Tone 1	/55/	/44/
Tone 2	/35/	/11/
Tone 3	/214/	/53/ or /55/
Tone 4	/51/	/24/ or /424/

The third and last option for tonal compositions is the observation of the classical Even/Oblique dichotomy. There are four historical tones in Chinese: Even (Ping), Ascending (Shang), Departing (Qu), and Entering (Ru). Even Tone forms one category in the Even/Oblique distinction, while the remaining three historical tones combine to form the Oblique Tone category. The correspondence between the modern Mandarin tones and the Even/Oblique dichotomy is given in (15).

(15)

Mandarin Tones		Even/Oblique Category
Tone 1	/55/	Even Tones: Most suitable are tone values 1, 3, 5. If a sliding pitch is used, it should begin high and end low.
Tone 2	/35/	
Tone 3	/214/	Oblique Tones: Multidirectional pitch changes, or use tone values 2, 4, 6, 7.
Tone 4	/51/	

A rough description is given in (15) of the phonetic values for Even-toned syllables versus Oblique-toned syllables in singing is included, based on

Chao (1960:13). An ascending pitch range, from '1' to '7' is used in the description, to indicate basically that the Even Tone syllables are assigned a relatively lower pitch level than the corresponding Oblique Tones. (More concerning the modern system of transcribing notes in Chinese is given in section 2.4.1.) The relative pitch differences are determined locally (e.g., within a word or a phrase). Moreover, observance of the pitch values is only relevant for important words in the lyric, especially the rhyming word.

Returning now to a discussion of Chao's observations concerning tonal and atonal compositions, Chao claims that song writers compose primarily atonal compositions. In the next subsection concerning the structure of the lyrics in the six songs, the first question is whether or not most of these songs are atonal in composition.

Then, there remain three other options which do pay attention to tone. There are several relevant questions that need to be answered. First of all, if tones were taken into consideration in the six songs, which of the options were selected for the songs? And, of those options, is there one which was preferred above the others? Chao seems to regard tonal compositions based on the artificial Central pronunciation to be the most common of the three options. It remains to be seen whether this is indeed the case for the Mandarin songs in the present study. Again, as in the study of the Cantonese case, one task is to analyze the tonal structure of the lyrics to determine, first of all, if the compositions are tonal or atonal, and whether there are certain tonal pairings that would reveal the tonal compositions to be based on one option rather than another. The second task is to study the tone-melody interface to determine whether the words are sung without regard to any type of tonal system, or whether they are sung with some attempt to follow one of the three tonal systems. Before proceeding to those two tasks, some background information is provided in the next subsection on the six songs.

2.2. The Data: Six Modern Mandarin Songs

In the comparison of the tone-melody interaction in Mandarin, six Mandarin songs were selected from six movies produced in China during the 1979 to 1982 period. The songs were recorded in the 1982 casette tape entitled "Zhi Yin ("Intimate Friend"), based on the movie by that name. The six songs are listed in (16):

(16)
1. Zhi yin. (Intimate friend (literally, 'know-sound'))
2. Zou xiang haiyang. (Head for the ocean)
3. Yinsede yueguang. (Silver moonlight)
4. Nansu xiangsi. (Difficult to tell (of one's) yearing)
5. Mudanzhi ge. (Song of the peony)
6. Renjiade chuan er jiang cheng shuang. (Other people's boats (their) oars form a pair) (Hereafter, simply "Renjiade chuan.")

Each of the songs is sung by a different singer who may be male or female. Song 1 is sung by a female vocalist, songs 5 and 6 by a male vocalist, while the remaining three songs are shared by a male and a female vocalist. These particular songs were were selected from the tape because musical notations for them were available in a song book published in 1984 by the Chinese movie industry, Shi San Ren Yanchang Dianying Gequ Jijin

(Choice collection of movie songs sung by thirteen people -- i.e., those who had sung the songs in the movies). Some of the songs are sung at a very slow overall tempo; none of them are sung at a very quick or fast tempo. Hence, the loss, or potential loss, of pitch contour due to a quickening in tempo found in Cantonese is not a relevant issue here. Of greater import here is the question of whether, even at slower tempo, are the tones (from any of the three tonal systems) preserved in the Mandarin songs.

2.3. Tonal Structure of the Mandarin Lyrics

2.3.1. Permitted Tonal Pairings in Mandarin Songs

The first task is to determine if tones were taken into consideration in the compositions. An example is given in (17), from "Mudanzhi ge." The example is excerpted from the second half of Line 4 in Stanzas 1 and 2. The tones are isolated in (17'), using T1, T2, T3 and T4 to represent the four lexical tones. 'T0' represents the neutral tone.

(17) Example from "Mudanzhi ge."

a. na.214	zhi.55-dao.0	ni.214	ceng.35	li.51-jin.51	pin.35- han.35
(who	know	you	once	to-experience	poverty)

b. ni.214	ba.214	mei.214 - li.51	dai.51-gei.0	ren.35-jian.55
(you	take	beauty	bring-give-to	the-world)

(17') The tone classes of the lyrics in (17).

a.	T3	T1	T0	T3	T2	T4	T4	T2	T2
B.	T3	T3		T3	T4	T4	T0	T2	T1

The above example clearly shows that the composition is not entirely atonal, but that the songwriter did pay some heed to the tones. In this part of the study, the data consists of a total of 278 sets, including sets with neutral-toned syllables.[7] Of that total, there are 140 sets with full-toned syllables that appear to be tonal mismatches. Nonetheless, a pattern emerges. Although the results are not as dramatic as in the Cantonese case, certain permitted tonal pairings can be discerned in the Mandarin case. These tonal pairings are given in (18).

(18) Permitted tonal pairings for Mandarin songs.

a. Tone 1 - Tone 2
b. Tone 1 - Tone 4
c. Tone 2 - Tone 4

The tonal pairings in (18) account for 95 of the 140 sets, or over two-thirds of the sets, that might potentially be tonal mismatches. The specific pairing of tones given in (18) is unlikely to have occurred by chance. (Statistics on the 140 sets of tonal pairings for the six songs are given in Appendix A.) The proposal here, therefore, is that the 95 sets involve permitted tonal pairings, as shown in (19a), while the remaining 45 sets, shown in (19b), may be genuine tonal mismatches. In (19a), the last row of tonal pairings involves three-member sets containing the cross-pairing of Tones 1, 2, and 4. Two of the six songs have three stanzas, namely, "Nansu xiangsi" and "Renjiade chuanr jiang cheng shuang".

(19) a. Summary of permitted tonal pairings (Total: 95 sets).

TONAL PAIRINGS	NO. OF SETS
Tone 1 - Tone 2	30
Tone 1 - Tone 4	31
Tone 2 - Tone 4	26
Tone 1 - Tone 2 - Tone 4	8

b. Summary of tonal mismatches (Total: 45 sets).

TONAL PAIRINGS	NO. OF SETS
Tone 1 - Tone 3	8
Tone 2 - Tone 3	9
Tone 3 - Tone 4	17
Tone 1 - Tone 2 - Tone 3	6
Tone 1 - Tone 3 - Tone 4	3
Tone 2 - Tone 3 - Tone 4	2

Note in (19b) that these cases all involve Tone 3: the pairing of Tone 3 with Tones 1, 2 and 4. Hence, assuming that Tone 3 does not undergo tonal matching with other tones, the remaining three-member tonal pairings are treated as mismatches and placed under (19b), since they all contain Tone 3.

There may be some doubt concerning whether the pairing of Tone 3 with Tone 4 should constitute a tonal mismatch. It is significant that 13 of the 18 tonal mismatches were contributed by two songs, "Zou xiang haiyang" and "Nansu xiangsi." However, that pairing is totally absent in two of the songs, "Yinsede yueguang" and "Mudanzhi ge." This raises the question of whether these two songs were composed on the basis of the Even/Oblique dichotomy, where one would expect Tones 1 and 2 to be paired together as Even Tones, and Tones 3 and 4 to be paired together as Oblique Tones. However, although Tone 3 is often paired with Tone 4, one also find frequent pairing of Tone 1 with Tone 4, and Tone 2 with Tone 4, as shown in (20). This would not be expected if the pairing is based on the ancient tonal classification. Alternatively, assuming the permitted tonal pairings given in (19a) results in far fewer tonal violations for the two songs, as demonstrated in (20'). In (20) and (20'), "Z" refers to "Zou xiang haiyang", "N" to "Nansu xiangsi", "N/A" to "Not Applicable", and "Others" to the various three-member sets.

(20) Tonal pairings of two songs based on the Even/Oblique dichotomy.

Song	Permitted Pairings		Tonal Violations				
	T1-T2	T3-T4	T1-T4	T2-T4	T1-T3	T2-T3	Others
Z	6	6	5	7	1	3	N/A
N	10	7	8	3	0	2	12
Total	29		41				

(20′) Tonal pairings of two songs based on the permitted pairings in (18).

Song	Permitted Pairings T1-T2	T1-T4	T2-T4	T1-T2-T4	Tonal Violations T1-T3	T2-T3	T3-T4	Others
Z	6	5	7	N/A	1	3	6	N/A
N	10	8	3	4	0	2	7	8
Total	43				27			

For the other four songs, there is even less reason to argue for the compositions being based on an Even/Oblique distinction, given the scarcity of Tone 3 being paired with Tone 4 in those cases, while there is a large number of pairing of Tones 1 and 2 with Tone 4 across all songs. If there are traces of the Even/Oblique distinction in the songs, it is not readily apparent, and is obviously not the overriding principle for the compositions.

Briefly summarizing the points above, the particular distribution of tonal pairings in the lyrics suggests that certain tonal pairings are preferred, which are treated here as permitted tonal pairings, while others occur less frequently and are analyzed here as tonal mismatches, or tonal violations. Furthermore, a study of the tonal patterning in the lyrics shows that the general tonal structure is not based on the classical Even/Oblique dichotomy. Thus, one of the three options for tonal composition is ruled out by the study of the tonal structure of the lyrics.

2.3.2. Dialect Base for the Tonal Pairings

Having excluded the Even/Oblique distinction as the basis for the tonal pairings, it is still necessry to determine if the songwriters intended the tonal pairings in (18) to be based on the modern Mandarin tones or on the artificial Central dialect. In either case, it would be reasonable to assume that the tonal pairings are based on phonetic similarity. Recall that in the Cantonese case, the tonal pairings were based the end-point, or target pitch height, of the tones.

(21) Phonetic similarity within the tonal pairings.

Tonal Pairings	Mandarin	Central	
Tone 1 - Tone 2	/55/ - /35/	/44/ - /11/	
Tone 1 - Tone 4	/55/ - /51/	/44/ - /424/	(or /24/)
Tone 2 - Tone 4	/35/ - /51/	/11/ - /424/	(or /24/)

Whether the songwriters intended the tonal pairings to be based on modern Mandarin or the Central pronunciation is not obvious from studying (21). Nonetheless, the proposal here is that the songwriters intended to compose on the basis of modern Mandarin tones. The reasons are as follows.

Regarding the pairing of Tone 1 (/55/) with Tone 2 (/35/), it is significant that in his tone perception study, which include Cantonese, Mandarin, Taiwanese, and Thai listeners, Gandour (1983) finds that the high level tone, [44], is perceived as similar to the rising tone, [35], by his fifty Mandarin subjects, and are thus clustered together.[8] Recall in (13) on the tonal system of Mandarin that Tone 1 is [55] or [44] phonetically. Furthermore, [55] (or [44]) serves as a sandhi form for Tones 2 and 3 in certain tone sandhi environments. Hence, with respect to the Mandarin listening subjects in Gandour's tone perception study, their clustering of tone [44] (corresponding to Tone 1) with tone [35] (corresponding to Tone 2) provides some phonetic evidence for the pairing of Tones 1 and 2 in the songs.

Gandour attributes the clustering of [44] and [35] in Mandarin to the specific tone sandhi rules in the dialect. However, one might argue additionally for the clustering based on the phonetic shape of Tones 1 and 2: both have a rising pitch, albeit very slight in the case of Tone 1. The slight pitch rise at the end of Tone 1 is not normally noted in the literature, but it showed up in the display of the pitch shape of Mandarin Tone 1 in Gandour (1983), originally in Chuang, Hiki, Sone and Nimura (1972), and in Connell et al. (1983) for /ba.55/ 'eight' (while /bi.55/ and /du.55/ have falling pitch contour). Thus, the pairing of Tone 1 with Tone 2 in the Mandarin songs could be due to tone sandhi forms that link Tone 1 with Tone 2, or simply the phonetic shapes of the two lexical tones. It is noteworthy that Tone 1 is frequently sung with a rising pitch. This occurs even when both members of a set are Tone 1 syllables.

With regard to the pairing of Tone 1 (/55/) with Tone 4 (/51/), Gandour's (1983) study shows that Mandarin listeners perceive level tone [44] to be more similar to rising tone [35] than to falling tone [53]. Nonetheless, [44] does cluster with [53] for the Mandarin listeners. It is important to note that Tone 1 often has a pitch drop prepausally. Recall also that Tone 4 has [53] as a sandhi form before another Tone 4. Thus, both Tones 1 and 4 have a pitch drop as one of their tonal variants. In songs, when Tone 4 is sung with a pitch drop, that drop is never abrupt or sharp, as it is in the spoken form, particularly in citation context. Thus, there is some phonetic basis for the pairing of Mandarin Tone 1 with Tone 4 which is supported by the clustering of [44] with [53] for the Mandarin subjects in Gandour's perceptual study.

The pairing of Tone 2 (/35/) with Tone 4 (/51/) appears rather anomalous. However, phonetically, Tone 4 does not actually begin at the highest pitch; rather, it begins slightly lower, and rises to the highest point, and is hence a rising-falling tone in narrow phonetic description. A display of the [i] vowel in Tone 4 was given earlier in Figure 7. As the figure shows, the pitch fall does not actually begin until almost half-way into the vowel. A slight rise before the fall in pitch for Tone 4 is also displayed in Chuang et al. (1972), adopted in Gandour (1983)). Moreover, it is worth noting that in Tseng's example of Tone 2, also given in Figure 7 here, the tone ends with a slight fall, as one might expect in citation context. Thus, phonetically, the two tones are actually very similar in their pitch contours, although this is not readily apparent in the phonemic values assigned to the two tones. Given phonetic similarities observed in Tones 2 and 4, it is not surprising to find that, for the Mandarin listeners in Gandour's study, the rising tone, [35], is not distinguished from the rising-falling tone, [353], in the clustering of the tonal stimuli. For the subjects, Tone [35] would correspond to Tone 2, while [353] would correspond most closely to Tone 4 in the dialect. Thus, although the pairing of Tones

2 and 4 in the songs appear initially as being highly irregular, there is sufficient evidence for the pairing of Tones 2 and 4 on a phonetic basis.

To summarize thus far, evidence based on the phonetic similarity of the tones and Gandour's (1983) perception study support the proposal advanced that the tonal pairings in (18) are based on the modern tones in Mandarin. The alternate proposal, that the tonal pairings are based on the Central pronunciation, receives support neither from the phonetic shape of the tones in the Central pronunciation, nor from Gandour's perception study. If the pairings are based on the Central pronunciation, the similarities within a tonal pairing would need to be at a more abstract level, for which the current study is not equipped.

2.3.3. Sets with Appropriately and Inappropriately Matched Tones

Having established that there are permitted tonal pairings in the Mandarin songs, and further, that the tonal pairings in the lyrics are based on modern Mandarin tones, the question of the proportion of sets with appropriately versus inappropriately matched tones still needs to be addressed. Recall that genuine tonal mismatches constituted about ten percent of the total sets in the Cantonese songs (that is, 23 out of 248 sets). Thus, about ninety percent of the sets in Cantonese are appropriately matched. In the Mandarin case, even liberally treating sets with neutral-toned syllables as appropropriately-matched sets, there are still a total of 45 out of 278 sets which contain genuine tonal violations, or about 16% of the sets. The distribution of tonal mismatches among the six songs is given in (22), divided into two- and three- member sets. In no case is there a total absence of tonal mismatches. While 45 out of 278 sets contain tonal mismatches, there are roughly another 33 sets out of the 278 sets which contain neutral tones; hence, only 200 out of 278 sets involve full-toned syllables that are appropriately matched, or about seventy percent of the data, compared to about ninety percent of the data for the Cantonese case. The statistics for the Mandarin songs are summarized in (23).

(22) Tonal mismatches in the six songs.

Set	Song	Tonal Mismatches	Total Sets	% of Mismatches
2 members	ZY	2	26	8
	Z	10	65	15
	Y	4	46	9
	M	4	46	9
3 members	N	17	49	35
	R	9	40	23
TOTAL		45	278	16

ZY = Zhi yin. N = Nansu xiangsi.
Z = Zou xiang haiyang. M = Mudanzhi ge.
Y = Yinsede yueguang. R = Renjiade chuan.

(23) Summary of appropriately and inappropriately matched tones.

Sets	Number	Percentage
Tonally mismatched sets	45	16
Tonally-matched sets		
Sets with Neutral-toned syllables	33	12
Sets with Full-toned syllables:	200	72
Total	278	100

The difference in the extent of total pairing between the Cantonese and Mandarin songs is reflected in the difference between the two dialects in the tone-melody interaction, as the next subsection on tone and melody interaction in Mandarin will demonstrate.

2.4. Tone and Melody Interaction in Mandarin

In examining the interaction of tone and melody in Mandarin using the song book, it is necessary to first give the general reader some background on the current system of transcribing music in Chinese.

2.4.1. The System of Transcribing Music for Singing

The Chinese uses a system of tone numbers for transcribing music, adopted from Japan (Liu 1968), that is particularly suitable for sight singing. The seven-tone scale forms the basic scale. The degrees of the scale are assigned the tone numbers '1' through '7', the equivalents of the Western tone syllables: Do, Re, Mi, Fa, Sol, La, Ti. To transcribe the tones an octave higher, a dot is placed above the numbers, while the tones in the next lower octave is indicated by a dot below the numbers. Thus, the system of tone numbers facilitates the transcription of three octaves, informally designated as "Low", "Mid", and "High" in (23). The tone numbers are arranged from left to right in order of ascending pitch.

(23) Tone numbers for the seven-tone scale in three octaves.

LOW	MID	HIGH
$\underset{\cdot}{1}, \underset{\cdot}{2}, \underset{\cdot}{3}, \underset{\cdot}{4}, \underset{\cdot}{5}, \underset{\cdot}{6}, \underset{\cdot}{7}$	1, 2, 3, 4, 5, 6, 7	$\dot{1}, \dot{2}, \dot{3}, \dot{4}, \dot{5}, \dot{6}, \dot{7}$

The system of tone numbers is not applied to fixed notes, so that '1' through '7' are not notational equivalents of the seven notes, C, D, E, F, G, A, and B, respectively. Instead, at the beginning of each song, '1' is assigned to a specific note which may or may not be 'C'. Thus, '1' corresponds to the note, G, in "Zhi yin", for example, but to E, in "Yinsede yueguang", and to A in "Renjiade chuan".

Although the seven-tone scale is the basic one in this system, the five-tone (pentatonic) scale is in fact the one that is more commmonly used in the traditional Chinese songs. The music for four of the six Mandarin songs are in the pentatonic scale: "Zhi yin", "Nansu xiangsi", "Mudanzhi ge", and "Renjiade chuan." The pentatonic scale simply omits '4' and '7' in the full, seven-tone scale.

In assigning values or durations to notes in this musical notation system, the quarter note is the basic note. The assignment of values is as follows, where 'x' represents any note, including silence, or rest, which is transcribed with a zero ('0').

(24) Note values.

x - - -	whole note	$\underline{x}$	eighth note
x -	half note	$\underline{\underline{x}}$	sixteenth note
x	quarter note	$\underline{\underline{\underline{x}}}$	thirty-second note

x. half length added to the note without the dot

As in Western musical notation, a ligature, or "slur", is used to connect two notes (e.g., $\overset{\frown}{2\ 3}$), while grace notes are transcribed by superscripting the note and connecting it to the main note with a slur (e.g., $^{2}3$). A trilled note is indicated using the zigzag line above the note as in Western music (e.g., $\overset{\sim}{3}$), and the means to indicate flats, sharps, beats and measures are the same as in Western musical notation.

Having provided a brief description of the musical notations used in Chinese songbooks, we proceed to the investigation of the interaction of tone and melody in Mandarin.

2.4.2. Correspondence between Tone and Melody

The data for studying the correspondence between the lexical tones and the melody consists of a total of 602 full-toned syllables.[9] Excluded from the discussion are approximately sixty neutral-toned syllables. The first question to be addressed is whether the pitch contours of the lexical tones are preserved in the melody. For ease of exposition, the first concern is to tabulate the lexical tones with respect to whether they are rendered as level or contour in the melody. Level tones are sung on a definite pitch (i.e., on a single note), while contour tones are sung on a sliding pitch (i.e., two or more dissimilar notes connected by a slur, or a note combined with a grace note).[10] The results are given in (25).

(25) Definite or sliding pitch on the lexical tones.

Tone Class		Definite Pitch	Sliding Pitch	Total
Tone 1	- /55/	111	80	191
Tone 2	- /35/	68	59	127
Tone 3	- [214],[35]	12	35	47
	- [21]	47	10	57
Tone 4	- /51/	98	82	180
Total		336	266	602

As (25) shows, there is levelling of the tones across all four tonal categories. Definite pitch is assigned to slightly over half of the full-toned syllables. Tone 3 is divided into two categories because of the differences in behaviour between them. Recall that Tone 3 has three important tonal variants: [214] which occurs prepausally, [35] before another Tone 3, and [21] elsewhere. There were only a couple of cases of a Tone 3 occurring before another Tone 3 in the songs. Due to their paucity and similarity in shape to the [214] variant (both having a rising contour), the [35] variant is simply included with the [214] variant in (25). The [21] variant is categorized separately.

Despite the relatively slower tempo of the Mandarin songs, the melody often levels out the pitch contours without regard to tone class. The only exceptions are the rising tonal variants of Tone 3; they are more frequently rendered with a sliding pitch. The levelling of the lexical tones is similar to what was observed in the "Happy birthday" song in Figure 6. In this respect, Mandarin differs significantly from Cantonese.

We turn now to the 266 syllables with sliding pitch. The crucial question is whether these syllables are sung to accommodate the pitch contour of the modern Mandarin tones. The pitch contours are divided into three categories in (26): Falling, Rising, and Falling-Rising or Rising-Falling, abbreviated as "FR/RF" in the table. The third category includes a few occurrences of multi-directional pitch contours.

(26) Sliding pitches on the lexical tones.

Tone Class		Falling	Rising	FR/RF	Total
Tone 1	- /55/	33	32	15	80
Tone 2	- /35/	17	23	19	59
Tone 3	- [214],[35]	1	23	11	35
	- [21]	6	4	0	10
Tone 4	- /51/	33	34	15	82
Total		90	116	60	266

Several remarks can be made concerning (26). Of particular interest is that almost one-quarter of the cases involve complex pitch contours, including falling-rising and rising-falling. It is precisely such pitch shapes that readily accommodate the lexical tones with different pitch shapes. An example with bidirectional, rising-falling pitch contour on two tonally-matched sets is given in (27), excerpted from the end of the two stanzas in "Zhi yin". (# is the symbol for 'sharp'.) Both the second and third syllable in the two stanzas involve Tone 2 (/35/) and Tone 4 (/51/). Thus, the bidirectional pitch contours are incorporated into the melody, a strategy for preserving the lexical tone shapes which was not used in the six popular Cantonese songs in this study. In (27), the final slur actually continues into the next few measures, but is truncated in the example; the singing fades by the end of measure on the third syllable.

(27) Pairing of Tones 2 and 4 with bidirectional pitch contours.

a. 6. 7 6 5 6 - | 3. #4 3 2 1 - | 7. 2 3 5 3 2 7 5 | (1 = G 4/4)

b. zui.51 (most | nan.35 difficult | mi.51 to-seek) | (from L.5, S.1)

c. rao.51 (move-about | zhan.51 battle | qi.35 flag) | (from L.5, S.2)

Tone 4 (/51/) on the first syllable of Stanzas 1 and 2 in (27) would have been sung simply at the '6' note, except that two short notes, '7' and '5', were "smuggled in", creating a falling contour that enabled the falling pitch of Tone 4 to be realized in the melody. Smilarly, in the second syllable, the insertion of the '#4' note to the measure acommodated the rising contour on /nan.35/ 'difficult'.

The use of quick pitch changes to accommodate the lexical tones is also exemplified in (28), excerpted from Line 4 in "Nansu xiangsi". The second syllable involves Tone 4 (/51/) in Stanza 1, Tone 2 (/35/) in Stanza 2, and Tone 1 (/55/) in Stanza 3. The syllable is sung in a falling-rising-falling pitch in all three stanzas. Recall that the pairing of Tones 1, 2 and 4 are permitted tonal pairings. While a falling, '3 2' sequence would have accmmodated Tones 1 and 4, the insertation of a sixteenth note, '3', to form '3 2 3 2' enabled the pitch contours of all three tones to be realized. Observe the prepausal pitch drop on the third syllable in each of the three stanzas. The pitch drop on Tone 1 (/55/) signals the end of the phrase, as would be the case in sentence intonation.

(28) Pairing of Tones 1, 2, and 4 with complex pitch contours.

a. 3 ______ 3 2 3 2 1. 7 | (1 = F 4/4)

b. jin.55 - ri.51 shou.55 (from L.4, S.1)
(today end/harvest)

c. si.51 can.35 qiu.55 (from L.4, S.2)
(like cruel autumn)

d. hen.51 you.55 - you.55 (from L.4, S.3)
(hate long-drawn-out)

The same strategy of tone-melody coordination using complex pitch contours is also employed for mismatched tones. This is exemplified in (29) from "Renjiade chuan", involving the mismatching of Tone 3 (/214/) with Tone 4 (/51/) on the first syllable.

(29) Accommodating Tones 3 and 4 with bidirectional pitch contours.

a. 2 3 2 3 5 2 | 1 0 (1 = A 2/4)

b. zen.214 fei.55 - xiang.35 (from L.4, S.1)
(how (would it) circle-in-the-air)

c. zuo.51 - dong.51 - fang.35 (from L.4, S. 1 & 2)
(consummate-marriage)

Note that (29) also provides an example of the permitted pairing of Tone 1 (/55/) with Tone 4 (/51/) on the second syllable. The trilling of the note on the second syllable in (29) is also employed in the permitted pairing of Tone 1 (/55/) with Tone 2 (/35/). In (30), although the second syllable in the two stanzas is sung with a falling pitch, the initial part of the syllable is actually trilled. The trilling can be viewed as a means of incorporating the rising pitch on the lexical tone, /35/, without introducing a grace note or echapee that would disrupt the melody. The example in (30) is from "Yinsede yueguang". (Only Stanzas 2 and 3 are given in the example because the two lines in the opening stanza have a separate melody. The same melody is only repeated in the four lines of Stanzas 2 and 3.)

(30) Accommodating Tones 1 and 2 with trilled notes.

a. 3 2. 1 | 1 - | 1 0 (1 = E 3/4 2/4)

b. qu.55 you.55 shang.55 (from L.4, S.2)
(disperse worry (and) distress

c. kan.55 yi.35 wang.51 (from L.4, S.3)
(may lose (and) forget)

From the examples above, one can see that both appropriately and inappropriately matched tones are accommodated in the melody by the use of complex pitch contours and trilled notes, A further study of the example shows that the converse also holds: the melody can ignore the lexical tones even if the sets are perfectly matched, as in the pitch-levelling of the last syllable in Stanzas 1 and 2 in (29). Another example is given in (31), from "Zou xiang haiyang." Note in particular the level pitch for the falling tone, /51/, in the first syllable in both stanzas. There are relatively few sliding pitches in this song, which has a light and merry tune. (Neutral tone is indicated by '0'; S-PRT = sentence particle.)

(31) Levelling of contour lexical tones.

a. 5. 5 | 4. 5 6 | (1 = G 2/4)

b. kuai.51 - kuai.51 hua.35 ya.0 (L.5, S.1)
(quickly to-row S-PRT)

c. fang.51 - sheng.55 - chang.51 ba.0 (L.5, S.2)
(heartily-sing S-PRT)

Tone 3 is treated somewhat differently in the tone-melody interaction. The melody treats the rising variants, [214] and [35], differently from the low, or low-falling, variant, [21]: the rising variants are sung largely with rising pitch or with bidirectional pitch contours, while the low [21] variant is predominantly rendered level in the songs. (29) contains an example of rising pitch on [214] preserved in the melody. An example of level pitch on the [21] variant of Tone 3 is presented in (32) on the next page, from "Zou xiang haiyang".

Level pitch on Tone 1 (/55/) in the melody is not exceptional, since the tone is level, with or without slight pitch rise or pitch drop in spoken form. Pitch drop on Tone 1 is already observed in example (28). Pitch rise on Tone 1 is shown in (33) and (34), from "Zhi yin". The lyrics in (34) immediately follow those in (33). The examples are from the latter portion of their respective lines.

(32) Level pitch on the low tonal variant of Tone 3.

a. 0 3 2 _____ 1 | 2 6 | (1 = G 2/4)

b. lai.35 - dao.51 - le.0 hai.21 - shang.51 (from L.3, S.1)
(arrived at-sea)

c. sheng.55 - huo.35 zai.0 hai.21 - shang.51 (from L.3, S.2)
(to-live at at-sea)

(33) Rising pitch on Tone 1.

a. 5 5 6 6 1 | (1 = G 4/4)

b. ren.35 - sheng.55 nan.35 de.35 (from L.3, S.1)
(life difficult to-obtain)

c. (6 6 1) (melody adjustment)

d. jiang.55 - jun.55 ba.35 jian.51 (from L.3, S.2)
(general to-draw (his) sword)

(34) Rising pitch on Tone 1.

a. 2 2 3 2 - | (1 = G 4/4)

b. yi.55 zhi.55 ji.214 (from L.3, S.1)
(one to-know self)

c. nan.35 tian.55 qi.214 (from L.3, S.2)
(southern sky to-rise)

Observe in (33) that the basic melody is given on the first line, and then locally adjusted for the last two syllables in Stanza 2. The note on /ba.35/ ‘to draw’ is shortened, to allow a sliding pitch on the Tone 4 word, /jian.51/ ‘sword’. Deliberate local adjustment of the melody to create a rising pitch on Tone 4, as in /jian.51/, is not limited to (33): it also occurs elsewhere in the six songs. Table (26) further shows that out of the 82 cases of Tone 4 syllables with sliding pitches, 33 are falling, and 34 are rising. The number of rising tones is very large. While some of the exceptions can accounted for by the permitted pairing with Tone 2 (/35/), cases such as (33) cannot be: although Tone 4 is paired with Tone 2, only the strategic word ‘sword’ is sung with rising pitch. It is significant that /de.35/ ‘to obtain’ is a rising tone in the modern tonal system of Mandarin. Nonetheless, it is deliberately excluded from the local melody adjustment and is sung with a level pitch. The rendition of ‘sword’ with pitch rise may be due to some influence from the Central pronunciation, where Tone 4 has a rising contour, /24/ or /424/, or to the more abstract Even/Oblique dichotomy where Tones 1 and 2 (Even tones) would have long or descending notes, while Tones 3 and 4 (Oblique tones) would have "quick changing or widely skipping notes" (Chao 1956:58). Rising pitch on Tone 4 would be compatible with either the classical Even/Oblique distinction, or the Peking opera tradition.

Other exceptions in table (26) are due to such factors as the accommodation of one tone versus another in tonally-mismatched sets, and the imposition of the melody on the lexical tone. By and large, there is greater accommodation of the lexical tones in the melody than might be expected in the six Mandarin songs, particularly as a result of complex pitch contours that permit mismatched tones to be incorporated into the melody. For these six Mandarin songs, although they were produced in recent years, there was some effort on the part of the songwriters to pay heed to the modern tones in composing the lyrics. To accommodate the different shapes of the lexical tones, the melody often inserted quick pitch changes, resulting in multidirectional pitch contours on single syllables. Nonetheless, unlike the Cantonese songs, even at slower tempos, the contour tones are frequently levelled out in the Mandarin songs.

There are even more crucial differences between the Cantonese and Mandarin songs. In Mandarin, the tendency is to allow the overall melody to dominate, as in (35), where a phrase containing a sequence of Tone 1 (/55/) syllables is sung with a wide, sweeping falling-rising-falling contour over the entire phrase, rather than the observance of the pitch on the individual syllables. (35) contains the first half of the opening lines for Stanzas 1 and 2 in "Zhi yin".

(35) Domination of overall melody over individual lexical tones.

a. 5 3 2	7.2 3 5	¦	3 2 - - - ¦	(1 = G 4/4)
b. shan.55 (mountain	qing.55 green		qing.55 green)	(L.1, S.1 & 2)

Thus, in Mandarin songs, word tones are often suspended in favour of the overall melody, with its greater concern for the undulations in pitch across words and phrases in a line. In order for a song to sound more melodious, both pitch contour and relative pitch height are regularly sacrificed. The subordination of relative pitch height is shown in (36), from "Zhi yin". The excerpt is the first half of Line 2 in Stanzas 1 and 2. Although the line begins with /gao.55/ 'high' and /shan.55/, the two syllables are sung at a relatively low pitch despite being high level tones in the phonology. In contrast, /liu.35/ 'flow' and /shui.214/ 'water' are sung at a higher pitch than /gao.55/ and /shan.55/ The effect, again, is a sweeping, falling-rising-falling contour over the entire phrase.

(36) Subordination of relative pitch height.

a. 1	1 7 6 0 4 ¦	3 ______	3 5 3 2 1 - ¦	(1 = G 4/4)
b. gao.55 (high	shan.55 mountain	liu.35 flow(ing)	shui.214 water)	(L.2, S.1 & 2)

In (37), from Line 6 of Stanzas 1 and 2 of "Zou xiang haiyang", the melody begins at mid low pitch and rises to a very high pitch at the preterminal syllable. The first syllable is held at mid level pitch. The discrepancy between melody and lexical tone is particularly striking in the high-mid (instead of low-high) sequence on the last two syllables of the two stanzas.

(37) Subordination of relative pitch height.

a.	2	2	3	4. ______	5	6 |	3 - | 3 - |
b.	ba.214 (take	chaun.35 boat	- er.0 (small)	hua.35 to-row	xiang.51 towards	yuan.214 faraway	- fang.55 place)
c.	rang.51 (let	ge.55 song	sheng.55 sound	fei.55 fly	bian.51 all-over	hai.214 seas	jiang.55 border)

3. Summary.

To summarize, the lyrics in the six Mandarin songs recently produced from China are not atonal in composition: some effort was made to compose with the lexical tones in mind. Furthermore, in putting the words to music, there was some effort on the part of the composers to "smuggle in" the lexical tones in the melody. Traces of the use of other tonal systems also appear in the tone-melody interaction. Ultimately, however, the most important consideration in the tone-melody interaction is the melody of the song. Pitch shapes and pitch heights were only preserved in the Mandarin songs if they harmonized with the melody; that is, if they could be accommodated without violating the melody.

The differences between the Cantonese and Mandarin songs in the tone-melody interaction are very striking. A crucial difference between Mandarin and Cantonese pertains to their respective tonal system. Cantonese has a system containing several different pitch heights for the level tones, and an upper and lower register for the contour tones. Hence, a careful selection of the words for the lyrics would enable the words to be sung to a melody already suggested by the sequence of word tones in the lyrics.

Mandarin, on the other hand, has only two basic oppositions in its tonal system: (1) high versus low (for Tone 1 (/55/) versus Tone 3 (/214/) -- in particular, the [21] variant), and (2) rising versus falling (for Tone 2 (/35/) versus Tone 4 (/51/). Without gradations in pitch changes, the preservation of the two oppositions would require a great deal of effort even in slow speech, since the shifts in pitch would be constant, and at the extreme ends. One finds, in fact, that the tones in Mandarin are highly modulated by intonation in spontaneous speech. For syllables produced in spontaneous speech, Tseng (1981:73), for example, found that, out of 361 full-toned syllables, only 145 of them (or 40.17%) were produced in which the phonetic values of the output correlated with the phonological prediction of what their phonetic values would be. For the majority of cases, sentence intonation had modulated the tones to the extent that they no longer possess the tonal values which they were expected to have.

To conclude, a parallel can be drawn in Mandarin between melody domination over word tones and the modulating effect of intonation on word tones. In both cases, it is the pitch pattern over units larger than the syllable that dominates. In Cantonese, the prediction would be that sentence intonation, similar to melody, would exert less influence on the word tones. Based on the study of the tone-melody interaction in the Cantonese songs, a further prediction is that greater constraints would exist to minimize the loss of relative pitch height.

Notes

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2. The phonetic value for some of the vowels are: aa = [A] (low central vowel), a = [ɐ] (except syllable-finally, where it is [A]), y = [y], and oe = [œ]. For the consonants, ng = [ŋ], and y =[y̌] in syllable-initial position before [y], and [i̭] elsewhere in syllable-initial position.

3. There are also some stanzas that have their own melodies, such as one finds in refrains in English songs. Within these stanzas, one sometimes finds adjacent lines sung to the same tune. These lines are also included in the study.

4. Only three cases can be found from a total of 248 sets. They all involve the pairing of /21/ with the Mid-level tone.

5. Vance (1977) treats these two tones as differing only in pitch level (mid-low versus low-low). Very low pitch, however, is not the primary acoustic cue for distinguishing tone /21/ from tone /22/, as his perceptual study reveals. (See Vance 1977 for details.) The proposal here is that the primary perceptual cue is the initial pitch drop in tone /21/.)

6. Special thanks go to Brian McHugh for his assistance. The main observation to be made concerning Figure 3 is the maintenance of the relative pitch levels.

7. A total of about 35 sets contain neutral-toned syllables. Since at least one member of these sets lack their own, inherent tone, none of these sets are taken into considertion in determining the number of sets with potentially mismatched tones. Only a rough figure is intended for the neutral-toned syllables, since many Mandarin words contain syllables which are optionally in the neutral tone.

The total of 278 sets do not include the short opening stanza in two of the songs where the first and second lines are identical.

8. See Gandour (1983) for details on the specific threshold levels at which various tonal stimuli are clustered together in his hierarchical clustering analysis. For our purposes, the general observations concerning similarities between tones reflected in the clustering will suffice.

9. As noted in footnote 7, the opening stanza in two of the songs contain two lines which are identical. The syllables in the first line are included in the total count of 602 full-toned syllables.

10. The analysis of the Mandarin songs pertains to the interaction of the lexical tones and the melody as written by the composer. However, there is still a third dimension in the study of the tone-melody interaction in Mandarin which will not be dealt with here, namely, the singer, who may introduce a grace note in the singing of a particular syllable that is not indicated on the music sheet. Chao (1956:57) makes the following comment with respect to tonal compositions:

> "Since ... much of Chinese music is written without indication of embellishments, the singer is allowed and expected, within limits of good and bad taste, to introduce grace notes of his own to the main melody. Some of the grace notes follow conventional musical usage, such as free addition of a note by way of an echappee. Others are added in order to "smuggle in" the tone, if not already suggested in the main melody. The effect of smuggling in the tones is that of clearer "diction" (in the singing-lesson sense), since phonemic tone is part of the constituent elements of the words."

Chao (1960:14), however, cautions that such grace notes can only be added in appropriate places and cannot be used everywhere. Hence, for those without much musical knowledge or experience, he recommends that they follow strictly the notes on the music sheets.

As an added note of interest, Chao (1960) states that grace notes are used more frequently in Chinese music, and are, moreover, sung more quickly and less precise in their pitch than in Western music. These factors contribute to giving a distinctive flavour to the Chinese songs.

Bibliography

Bright, William. (1955-1956). "Singing in Lushai." Indian Linguistics 17: 24-28.

Catlin, Amy. (1982). "Speech Surrogate Systems of the Hmong: From Singing Voices to Talking Reeds." In: The Hmong in the West: Observations and Reports. Edited by Bruce T. Downing and Douglas P. Olney. Minneapolis: Southeast Asian Refugee Studies Project, Center for Urban and Regional Affairs, University of Minnesota.

Chan, Marjorie K.M. (1987). "Tone and Melody in Cantonese." Proceedings of the Thirteenth Annual Meeting of the Berkeley Linguistics Society. Pages 26-37.

Chao, Jung-lang. (1968-1969). "The Phonological System of the Language in Peking Opera." Unicorn 3: 15-28.

Chao, Yuen Ren. (1956). "Tone, Intonation, Singsong, Chanting, Recitative, Tonal Composition, and Atonal Composition in Chinese." In: For Roban Jakobson: Essays on the Occasion of His Sixtieth Birthday. Edited by

Morris Halle et al. The Hague: Mouton and Co. Pages 52-59.

Chao, Yuen Ren. (1960). Xin Shige Ji. [A collection of new poems and songs] Second edition. Taipei: Shangwu Yinshuguan.

__________. (1968). A Grammar of Spoken Chinese. Berkeley: University of California Press.

Connell, Bruce A., John T. Hogan and Anton J. Rozsypal. (1983). "Experimental Evidence of Interaction between Tone and Intonation in Mandarin Chinese." Journal of Phonetics 11:337-351.

Deepuengton, Pawadee. (1985). "Distortion of Tones in Thai Country Songs." Aksornsart Niphon 4: Studies in Linguistics. (English abstract.)

Gandour, Jack. (1981). "Perceptual Dimensions of Tone: Evidence from Cantonese." Journal of Chinese Linguistics 9.1:20-36.

__________. (1983). "Tone Perception in Far Eastern Languages." Journal of Phonetics 11:149-175.

__________. (1984). "Tone Dissimilarity Judgments by Chinese Listeners." Journal of Chinese Linguistics 12.2:235-261.

Huyi "Gequ Xiezuo Wenda" Compilers. (1977). Gequ Xiezuo Wenda. [Song-writing questions and answers] (No Place): Hubei Renmin Chubanshe.

Kratochvil, Paul. (1968). The Chinese Language Today. London: Hutchinson and Co., Ltd.

Kwok, Helen and K.K. Luke. (1986). "Intonation in Cantonese: A Preliminary Study." Paper presented at the XIXth International Conference on Sino-Tibetan Languages and Linguistics, Ohio State University.

Leben, William R. (1983). "On the Correspondence between Linguistic Tone and Musical Melody." Proceedings of the Ninth Annual Meeting of the Berkeley Linguistics Society. Pages 148-154.

List, George. (1972). "Speech Melody and Song Melody in Central Thai." In: Intonation: Selected Readings. Edited by Dwight Bolinger. London: Penguin Books Ltd.

Liu, Yizhi. (1968). Guo Le Qian Shuo. [A short description of national music] (= Guo Le Lu Liang, Volume 1) Taipei: Da Zhongguo Tushu Gongsi.

Randel, Don Michael. (1978). Harvard Concise Dictionary of Music. Cambridge: The Belknap Press of Harvard University Press.

Su, Xue'an. (1963). Beiju Shengyun. [Peking opera tones and rhymes] Shanghai: Shanghai Wenyi Chubanshe.

Tse, John Kwock-Ping. (1978). The Upper Even Tone in Cantonese: An Instrumental Investigation. Taipei: Taiwan. (Wenhua Jijinhui Yanjiu Lunwen, Number 342).

Tseng, Chiu-yu. (1981). An Acoustic Phonetic Study on Tones in Mandarin Chinese. Ph.D. Dissertation, Brown University.

Vance, Timothy J. (1976). "An Experimental Investigation of Tone and Intonation in Cantonese." Phonetica 33:368-392.

__________. (1977). "Tonal Distinctions in Cantonese." Phonetica 34:931-107.

Wang, Jingyi and Hongwe Liao (Compilers). (1984). Shi San Ren Yanchang Dianying Gequ Jijin. [Choice collection of movie songs sung (and performed) by thirteen people] Beijing: Zhongguo Dianying Chubanshe.

Wu, Zongji. (1982). "Putonghua Yujuzhongde Shengdiao Bianhua." [Tone Sandhi in Connected Speech in Putonghua] Zhongguo Yuwen (1982) 6:439-450.

Xu, Muyun and Jiaheng Huang. (1963). Beiju Ziyun. [Peking opera words and rhymes] Shanghai: Shanghai Wenyi Chubanshe.

Yuan, Jian Hua et al. (1983). Hanyu Fangyan Gaiyao. [Outline of Chinese Dialects] Second Edition. Beijing: Wenzi Gaige Chubanshe.

Appendix A: Tonal Matching of the 140 Sets

ZY = Zhi Yin
Z = Zou Xiang Haiyang
Y = Yinsede Yueguan
N = Nansu Xiangsi*
M = Mudanzhi Ge
R = Renjiade Chuan*
(*Song with three-member sets.)

T1 = Tone 1 T2 = Tone 2 T3 = Tone 3 T4 = Tone 4

Tonal Matching	ZY	Z	Y	N	M	R	Total
T1 - T2	1	6	7	10	4	2	30
T1 - T3	1	1	2	0	3	1	8
T1 - T4	2	5	12	8	2	2	31
T2 - T3	1	3	1	2	1	1	9
T2 - T4	4	7	6	3	4	2	26
T3 - T4	0	6	0	7	0	4	17
T1 - T2 - T4	-	-	-	4	-	4	8
T1 - T3 - T4	-	-	-	3	-	0	3
T2 - T3 - T4	-	-	-	4	-	2	6
Total	9	28	28	42	14	19	140

Appendix B:
Pitch Contours of the 602 Full-Toned Syllables in the Melody

ZY = Zhi Yin
Z = Zou Xiang Haiyang
Y = Yinsede Yueguan

N = Nansu Xiangsi*
M = Mudan Zhi Ge
R = Renjiade Chuan*
(*Song with three-member sets.)

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L = Level pitch
F = Falling pitch

R = Rising pitch
FR/RF = Falling-rising, or rising falling pitch, or multidirectional pitch changes

Tone Class	Pitch	ZY	Z	Y	N	M	R	Total
Tone 1	L	9	24	20	22	27	9	111
/55/	F	6	2	15	6	2	2	33
	R	6	4	2	15	0	5	32
	FR/RF	3	1	0	9	2	0	15
Tone 2	L	8	17	8	15	6	14	68
/35/	F	2	1	6	7	0	1	17
	R	3	1	1	8	6	4	23
	FR/RF	3	1	3	7	4	1	19
Tone 3	L	2	3	1	3	1	2	12
[214],	F	0	0	0	0	1	0	1
[35]	R	1	0	0	11	4	7	23
	FR/RF	3	0	0	2	5	1	11
Tone 3	L	1	17	7	4	15	3	47
[21]	F	0	0	0	3	1	2	6
	R	0	4	0	0	0	0	4
	FR/RF	0	0	0	0	0	0	0
Tone 4	L	2	31	23	16	18	8	94
/51/	F	8	0	10	2	8	5	33
	R	3	2	3	13	4	9	34
	FR/RF	6	0	2	4	1	2	15
Total		66	108	101	147	105	75	602

Voicing Assimilation across Word Boundaries in Russian

Rebecca Wells

Though handbooks of Russian phonetics such as Avanesov's Русское литературное произношение (1968) and Halle's Sound Patterns of Russian (1971) indicate that Russian obstruents undergo regressive voicing assimilation within words (i.e. pros'ba > [próz'ba], lodka > [lótka])[fn], little or nothing is said about tendencies toward voicing assimilation across word boundaries. Avanesov ignores the situation completely, but the transcriptions of texts in the back of his book imply that voicing assimilation does not occur across word boundaries, since none of the potentially voiced clusters are transcribed as voiced. Thus he transcribes "belyx gusej" as [b'élyx gus'ej] and "migajut zvezdy" as [m'igájut zv'ózdy] (Avanesov 1968: 228). Halle attempts a discussion of the question in relationship to his concept of the "phonemic phrase boundary," which corresponds to his syntactic units of noun phrase, verb phrase etc..., but he too hints that little assimilation occurs across word boundaries.

> At the end of a phonemic phrase, where a pause is admissible in the utterance, only voiceless obstruents can occur. For this reason in a slow, solemn style of speech, where there is a tendency to treat every accented word as a separate phonemic phrase and hence to pause between words, there is also a tendency to unvoice all obstruents before the word boundary. Before enclitics and after proclitics, and in sequences of words in close contact, like {kn'áz' bor'ís} "Prince Boris," where a phonemic phrase boundary is not admitted, this phenomenon does not occur. (Halle 1971: 64)

Halle's rule seems correct if we change the wording slightly, and if we develop a broader concept of phonemic phrase, which might eventually be partly defined by the presence or absence of voicing assimilation. We might say instead that devoicing of obstruents occurs not everywhere that a pause in the utterance is "admissible," as Halle states but only where a pause "occurs." Halle's rule would imply that even if a pause did not occur, if a pause was admissible, devoicing would occur. I offer the new hypothesis that assimilation will occur across word boundaries unless there is a pause between words. I further hypothesize that the likelihood of a pause will be correlated with the semantics and syntax of the juxtaposed words. I report here on an experiment I performed to test this hypothesis.

The experiment is narrowly focused on verbal collocations with adverbs, subjects, and non-nominative complements commonly associated with a given verb. I will refer to them here as VCs, or verbal complements. My specific hypothesis was that voicing assimilation would follow two hierarchies, one correlated with inherent semantic content, the other related to the strength of the syntactic boundaries. Assimilation would be more likely for verbs with less semantic content, and across weaker syntactic boundaries (i.e. VC > Adv. > Subj.) I had no hopes for a clean, neat hierarchy, as I suspected that voicing assimilation could occur across all of these boundaries.

To test my hypothesis I devised a questionnaire of twenty-eight sentences which was read by four native speakers of Russian. Recordings were made of each speaker and spectrograms were run for each token of potential voicing assimilation. The questionnaire attempted to compare a range of verbs, from semantically weak to semantically richer verbs. The 8 verbs compared in all three collocations (+VC, +adverb, +subject) were: byt' 'to be', stat' 'to become, begin', vozvraščat' 'to return', iskat' 'to look for', videt' 'to see', rabotat' 'to work', jexat' 'to ride', prevraščat' 'to turn into'. The phonetic environment was held fairly constant. The syllable before the obstruent cluster was unstressed and in most sentences the syllable following the cluster was stressed. This word also received sentential stress. The only cluster tested was /td/, except for a few sentences with an intervening preposition, which were included only as a matter of peripheral curiosity. I suspect that factors of stress location and the nature of segments involved in assimilation would have affected my results, and further experiments might test these effects.

Before reading the sentences speakers were asked to read a paragraph from one of the texts transcribed by Avanesov, both as a warm-up and to test some of the spots where voicing assimilation is not indicated by Avanesov's transcriptions, but where it might have occurred. The questionnaire, as well as Avanesov's transcription of the passage, are included as Appendix I.

Speakers were instructed to read clearly and carefully, but at a normal, conversational speed. All of them read fairly deliberately, especially speakers S and G. The speakers themselves were of varied backgrounds. M and S completed university work in Leningrad, spent several years in Israel and are now graduate students in the U.S. They both prefer to speak almost exclusively Russian. G grew up and completed her education in Lithuania, but she is Russian and prefers to speak Russian, though her English is good. V is from Armenia, but of Russian descent. Though she speaks Russian at home, her English is native and she prefers to use it. All of the speakers were female.

I have summarized the results of my recordings and the subsequent analysis of spectrograms in Table 1.

Table 1--% voiced tokens

		boundary strength →			
		Adv.	VC	Subj.	total
semantic strength ↓	budet	100.0	87.5	87.5	92.0
	stanet	87.5	100.0	83.3	90.0
	iščet	87.5	75.0	100.0	87.5
	vozvraščaet	100.0	62.5	83.3	82.0
	vidit	100.0	75.0	66.7	81.0
	rabotaet	100.0	66.7	75.0	81.0
	jedet	66.7	100.0	50.0	72.0
	prevraščaet	66.7	83.3	66.7	72.0
	total	88.0	82.0	76.0	

The table gives percentage figures for the number of voiced tokens for a given collocation in relation to the total number of tokens for that collocation. Segments which I analyzed as partially voiced counted as half of a voiced token in my calculations. I will, however, leave the discussion of partial voicing assimilation for later. To test my proposed hierarchy I totalled the percentages for each verb and for each of the various verbal collocations. As we see from the chart, voicing assimilation can occur across any of the given boundaries. Because it could and did occur so frequently, my results give little conclusive evidence for the semantic and syntactic hierarchies I proposed. No one speaker observed these hierarchies, but the total percent of assimilations for each verb and for each of the three types of collocations reveals that the hierarchy may exist. Certainly, semantically weaker verbs seem to be more likely to allow voicing assimilation, and verb-subject collocations seem less likely than other collocations to permit assimilation. I hesitate to go any further in specifying the hierarchy, since many of the numbers are very close and based on such few tokens that a fifth speaker might change things drastically. If the hierarchy is to be confirmed and further specified, many more speakers need to be recorded and they should probably read each sentence more than once, in order to establish some degree of consistency.

Though the passage from Avanesov does not relate to my specific hypothesis, it does contribute to the overall evidence for voicing assimilation across word boundaries. The results from this passage are recorded in Table 2.

Table 2--voicing assimilation in Avanesov passage

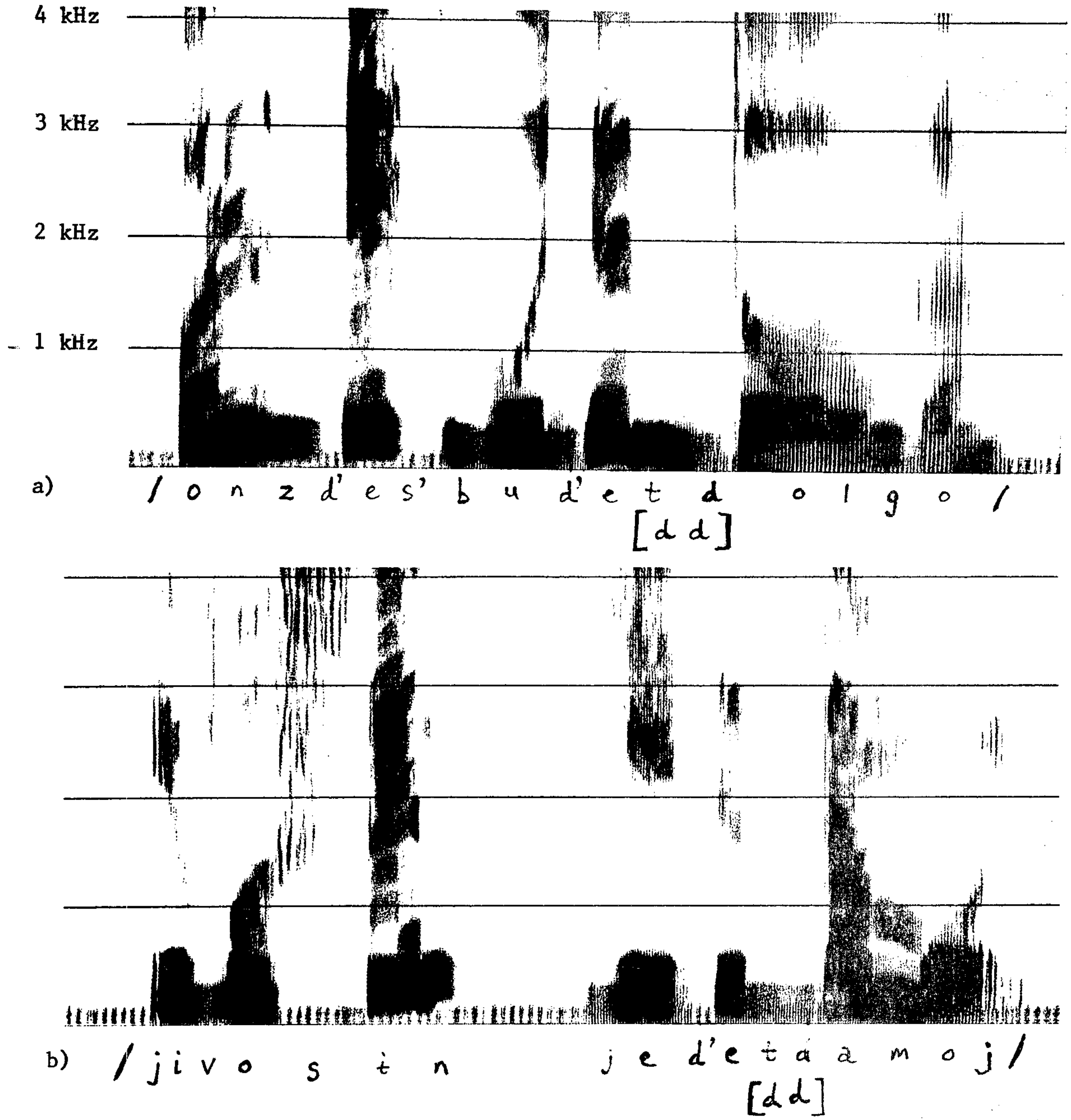
	speaker			
	M	S	G	V
a. "grandioznyx zadač"	+	+	+	+
b. "glavnejšix zadač"	+	+	+	+
c. "cennost' dorevoljucionnyx"	+	-	-	-
d. "služit' dal'nejšemu"	+	-	+	±

A plus indicates assimilation by the given speaker, and a minus indicates lack of assimilation. The ± indicates partial assimilation. The tendency toward assimilation appears hierarchized here as in the questionnaire. Within the noun phrases "glavnejšix zadač" and "grandioznyx zadač" everyone assimilated /xz/ > [ɣz]. The other two collocations were less likely to assimilate. The first, a noun + its genitive modifier, had extra phonetic factors inhibiting assimilation, since assimilation of a palatalized cluster /st'/ was in question. The second, an infinitive verb + its dative complement, seems to have been more likely to allow some assimilation. Speaker S, who did not assimilate this cluster, read the sentence with a phrase break between the two words. Having speakers read an extended passage of this nature indicated that perhaps the isolated sentences of the questionnaire, which were very simple, both grammatically and intonationally, were not true indications of a speaker's reflexes in a discourse situation. The passage also illustrated the variety of syntactic collocations which might be looked at in further experiments.

Avanesov's own transcriptions of these passages at first appear to display inattention to the problem of voicing assimilation across word boundaries, but my own experience in listening to these tapes leads me to believe that his transcriptions of these clusters may be indicative of discrepancies between perception and acoustic measurement. Without measurements it was extremely difficult to detect whether or not there was voicing assimilation in these clusters. A related experiment might compare speakers' perceptions to these measurements.

In both sections of this experiment we have seen support for the intuition that voicing assimilation has a much wider scope than the word-internal one implied by Avanesov. We have, however, certainly not seen the limits of this scope. We have seen weak support for a correlation between semantic power in the verb and lack of assimilation. The syntactic structure of the phrase also seems to encourage or discourage voicing assimilation, with verb-subject collocations definitely discouraging it more than VC and adverb juxtapositions. Further experiments with more speakers reading at varied tempos, more complicated utterances, and a wider variety of syntactic groupings need to be done before any true conclusion can be reached about my more general hypothesis that voicing assimilation across word boundaries is dependent on the syntax and semantics of the juxtaposed words. If this question of voicing assimilation can be answered, we can begin to redefine terms such as Halle's "phonemic phrase boundary," and begin to talk about a hierarchy of such boundaries.

Some of my measurements also indicate that the nature of voicing assimilation itself may need to be re-examined. Earlier I mentioned cases of <u>partial</u> voicing assimilation, a problematic term for the system of binary features (i.e. + voice vs. - voice) that we usually work with. If we look at the spectrograms in figures 1, 2, 3, and 4 we see that the plus or minus voicing distinction is not always clear. For the majority of cases, where full voicing assimilation obtained, the facts were clear. Figure 1 shows various examples of full voicing by various speakers. Note that the voicing band continues through the one long closure



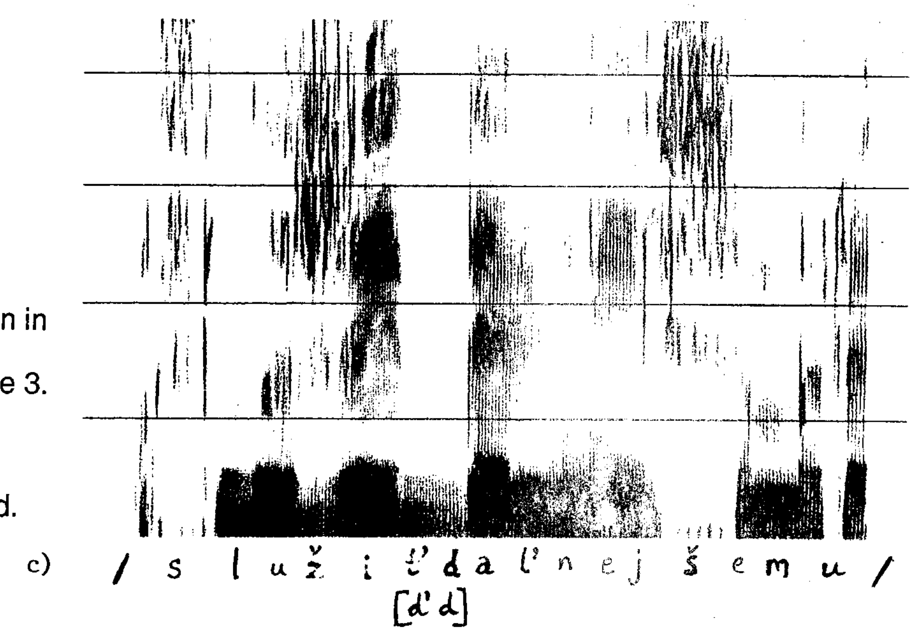


Figure 1.

Examples of full voicing assimilation in cluster /td/. a) Speaker G, sentence 3. b) Speaker S, sentence 20. c) Speaker M, Avenesov text, item d.

formed by the /td/ cluster. Figure 2 illustrates a complete lack of voicing assimilation. Such examples were very uncommon, and usually accompanied by a long pause between the two words. Figure 3 is the surprising one. It shows varying degrees of voicing assimilation, none of which clearly fall into the category of + voiced or - voiced. Such cases were far less frequent than those of complete assimilation, but more common than those with an absolute lack of assimilation. In these cases some sort of interruption of the air flow causes attenuation or even an interruption in the voicing assimilation, which we see as a decrease in intensity or a break in the voicing band. Such attenuation, or possibly interruption, also occurred in in cases like Figure 4, where there was an intervening preposition /s/. The consistency exhibited across speakers in these two examples indicates that such gaps in voicing assimilation may be a regular phenomenon.

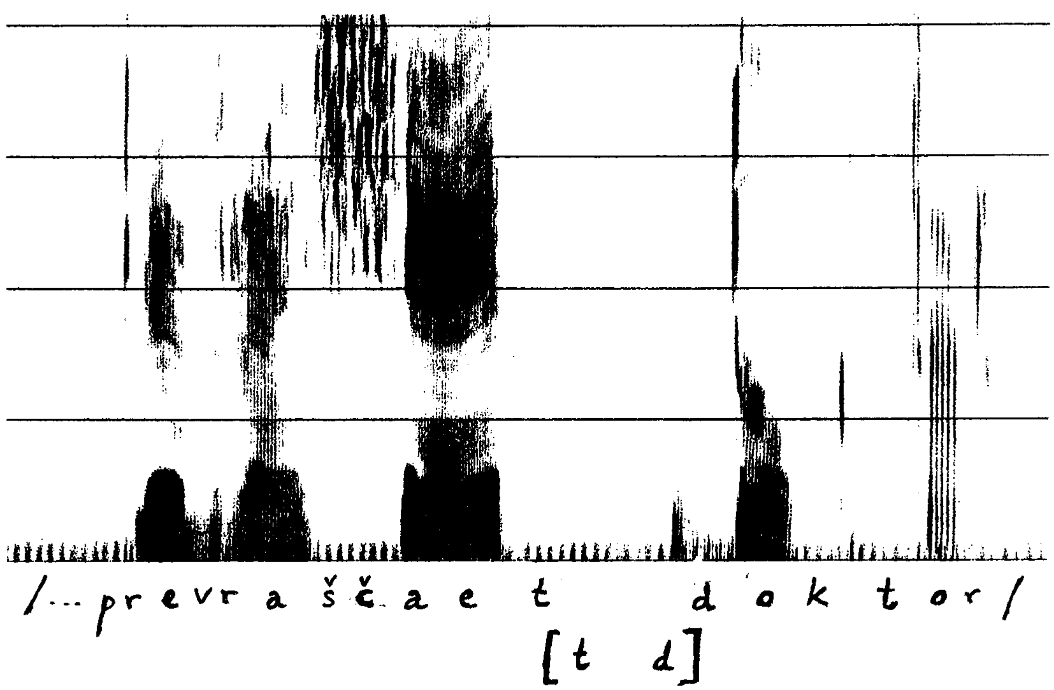


Figure 2. Absence of voicing assimilation. Speaker S, sentence 28.

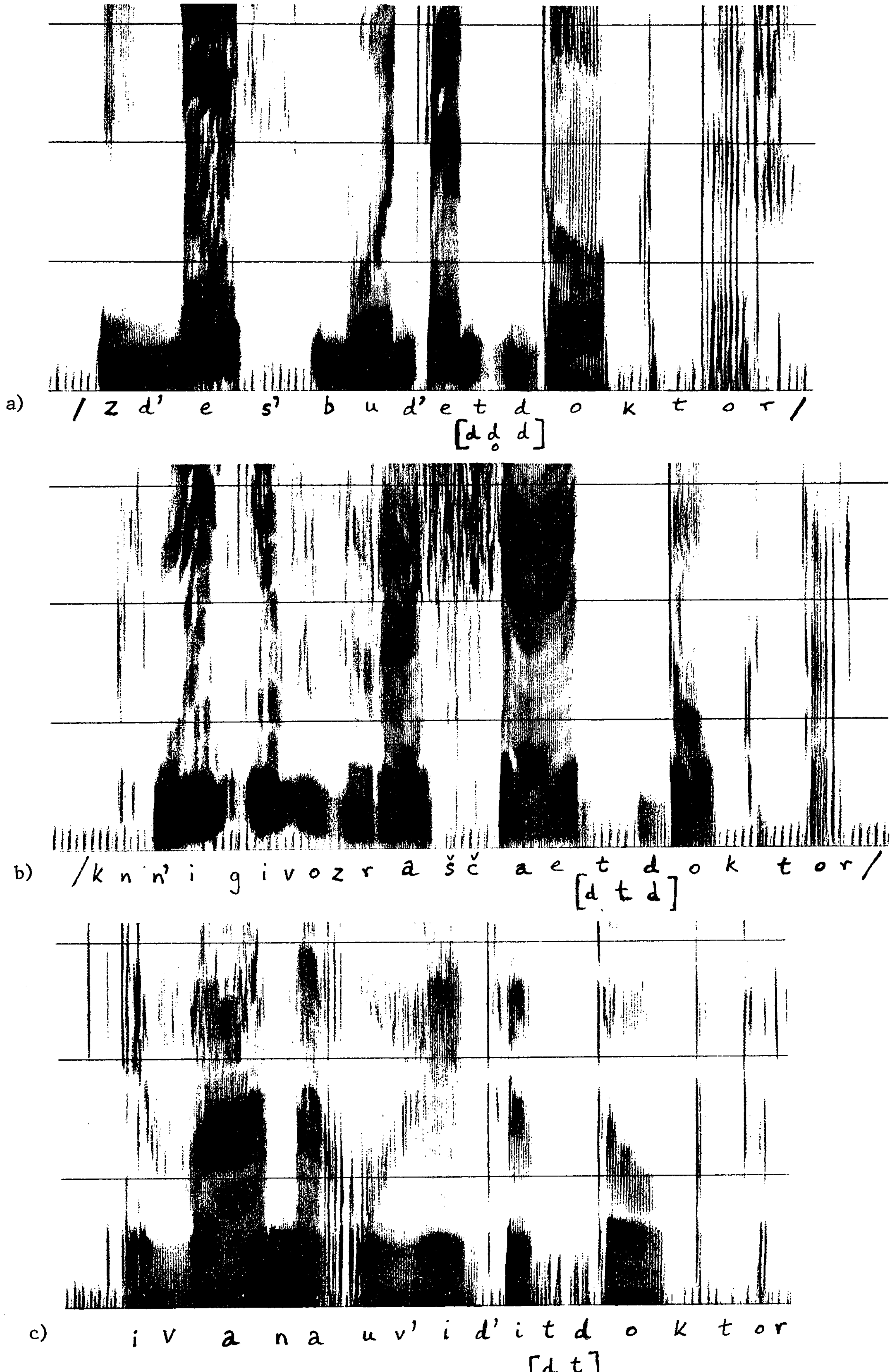
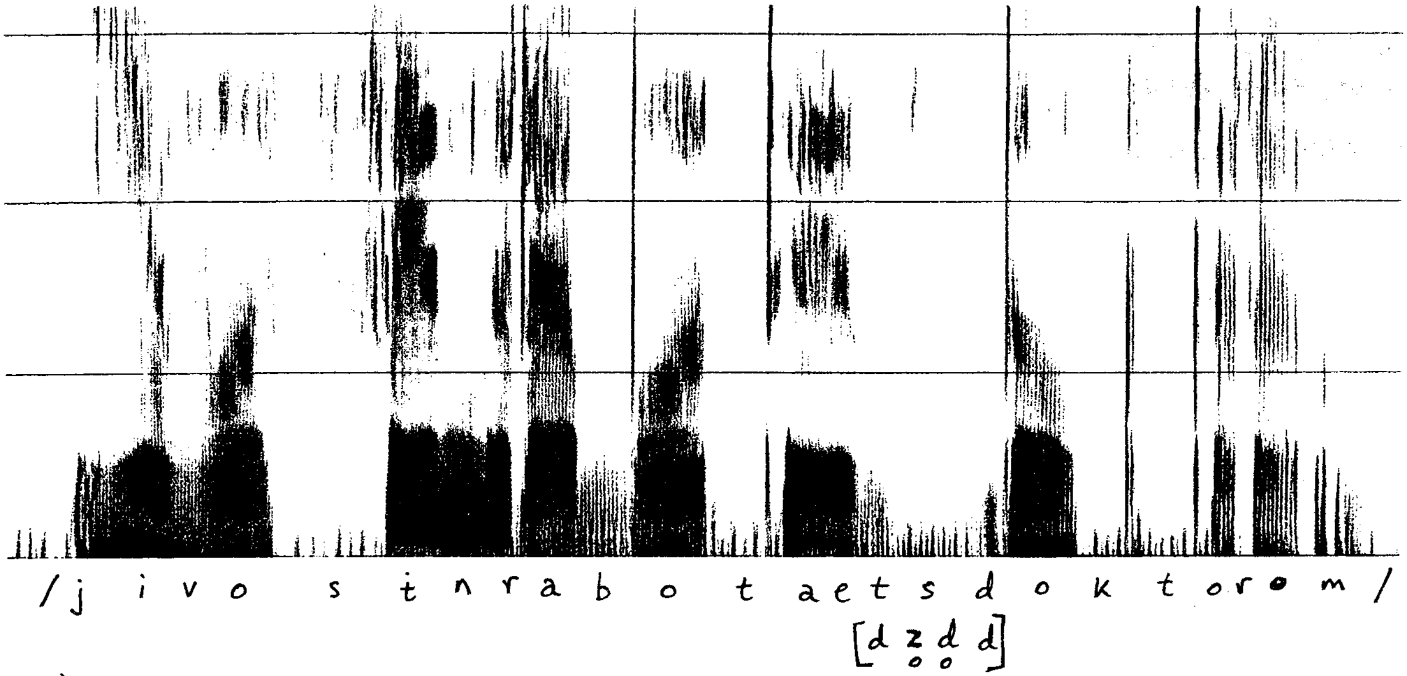


Figure 3. Partial or weakened voicing in cluster /td/. Attenuated voicing is transcribed [d̥]. a) Speaker G, sentence 4. b) Speaker S, sentence 19. c) Speaker M, sentence 26.



a)

b)

Figure 4. Partial or weakened voicing in cluster /tsd/. a) Speaker M, sentence 15. b) Speaker S, sentence 15.

Such voicing assimilation cannot be considered as strong as that in the first examples of full assimilation, but it is definitely present. The attenuation and resumption of voicing acts as an intermediary type of boundary marker, something in between full assimilation with a single closure and no assimilation with a lengthy pause. In a more detailed examination of phonemic phrase boundaries a graduated concept of voicing assimilation needs to be incorporated when defining a hierarchy of these boundaries.

The nature of these gradations in voicing assimilation, that is, voicing, an attenuation, and a resumption of voicing, may also have theoretical implications for our understanding of the voicing assimilation process. If the assimilation can be interrupted and resumed, a purely mechanical explanation for the assimilation becomes inadequate. The speaker must possess some conception of a voicing assimilation rule which allows him to assimilate voicing even across a gap. That more general question is far beyond the scope of this paper, but the evidence here does give us reason to re-examine the model.

References

Avanesov, R. I. (1968) Русское литературное произношение. Москва: Изд. Просвещение.

Halle, M. (1971) The Sound Pattern of Russian. The Hague: Mouton.

Footnote
Palatalized consonants are indicated in the usual manner in Russian studies, that is, by an appostrophe after the consonant symbol (b' l' s' etc). Stress placement is indicated by an acute accent on the stressed vowel.

1. Его сын будет доктором.
2. Он станет доктором.
3. Он здесь будет долго.
4. Здесь будет доктор.
5. Он станет долго учиться.
6. Его сын имеет дом.
7. В поликлинике работает доктор.
8. Он эти доллары ищет дольше, чем следует.
9. Его сын видит доктора.
10. Он ищет долларов.
11. Долго едет доктор.
12. Его сын возвращает доктора в поликлинику.
13. Деньги ищет доктор.
14. Ведьма превращает доктора в лягушку.
15. Его сын работает с доктором.
16. Он уже туда едет долго.
17. Ведьма превращает в доктора лягушку.
18. Он работает дома.
19. Книги возвращает доктор.
20. Его сын едет домой.
21. Ведьма детей в лягушек превращает долго.
22. Его сын едет к доктору.
23. Он доктора возвращает домой.
24. Врачом станет Даша.
25. Деньги ищет доктор.
26. Ивана увидит доктор.
27. Он видит дальше, чем его мама.
28. Больного в здорового превращает доктор.

О языке

В числе **a.** грандиозных задач создания новой, социалистической культуры пред нами поставлена и задача организации языка, очищения его от паразитивного хлама. Именно к этому сводится одна из **b.** главнейших задач нашей советской литературы. Неоспоримая **c.** ценность дореволюционной литературы в том, что, начиная с Пушкина, наши классики отобрали из речевого хаоса наиболее точные, яркие, веские слова и создали тот «великий и прекрасный язык», **d.** служить дальнейшему развитию которого Тургенев умолял Льва Толстого. Не надо забывать, что наша страна разноязычна неизмеримо более, чем любая из стран Европы, и что, разноязычная по языкам, она должна быть идеологически единой.

ф-ч'ис'л'é грън'д'и·ózных зʌдá·ч' сʌздá·н'иḭъ [1] нóвъḭ / съцыал'ис'т'ӣч'ъскъḭ [2] кул'тýры / пр'и^ед-нá·м'и пʌстáвл'ьнъ и зʌдá·ч'ъ ʌргън'изáцыи ḭьзыкá [3] / ʌч'иш':ён'иḭъ [4]-ḭьгó [5] ʌт-пъ-ръз'ит'ӣвнъвъ хлáмъ // ӣм'ьн:ъ к-э́тъму [6] свó·д'и^тцъ ʌднá-из-глʌвн'ёḭшых зʌдá·ч' нáшъḭ сʌв'éцкъḭ л'ит'ьрʌтýры // н'ьʌс-пʌр'ӣмъḭъ цэ́н:ъс'т' дър'ьвъл'ÿцыóн:ъḭ [7] л'ит'ьрʌтýры ф-тóм / штъ [8]-нъч'инá·ḭъ с-пýшк'инъ / нáшы клá·с'ик'и ʌтʌбрá·л'и из-р'ьч'и^евóвъ хáосъ / нъибó·л'ьḭь [9]-тó·ч'ныи [10] / j·áрк'ии [10] / в'éск'ии [10] слʌвá и-сóздъл'и тóт в'и^ел'ӣкъḭ [11] и пр'и^екрáснъḭ [12] ḭи^езы́к [13] / служы́·т' дʌл'н'ёḭшъму рʌз'в'ӣт'иḭ·у [14] кʌтóръвъ / тург'éн'ьф умʌл'·áл л'вá тʌлстóвъ // н'и^е-нáдъ зъбывáт' / штъ-нáшъ [15] стрʌнá ръзнъḭи^езы́·ч'нъ н'ьиз'м'и^ер'ӣмъ бó·л'ьḭь [16] / ч'ьм-л'ÿбá·ḭъ ис-стрáн ḭи^еврóпы [17] / и-штъ-ръзнъḭи^езы́·ч'нъḭъ пъ-ḭьзыкáм / ʌнá дʌлжнá-быт' идьълʌ-г'ӣч'ьск'и [18] ḭи^ед'ӣнъḭ ///