

CHAPTER 4. SEGMENTAL PHONOLOGY AND PHONETICS

4.1. Introduction

What are you trying to figure out when you begin to analyse the segments of a language's sound structure? Not everyone who sets out to study segmental phonology in a field situation has the same objectives. One person might study the segmental phonology so that they can have a consistent system for representing language data for research on other aspects of the grammar. Another might study the segmental phonology in order to help develop a literacy program with a particular community. Or one might study the segmental phonology because they are a phonologist or otherwise interested in theoretical issues of sound structure. No matter what one's overall objectives are, it is vital that they do a good job and that results be backed-up by high-quality digital sound files so that the analysis can in principle be replicated, without the need, insofar as possible, for additional field trips. The analysis of the segmental phonology of the fieldwork language should accomplish the following:

- I. Provide an explicit, clear account of the phonetics (contrast, variation, and make-up) and distribution of all sounds of the language.
- II. Offer a clear statement of the *phonemes* (or *distinctive segments*) of the language, with supporting analysis and data.
- III. Discuss or point out any typologically unusual or theoretically noteworthy characteristics

In my experience, phonology is usually the least developed portion of descriptive grammars. This is due to several reasons. First and most significant, perhaps, is that most linguists are interested in morphosyntax and semantics and many (wrongly) view phonology as unconnected to those goals or as inherently less interesting (see the next chapter on prosody for an effective refutation of that idea). Another reason is that field phonology requires a well-developed skill, namely, phonetic ability, i.e. ability to both produce and recognize sounds of languages in field situations, in particular well-developed auditory discernment. Field phonologists must have good ears. Instruments, while necessary, are not sufficient. Ears are necessary and nearly sufficient (but not quite).

But all linguists can do high-quality field phonology. They can *develop* their ears and use acoustic analysis as an aid (and much more!). The purpose of this chapter is to help the field linguist provide his or her colleagues with a useful, convincing, and testable analysis of the segmental phonology of the language under investigation.

4.2. THE PHONEME

A phoneme is a set of sounds that speakers hear as the same sound for reasons of grammar. Because it is a set of sounds, a phoneme is, properly speaking, never heard.²²

²² In the late 1980s I was asked to visit a newly arrived linguist who was working on a language in the state of Amazonas, Brazil, to help him get started on analysis of the language he wanted to work on. So I flew to the nearest airstrip and then, with an Indian guide, hiked about 8 hours through swamps (walking through water up to my chest), over logs, up and down the banks of many streams, with 'cut grass', thorns, bugs, etc. plaguing me along the way (plus an impatient guide who could not believe how

At one time, many linguists likely thought that generative phonology (Chomsky and Halle (1968, ---)) had done away with phonemes. But as researchers in Lexical Phonology (see Mohanan ()) pointed out, the phoneme, or something like it, needs to be retained in phonological theories for at least two reasons. First, native speakers have intuitions of phonemes. Second, phonemes are theoretically significant (in some theories) and practically important in orthography design. In Lexical Phonology (Mohanen ()), for example, the output of the lexical rules is roughly equivalent to a pre-generative phonemic representation. Also, discussing the segmental phonology in terms of phonemic analyses is perhaps a more theory-neutral way of presenting research (though still problematic, see ____).

On the other hand, there is no standard terminology or theory that a field linguist should feel obliged to conform to except that which produces quality and clarity of analysis and presentation. Finding generalizations and understanding the system, whether as rules, constraints, principles, or all three, is what the field linguist is after. Phonemic analysis is just one way of getting at this goal.

The field linguist should, however, be aware that his or her phonemic analysis has ethical and political, as well as scientific implications, especially if it turns out to be the first graphic representation of the language. This is too often overlooked. Entering a community as a linguist will, in many communities, mean that some see you as an expert whose work should be taken seriously. So as you conduct your phonological analysis many are likely to take your proposals more seriously than you might have imagined. To give an example of a problem and how it might develop, let's say that in your early efforts you confuse a morphophonemic rule with a phonemic rule. This could have serious implications for the community. To see how, consider the hypothetical analysis of English nasals, beginning with the facts in () and ():

- (4.1) a. It is pink. [p^hiŋk]
 b. I want a pint. [p^haⁱnt]
 c. He is a pimple. [p^himpL]
- (4.2) a. It is inconceivable. [...ŋk...]
 b. It is intolerable. [...nt...]
 c. It is impossible. [...mp...]
 d. It is illegible. [...ll...]
 e. It is inordinate. [...n...]
 f. It is unrealis. [...rr...]

slow I was or how frequently I fell down). Arriving in the village where the linguist was beginning work, we began to discuss the language. 'How is the phonology coming?' I asked. 'Nothing to it', came the answer. 'Why is it so easy?', I asked skeptically. 'Oh, because you can *hear* the phonemes' came the answer. This person was a friend so I did not strangle him and toss him out in the swamp for the wildlife. I realized that this person who had made it into a good graduate program and had come this far, was in need of remedial phonology instruction. You cannot hear analyses; you cannot hear phonemes; you cannot even hear allophones until after you have done an analysis. I may strangle the next person, though, who tells me this. I am older now and less patient.

The linguist will notice from examples like () that nasals and following obstruents are homorganic, i.e. that they share the same place of articulation. And the same is apparently true of the examples in ().

Now let us further assume that the linguist has found, say by minimal pairs or near-minimal pairs (see ____) like those in (), that the nasals in question are separate phonemes:

- (4.3) a. sing [siŋ] (at least in my Southern California dialect)
 b. sim [sim] (as in 'my phone needs a new SIM card)
 c. sin [sin]

- (4.4) a. mother
 b. nother (as in, 'Nother?')
 c. --- (no word-initial /ŋ/ in English)

Based on (4.3) and (4.4), the linguist is reasonably sure that the nasals are each separate phonemes. Then, based on these facts, they could, wrongly, conclude, wrongly, that when immediately preceding an obstruent, the place of articulation contrast between nasals is neutralized. One might propose a rule along the lines of ():

(4.5)

	+nasal	→	[βplace]/	_____ -sonorant
	αplace			βplace

But this would be wrong, problematic, and misleading. It would predict that there is only one kind of underlying representation and only one phonological process involved. To see why this is mistaken, compare the examples in () and ():

- (4.6) a. unobtrusive
 b. unreal (cf. *urreal)
 c. unpopular (cf. ?/*umpopular)
 d. untouchable
 e. unkillable (cf. ?/*unkillable)

If rule () is correct, why does it fail to apply to the examples in ()? Well, it doesn't apply to () because it is incomplete. There are two 'neutralization' processes for nasals in English. The first is a constraint on nasal + obstruent sequences within morphemes and the other is a constraint on nasal + obstruent sequences across only a certain set of morpheme boundaries (or alternatively, only affecting certain morphemes, e.g. {in-}, but not {un-}).

It is true that the linguist could fix the initial bad analysis on their next visit (see ____ on morphophonemic analysis). What is the big deal? Just how could this possible become an *ethical* problem?

The latter could arise if the linguist presented his or her analysis to the community too hastily and, if consequently, orthographic decisions were made on the basis of it (e.g. if some more progressive elements of the community began to write their language as the linguist represented it to them). If the linguist then says 'Whoops, I made a mistake. We need to redo the writing system, folks.' This would lead to

confusing representations or difficulty in teaching native speakers to read their own language. To attempt to undo this harm would require telling the community that the linguist was wrong and that they were going to need to retool and relearn how to write their own language. This would likely seriously undermine community confidence in the literacy process. It could even contribute to a feeling in the community that their language is inferior to the national (etc.) language, since, as far as the community knows, no such inconsistencies are ever found in teaching the larger or more prestigious language. These are ethical problems. The political issue is that it is the community, not the linguist, that must eventually agree on and adopt a particular orthography. The linguist must avoid inadvertently or purposely bypassing the community in introducing the orthography. In fact, they should have nothing to do with such issues unless invited to do so by the community. And they should participate only when phonological analysis has been carefully refereed by other linguists, whether or not it is published. We want to do it right, as right as we can, and avoid such problems. That is part of what this chapter is about.

The chapter is organized as follows. First, I present the standard methodology for 'phonemic analysis'. Then I consider potential problems and shortcomings of this procedure, supplementing it with suggestions based on modern phonological theory. This is followed by a section considering segmental phonology in the wider grammatical context. Some suggestions are then made for phonetic fieldwork, though this section is small and I refer the reader to the best source available anywhere on phonetic fieldwork, Ladefoged ().

4.3. METHODOLOGY

4.3.1. Caveat

There is no guaranteed way of analysing anything in any language. You could in principle come up with an excellent analysis without following anyone's suggestions, due to luck or genius. Or you could fail to come up with a satisfying analysis after trying all the methodological suggestion of this and other books on field methods. All things being equal, however, it is best to plan to use a tested methodology rather than to rely exclusively on being a genius.

4.3.2. Train the ears

I would recommend that the first step the linguist take before trying phonological analysis in the field is to train their ears for transcribing sounds and prosodies. One form of training is to listen to tapes of other languages and practice imitating them and transcribing them, preferably having someone who knows the language make the corrections. A related form of training is to find speakers of other languages in one's hometown, university, etc. and practice fieldwork with them. You can also train your ears if you play a musical instrument by learning new styles of music 'by ear'.

Another training method I have found very useful is to memorize texts of the language under study before learning what they mean. Then repeat these texts to native speakers and see if or how well they understand you.

It is also useful to eavesdrop and then imitate what you hear (assuming that no one minds and that you never record anyone without permission).

An additional means of hearing and pronunciation training is to compare spectrograms of your pronunciations of words of the language under study with spectrograms from native speakers' pronunciation of the same strings of words or

sounds. The linguist then practices and works to make his or her spectrogram, wave form, etc. look more and more like the native speaker's.

Last but not least, perhaps the best way to train your ears for phonological analysis is to learn to speak the language (see chapter ____). This is not only useful ear-training, it is of inestimable value for all your linguistic objectives and is important socially and culturally.

However, one thing that is less than useful, except for some aspects of prosody, is to rely for your practice of the language on analog recordings in the absence of native speakers. The reason for this is that analog recordings simply are not good enough for distinguishing many sounds, especially voiceless consonants.

4.3.3. Chart all sounds

It is essential that all sounds transcribed be charted in a standard phonetic chart. The sounds of the phonetic chart can be referred to as 'surface segments' or, to use a more traditional term, 'phones'. (Following analysis, the linguist produces another chart. This one is of 'distinctive segments' (or 'underlying segments', or, depending on your analysis, as 'phonemes'), which are those from which the linguist believes all related allophones are derived or which they believe is a useful label for the particular set of sounds.)

Once the linguist has charted the surface segments they have encountered, analysis should begin. Do not wait. Analysis of the segmental phonology should begin on the first day of linguistic research, though it might not be concluded for several weeks or much longer. As one proposes analyses to oneself, one better equips oneself to look for more and better data on the phonology. Your analysis feeds and enhances your fieldwork. So it should begin immediately (and this is true for all areas of analysis). The first thing I do in studying the phonology of a 'new' language is to indicate on my chart of surface segments what I consider to be suspicious pairs and suspicious segments. A 'suspicious pair' of sounds is any two sounds that differ in no more than one manner or one place of articulation. A 'suspicious sound' is one that can serve both as a syllable nucleus or a syllable margin (i.e. onset or coda). Once you have these indicated to yourself you are ready for the next stage of analysis. Before going into that, however, let's 'walk through' an example of what is suggested in this paragraph.

So let us say that you are working on Pirahã. You will notice immediately that there are very few surface segments in the language. They are shown in the charts below (one for consonants, one for vowels).

Table One
Pirahã Surface Segments

Consonants

p	t	k	?
		k ^w	
p ^l		tʃ	
p ^ɸ			
b		g	
ḃ	ɺ		
m	n		

s	ʃ	h
		h ₂ (with movement of tongue towards s position)
w	y	
Vowels		
i		
ɪ		
ε		o
	a	

So what is suspicious in the charts above? First, all the voiceless bilabials are suspect because they differ in no more than one manner of articulation. The voiced bilabials likewise. The weird lateral, [ɭ] (see Everett (1982)), and [n], the two [h]s, the two sibilants, [s] and [ʃ], and the front vowels should all be tested as groups to see if they are separate distinctive segments or members of the same phoneme (allophones). Second, the segments [w] and [y] are both suspect because they could simply be the phonetic realization of nonlow vowels ([i] and [o]) in onset position (Pirahã has no codas). How do we check these? Well, according to standard structuralist methodology, we first look for 'minimal pairs' or *Contrast in Identical Environments* (CIE). Herbert Landar (1980 IJAL 46:228) summarizes the structuralist viewpoint well when he says, "as with vowels and consonants, so with stress, pitch, and juncture: one minimal pair certifies phonemic integrity." CIE is defined in (4.7):

(4.7) CONTRAST IN IDENTICAL ENVIRONMENTS: Two sounds contrast in identical environments if and only if they are found in at least one set of two words that differ in meaning, where the only sound difference (segments and prosodies) distinguishing the words of the set are the sounds in question, and where the latter appear in exactly corresponding positions in each of the words in the set. The set is referred to as a *minimal pair*.

An example from English:

- (4.8) a. bit [bit]
b. beet [bit]

We will return to problems with this notion directly. But what if the linguist cannot find a minimal pair or CIE for a pair of sounds? Then they should look for *Contrast in Analogous Environments* (CAE) which can be defined as in (4.9):

(4.9) CONTRAST IN ANALOGOUS ENVIRONMENTS: Two sounds contrast in analogous environments if and only if they are found in at least one set of two words that differ in meaning, where the sound differences (segments and prosodies) distinguishing the words of the set are the sounds in question plus some other sound(s), where the former appear in nearly the same corresponding positions in each of the words in the set and any other different sound(s) is(are) unlikely to be responsible for the differences in the manner or place of articulation of the sounds said to contrast.

- (4.10) a. spit [spɪt]

b. Pete [p^hit]

Example (4.10) is CAE because the words compared differ in meaning and for the sounds in question (the vowels [i] and [ɪ]), as well as the additional [s] at the beginning of (a). This [s], however, is unlikely to be responsible for the fact that the vowels in question differ as they do, i.e. by the feature, [Advanced Tongue Root] ([ATR]).

If the linguist finds neither CIE nor CAE, then they should turn to consider that the two sounds in question are in *Complementary Distribution* or, in other words, in a relationship of allophony. Complementary distribution is the Superman vs. Clark Kent relationship (The reason Lois Lane suspected Clark Kent of being Superman was that he was similar to Superman and he was never in the same place at the same time as Superman):

(4.11) COMPLEMENTARY DISTRIBUTION: Two sounds are in complementary distribution if one is found in a specific phonological environment and the other one is never found there.

Let's examine this notion in more detail. Recall from introductory phonology courses that there are two forms of complementary distribution, namely, *ambient* and *positional*.

Ambient conditioning refers to changes in the sound under study (or, alternatively, selection of an allophone of the phoneme under study) effected by the 'contamination' from surrounding sounds. Consider the English example in (4.12):

(4.12) can't [k^hæ̃nt]

In this case, the oral vowel, /æ/, has been contaminated by the nasalization of the following nasal consonant. This is known as regressive assimilation (i.e. it spreads 'regressively', from right to left).

A further, well-known type of ambient conditioning is illustrated in Turkish, i.e. Vowel Harmony. Cases of Vowel Harmony can be very interesting because they show that conditioning can take place from non-adjacent items. Consider the following examples, which are standardly understood to illustrate the features of vocalic backness and lip rounding:

(4.13) Turkish Vowel Harmony: ip–in 'rope'; kız–ın 'girl'; yüz–ün 'face'; pul–un 'stamp', etc.

Epenthetic vowels (vowels inserted to satisfy constraints on syllable structure usually) also undergo Vowel Harmony, receiving rounding and backness specification from neighboring vowels according to the same rules, as shown in (3).

(4.14) a. /koyn/ → koyun 'bosom'
 b. /metn/ → metin 'text'
 c. /sabr/ → sabır 'patience'

In this case, assimilation is progressive, the vowel to the left triggering harmony on the vowel to its right (though not necessarily its immediate right, just the first vowel to the right).

Assimilation may in some cases produce a slightly different kind of result. An alternative to simple harmonic assimilation, a more complete version, if you will, is Vowel Coalescence, i.e. where two vowels merge to form a single vowel. Consider the following examples from Wari' Vowel Coalescence (Everett and Kern (1997, 331)):

- (4.15) a. $i + i = i$
 b. $xi' + \text{ -in} = xin$ [tʃin]
 1pincl:rf -3sn
- (4.16) a. $i + e = i$
 b. $xi' + \text{ -em} = xim$ [tʃim]
- (4.17) a. $i + o = u$
 b. $'iri' + \text{ -on} = \text{urun}$ [Y'rYn]
 1pincl:rp/p-3sm clitic cluster
- (4.18) a. $i + u = u$
 b. $xiri- + \text{ -u} = \text{xuru}$ [tʃY'rY]
 house- 1s 'my house'
- (4.19) a. $e + i = ei$
 b. $je + \text{ -in} = \text{jein}$ [ʔỹẽ¹]
 2p:rf-3n clitic cluster
- (4.20) a. $e + o = u$
 b. $\text{hwe} + \text{ -ocon} = \text{huhun}$ [hY'hYn]
 2p:rp/p -3pm clitic cluster
- (4.21) a. $e + a = e$
 b. $\text{hwe} + \text{ -am} = \text{hwem}$ [h^wim]²³
 2p:rp/p -3sf clitic cluster
- (4.22) a. $a + i = ai$
 b. $\text{wita-} + \text{ -in} = \text{wita'in}$ [wi'tãⁱ]
 mat -3n 'its mat'
- (4.23) a. $a + e = e$
 b. $'ina + \text{ -em} = \text{'inem}$ [ʔi'nim]
 1s:rp/p -2s

²³ The phonetic form differs from the phonological form, /e/, here, but is a natural realization of /e/ before /m/.

- (4.24) a. a + o = o
 b. ta + -on = ton [ton]
 1s:rf -3sm
- (4.25) a. o + u = u
 b. toco- -um tucum [tʏ'kʏm]
 eye- -2s 'your eye'

In general, what is happening is that the lower vowel is deleted and the higher vowel remains, except with [ei] and [ai]. This example is like vowel harmony except that that 'harmony' results in a blending of the vowels into one.

Positional conditioning is change produced by the location of the sound in question in the phonological or morphosyntactic constituent structure of the utterance, rather than by other sounds per se. Consider aspiration in English:

- (4.26) a. paper [p^heɪpə]
 b. tart [t^hart]
 c. call [k^haL]
 d. cheap [tʃ^hip]

Or consider the change in vowel quality effected by the vowel's location relative to stress placement in the word:

- (4.27) a. photo ['foto]
 b. photography [fo'tɔgrəfi]
 c. photograph [fotə'græf]

These are the standard methodological teachings that linguists have received over the years. And this methodology is extremely useful, which is why I have given space to it here. All field linguists should familiarize themselves with it. In the next section, however, I consider some problems with this methodology and offer additional suggestions for phonological analysis.

4.4. The Structuralist Methodology Reconsidered

4.4.1. Reconsidering minimal pairs

In his important monograph of 1968, Postal points out that a major weakness of 'autonomous phonemics' (the source of the methodology just introduced) is its inability to allow exceptions. This observation has several applications, but the situation I am referring to here is where linguistic generalizations are either not observed or not described because the linguist has found apparent minimal pair contrast. Specifically referring to minimal pairs, Chomsky puts his finger on a crucial problem:

'In general it should be observed that 'minimal pair' is not an elementary notion. It cannot be defined in phonetic terms but only in terms of a completed phonemic analysis ...' (Chomsky 1964:97).

And Postal (p28) paraphrases this to say, '... contrary to almost every introductory exposition of autonomous phonemic theory or practice, the discovery of phonetically minimal pairs does not *necessarily* [emphasis Postal; D.L.E.] permit an immediate conclusion about underlying phonological contrast'.

Postal goes on to argue, to me successfully, that analyses should be based on systematic regularities rather than 'static' exceptions. We do not thereby eliminate minimal pairs from analyses, but rather we bring the principle of their application into proper perspective.

Chomsky and Halle develop this notion further, as seen in statements such as: "Clearly, we must design our linguistic theory in such a way that the existence of exceptions does not prevent the systematic formulation of those regularities that remain" (1968:172).

The structuralist methodology from which CIE, for example, emerges has no elegant way of recognizing exceptions. What is clear is that regularities are the basis for linguistic analysis. Minimal pairs might, in fact, illustrate such regularities, in which case by all means use them. Or they might be useful predicting subregularities or creating doubt. Doubts refine hypotheses. But doubts caused by a single minimal pair, for example do not require, say, complete redesign of an orthography on the basis of two words.

Contrary to the Landar quote above, we do not 'certify' results by a methodological 'proof'. We do not do this in phonology, fieldwork, or science generally. Let's consider a couple of minimal pair problems to drive this point home.

Empirical and epistemological extensions

The misuse of minimal pairs has various empirical consequences. Consider the following examples.

Pirahã

Previous analyses of Pirahã tone (see Heinrichs () and Sheldon ()) based themselves primarily on series of minimal pairs. The following are some examples used to support the previous analysis proposing three phonemic tone levels.

- | | | |
|---------------|------------------------|------------------|
| (4.28) [ʔāòí] | MLH 'hand' | H, ' = high tone |
| (4.29) [ʔāōí] | MMM 'ear' | M, - = mid tone |
| (4.30) [ʔāòĩ] | LLM 'foreigner' | L, ` = low tone |
| (4.31) [ʔāòí] | LLH 'skin' | |
| (4.32) [ʔāòì] | MLL 'Brazil-nut shell' | |
| (4.33) [ʔāōĩ] | MHM 'basket' | |

In a theoretical framework which allows "minimal pair shortcuts," it is clear that (4.28)–(4.29) argue strongly in favor of a three-tone analysis. But this is why minimal pairs can be dangerous.

Closer examination of this series, however, reveals that between the [o] and [i], in each of these examples a semivocalic glide [w] occurs. This is rather uninteresting phonetically since such a glide is pretty much expected in this position for obvious reasons. However, as any first-year linguistics student knows, such a glide has (at least) three possible interpretations: (i) this could be perceived as simply a trivial transition effect, needing nothing more than a footnote; (ii) the glide could be functioning as a

consonant /w/ in the language; (iii) the glide could in fact be a vowel in underlying representation.

The determination of which option a–c is correct will have serious implications for the analysis of Pirahã. In my analysis, option c was selected. This not only allows for prediction of stress placement (Everett 1988), but notice the change in the tonal patterns of (4.34)–(4.39) (where [w] carries tone because it is an underlying vowel. Compare Everett, Forthcoming, for details.)

- (4.34) [ʔāòwí] MLHH ‘hand’
 (4.35) [ʔāōwĩ̃] MMMM ‘ear’
 (4.36) [ʔāòwĩ] LLMM ‘foreigner’
 (4.37) [ʔāòwí] LLHH ‘skin’
 (4.38) [ʔāòwĩ] MLLL ‘Brazil-nut shell’
 (4.39) [ʔāówí] MHHL ‘basket’

These representations then allow us to write rules to derive the mid-tone from perturbations affecting both high and low tones. These rules are given below. This phonological decision completely alters our initial perspective of the minimal pairs in ()-(), showing that the concept of what is 'minimal' depends on our analysis.

Pirahã Tone Rules

TONE LOWERING:

$$(4.40) \left[\begin{array}{c} +\text{high} \\ -\text{low} \end{array} \right] \rightarrow [-\text{high}] / \left[\begin{array}{c} [+ \text{low}] \\ \# \end{array} \right] \text{ — } [+ \text{low}]$$

TONE RAISING:

$$(4.41) [+ \text{low}] \rightarrow [-\text{low}] / \left[\begin{array}{c} [-\text{low}] \\ \# \end{array} \right] \text{ — } \left[\begin{array}{c} [-\text{low}] \\ \# \end{array} \right]$$

Asyllabification:

$$(4.41) \left[\begin{array}{c} +\text{syl} \\ +\text{rd} \end{array} \right] [-\text{syl}] / \left[\begin{array}{c} +\text{syl} \\ +\text{rd} \end{array} \right] \text{ — } [+ \text{syl}]$$

And these rules are important for Pirahã since they also explain the rarity of tone 2, a mere 'allotone' or surface variant, according to this analysis.

Tonal displacement

A further example of empirical problems for a minimal pair analysis may be seen in languages which manifest what has been termed “tonal displacement”:

Richardson (1971) discusses a phenomenon which he calls displacement, whereby tonal contrasts are realized several syllables to the right of their original position. The words [ný-kòlò] 'sheep' and [ný-kòlò] 'heart' in Sukama differ, in that 'heart' etymologically carried a high tone on the last syllable. Both are pronounced identically in isolation. However, consider the following forms:

- (4.42) a. ný-kòlò ný-tàalè 'big sheep'
 b. ný-kòlò ný-tàalé 'big heart'

The original tonal contrast is realized on the adjective big (Hyman and Schuh 1974:103).

Hyman and Schuh proceed to give a feasible account of this phenomenon, with 'sheep' and 'heart' contrasting in underlying form. Note that such an analysis would have been 'messy' or very difficult to state in a structural framework wherein preanalytical minimal pairs are phonetic units 'certifying phonemic integrity'.

Portmanteau

A final example in support of the thesis expressed in this paper is the phenomenon known as Portmanteau (or Coalescence, as seen in the Wari' examples in ()-()). A discussion of this is found in E. V. Pike (1974a:24):

A portmanteau phone is one surface sound which is produced by the 'fusion' of two underlying or distinctive segments. A unique phone, the one not part of a symmetrical pattern may turn out to be a portmanteau phone. When the units which make up the portmanteau phone are recognized, their occurrence should help to make symmetrical one of the nonsymmetrical patterns.

Pike gives the following examples (among others) of Portmanteau:

'Harris (1951:92) describes a flapped nasal which occurs in some environments in some dialects of American English (as in, for example, painting) as actualizing the sequence /nt/.

In Quiotepec Chinantec, the sequence /mĩ/ is actualized as a syllabic bilabial nasal (Robbins 1961:245).

In Ayutla Mixtec, the sequence /æ/ is actualized as [æ] when following an alveopalatal consonant (Pankratz and Pike, E. V. 1967:289)....'

Discussion

One might possibly respond to this data by saying, "Well, the initial minimal pairs were incorrect. As a matter of fact, once the proper forms were defined the contrast became obvious." But this reasoning is fallacious. The 'correct form' of these minimal pairs was determined *phonologically*, not phonetically. That is, no phonetician could have told us that the semivocalic glide from [o] to [i] in the Pirahã data was an underlying /o/ (which carries tone). Nor is the phonetic data sufficient to determine the presence of a displaced tone in the Sukama examples. Portmanteau is even more effective in revealing the shortcomings of CIE/minimal pairs because sounds are 'lost' on the surface.

Another way of thinking about this is in terms of the more general notions of *dependent* vs. *independent* variable. These are defined in () and (), respectively:

(4.43) DEPENDENT VARIABLE: The item in an experiment or study whose changes are effected by one or more independent variables.

(4.44) INDEPENDENT VARIABLE: An item manipulated in an experiment or study that effects change in the dependent variable.

To give an example, let us assume that we are studying the nasalization of vowels. We might ask whether the nasalization on the vowel, the dependent variable, is

caused by the nasalization of the consonant, the independent variable according to this hypothesis.

- (4,45) a. can't [k^hæ̃nt]
 b. cat [k^hæt]

In (), the [n] is the independent variable because we are manipulating it to see if it causes the nasalization of the vowel [æ], which is our dependent variable. From this we can draw the modest conclusion that it is ambitious, to put it mildly, for the fieldworker to believe they have controlled and distinguished variables in any pair of words at the beginning of field research. Rather, the understanding and recognition of such variables comes, if ever, only after a significant amount of rigorous analysis. Therefore, CIE, CAE, and CD, like other methodological notions, do not provide us with analytical algorithms but with heuristic procedures, rules of thumb.

To summarize what we learn from the cases above, the lesson is simply that if the fieldworker had stopped with the superficial phonetic form he could, according to structuralist methodology, have considered that:

- a. Pirahã has three tones and (by further data) unpredictable stress placement.
- b. Languages like Sukama have arbitrary allomorphs in grammatical sequences.
- c. Languages with portmanteau phenomena have arbitrary patterning in their phonemic inventories.

This type of data further illustrates the difficulties and dangers of minimal pair analysis for field linguists. Carrying the conclusion a step further, we might even say that a good analysis should determine minimal pairs rather than vice-versa. We need to remind ourselves that methodological suggestions are just that, suggestions. Ultimately, they are the 'icing' on a 'cake' of theoretically and typologically-informed analysis.²⁴

²⁴ As an epistemological aside, it might be noted that minimal pairs represent the effects of empiricist philosophy in linguistics. That is, they are the vestiges of the naive notion that "proofs" exist in science, in general. As Chomsky has frequently observed, data by itself is not sufficient for criticism of a given theory. Rather, one must say something about the data, which, by its very nature, is a theoretical activity. To criticize analysis a, for example, it is not enough to merely present contrary data. It is also necessary to (1) show how an analysis b would treat the data more effectively, and (2) how analysis a cannot be extended to handle this "extra information." Pure inductivism is a dead-end road.

In astronomy, a researcher might criticize a colleague's theory by noting that light rays and planetary motion in a particular section of the galaxy do not conform to this colleague's theory. Then the colleague may simply respond by saying, "Well, there's this thing called a 'black hole' up there which, although invisible, exercises an effect."

So, let's get some money from NASA and send up a rocket to check out the story. No black hole! Now we've got him! But, when presented with this new evidence, the shameless fellow replies, "You didn't find evidence of a black hole because your instruments were fouled up by magnetic clouds in the area (this example is largely from Marcelo Dascal, verbal communication).

4.4.2. Effect of change

Fieldworkers can also be confused by historical change that has left synchronically strange effects in the grammar. As an example, consider once again the chart in () of Pirahã surface segments. Because the pairs [g] and [ɺ] and [g] and [n] differ by multiple points and modes of articulation, they are not suspicious pairs so the fieldworker is unlikely to suspect them of being potential allophones/surface variants. And yet, they are surface variants of a single distinctive sound, as per the rules in ():

- (4.46)
- a. $\left[\begin{array}{l} -\text{continuant} \\ +\text{velar} \\ +\text{voiced} \end{array} \right] \rightarrow \left[\begin{array}{l} \mp\text{nasal} \\ +\text{coronal} \end{array} \right] / \# ___$
- b. $\left[\begin{array}{l} -\text{continuant} \\ -\text{syll} \\ +\text{velar} \end{array} \right] \rightarrow \left[\begin{array}{l} +\text{continuant} \\ +\text{lateral} \end{array} \right] \left[\begin{array}{l} /+\text{syll} \\ +\text{high} \\ +\text{round} \\ +\text{voiced} \end{array} \right] ___$
- c. $\left[\begin{array}{l} +\text{consonantal} \\ -\text{continuant} \\ +\text{voiced} \\ -\text{labial} \end{array} \right] \rightarrow [+ \text{posterior}] / ___$

This strange rule is, according to Everett (1979), the result of a historical process in which a diachronically prior sound [d] shifted to [g], while the remaining two sounds of the original phoneme remained as [+coronal]. This may be due to pressure to 'disperse' sounds more effectively to aid speaker perception (see X (), Y () for further development of the concept of 'dispersion'). But it is not expected from a purely synchronic view and, therefore, would pass beneath the radar of just about any methodology.

Another interesting case comes from the Ge language, Suyá (Kisedje). Consider the process of lenition in this language (Everett () and Foresti ()):

- | | | | | | |
|----|---------------------|---|----------------------|-------|-----------------|
| 1) | /t/ | → | [ɾ] / | _____ | phrase boundary |
| 2) | /p/ | → | [w] / | _____ | phrase boundary |
| 3) | /k/ | → | [g] / | _____ | phrase boundary |
| | [tɛp] | → | [tɛw ^ɛ] | | 'fish' |
| | [k ^h et] | → | [k ^h ere] | | 'no' (negation) |

This type of thing can go on and on unless colleague b gets fed up and says, "Listen—I have had it with your old fairytales. I have developed a theory which explains all of these phenomena, simply and satisfactorily without black holes, magnetic clouds, and so forth."

So it is with minimal pairs. They are only acceptable as evidence within a theory. The lack of a theory rules all of the data in the world irrelevant.

[sΛk] → [sΛg] ~ [sΛk] ~ [sΛk^h] ~ [sΛg[^]] 'bird'

Notice that although the coronal, /t/, and bilabial, /p/, stops lenite to continuants, the velar stop, /k/, is alternatively realized as [g], [k], [k^h], and [g[^]]. As Everett () points out, there is no continuant realization of /k/ in the phrase-final position, contrary to realizations for /t/ and /p/ in this position, because there is no distinctive segment that is velar and continuant. According to Everett (), this process is structure-preserving, that is, it can only substitute one distinctive segment or phoneme for another. Since /r/ and /w/ are both distinctive segments in the language, they may be substituted for /t/ and /p/, respectively, in phrase-final position. But since there is no continuant velar distinctive segment, /k/ behaves differently, as already seen. This is interesting because it shows that some constraints (Structure Preservation in this case, see Kiparsky ()) may prevent rules from being maximally general, contrary to the standard fieldwork methodology, and it also shows a possible case of a change in progress. In other words, the behavior of /k/ could be seen as asystematic by new generations of Kisedje/Suyá and this could lead to a new phoneme (e.g. [ɾ], which is continuant and velar) or to a removal of the Structure Preservation constraint). In any case, it is a case that is not completely compatible with the simple methodology in ---. So, once again, although that methodology is very helpful, one must be very careful to analyze and argue carefully for conclusions. And careful argumentation and analysis require knowledge of the literature, typological, theoretical, and descriptive.

For another caveat on the use of the standard methodology, see section ___ of chapter ___ on phonology and culture.

4.5. Orthography design

Phonological analysis is a necessary condition for orthography design, but it is not a sufficient condition. As is stated in ___ the choices involved in designing the visual representation of a language involve community values and discussion. And various other issues, such as non-trivial, but conflicting cultural values.

For example, do the people want to read in the first place? Do they want to read their language or the national language or both (each of these questions has implications for the literacy programme). Do they want their language to look like the national language or would they prefer that it look different, unique to them? Do they want the linguist's advice or not? Should the linguist offer advice even if it is not asked for (the linguist will have to answer this based on their understanding of the culture in question).

In 1980, Keren and I dedicated every night, six nights a week, to literacy and math classes among the Pirahãs, at the Pirahãs' request. Near the end of this time, we finally succeeded in getting the Pirahãs to read a word. We wrote the word **bigí** on the black board we were using. Everyone read the word out loud. Then they all started to laugh (about 30 people were present). I asked 'What's so funny?' They answered 'That sounds like our word for 'ground'. 'It IS your word for 'ground'', I replied. 'Oh, no' they said, 'We don't write our language. Is that what you are trying to teach us? Oh, we don't want that.' And they never returned to literacy classes.

Many agraphic societies will recognize the value of reading and writing their language, though certainly not all will. If you have an opportunity to contribute to

literacy or other educational goals of the community, especially as these goals implicate your linguistic skills, then you, qua linguist, are making a valued contribution to community life. This is both personally rewarding and community-empowering. Therefore, the fieldworker should feel privileged to contribute in this way. But at the same time, the fieldworker must take this privilege very seriously, recognizing the responsibility that it entails.

4.6. Back up your analysis with sound files

Until very recently it was impractical for the average reader of a grammar or phonological analysis to have the option of listening to the sounds upon which an analysis was based. Audio recordings would have been made on analog tapes stored exclusively at the linguist's home institution (by and large). However, digital files, servers, and the internet make it both possible and desirable for all phonological analysis to be backed up empirically such that any reader can replicate the measurements and analysis. This is a significant improvement over 'impressionistic', take-the-linguist's-word-for-it analysis. Sound files should be stored in .wav format (see the E-MELD 'best practice' page at: <http://emeld.org/school/>). For any phonological data archive or published study, each datum or analytical point should be accompanied by an address where the sound file which supports it can be downloaded.

4.7. Phonology in the wider context of the grammar

The procedures for segmental phonological analysis sketched above are incomplete because they treat phonology as an autonomous module unconnected with the rest of the grammar. However, as the examples from English in ()-() illustrate, morphosyntax can be causally implicated in phonological analysis. Although culture is also occasionally implicated in phonological analysis, this is treated in chapter _____. Here I want to consider ways in which morphology is crucial to understanding phonology. We begin by considering what Everett () refers to as encliticization, also discussed in Sheldon ().

Pirahã Encliticization

(4.47) tii ʔísitòi ʔòògàbàgàí → tii ʔísitòògàbàgàí
 lpsg egg want
 'I want an egg.'

(4.48) kàhàí ʔààgàhá → kàhàààgàhá
 arrow is
 'It is an arrow.'

In these examples, we see that the final vowel of the first word, the verbal object, deletes, as does the initial glottal stop of the following verb. However, the tone does not delete, as shown by the rising tone on the vowel to the right of the deletion site in both examples above. This means that the only way to get at the correct analysis of Pirahã tones, i.e. that they are underlyingly level and not contour, is by taking into consideration the effect of 'cliticization' on the surface forms of the tones. If the forms to the right of the arrows were analyzed without regard to the forms to the left of the arrows, the tonal analysis would have severe problems.

Moreover, as Pike and Fries () observe in their pioneering study, loan words can affect the phonological system of a language. So, for example, consider the phoneme /ʒ/ in English. This sound only occurs in loan words, e.g. *azure*, *garage* (some dialects), *fromage*, etc.

4.8. PHONETICS FIELDWORK

This section is a brief and humble introduction to how to begin to answer questions of phonetic theory. Maddieson () and Ladefoged () provide excellent introductions to phonetic field research, the latter a book-length survey and this section is meant as little more than an annotated reference to those works.

There are two broad domains of phonetic research: the nature of contrast, i.e. how the sounds of a language are perceived as different by native speakers, and variation, i.e. how sounds change diachronically and synchronically. Phonetics fieldwork in some senses underwrites or warrants all other fieldwork. If the phonetics (articulatory or acoustic) is bad, the entire documentary-descriptive effort is bad. But phonetics is not, as some people might think, the first type of fieldwork undertaken by the fieldworker. Before you begin serious phonetic analysis, you should have other analyses well under way.

Moreover, with phonetic fieldwork, as with all types of research, you must first be clear on your methodology, purpose, and technology. As an example, let's say that you want to study the contrast between two closely related sounds. You will have already established that these sounds contrast phonologically. You should next look to your dictionary or word list in order to find systematic sets of examples to test. If you do not have a sufficiently complete dictionary to arrange the necessary examples, William Poser has written a programme that will generate lists of hypothetical words, based on an input of the language's syllable structure and segmental phonology.

What kind of word list do you need? What are the guiding principles in devising a word list for phonetics field work? The basic idea is quite simple: the linguist wants to construct examples for testing in which the dependent and independent variables are properly controlled. That is, you the linguist want to be sure that you are studying what you think you are studying. Consider how you might go about studying the difference between a voiced stop and a voiceless stop. First, assemble words with the sounds in minimal or near-minimal pairs (see ____ above). For example, suppose that you want to study the contrast between /g/ and /k/. Word lists like those in () and () would give you a reasonable start (where I assume that all words differ in meaning).

(4.49) gabi, bagi, gut, tug, grat

(4.50) karg, garg, gark, kark, kãg, gãk, etc.

(4.51) kabi, baki, kut, tuk, etc.

That is, each segment to be tested should be recorded preceding and following all vowels and all consonants and in word-medial, initial, and final positions. Once this is done, if the recordings are of adequate quality (see ____ below) and quantity, then you have the basis for comparing spectrograms of the two segments. Likely, the most interesting distinctive phonetic process you will find in this case is Voice Onset Timing. However, perhaps you have reason to believe that the articulation of the sounds is also different in some way. You may want to make palatograms of each of

them. (How to do this is described in ____ below.) You may want to film speakers or use ultrasound, etc., depending on where you are at and what kind of research budget you have. I turn now to consider technical aspects of phonetic and phonological studies.

Recording

First, as mentioned in ____ above, the fewer the moving parts in your recording equipment, especially your recorder, the less chance there is for motor hum and other intrusive sounds to contaminate your recordings. Recording on solid-state digital recorders or directly onto your computer is therefore recommended over even quality digital recorders that use tapes, compact disks (CDs), or digital video disks (DVDs). Second, your microphone should be a dynamic, uni-directional mic, attached to a headset. (A capacitor microphone would be better if you were particularly interested in studying low-frequency sounds.) The purpose of the headset is to ensure a constant distance and angle between the microphone and the native speaker's mouth. Hand-held or table-top microphones are notorious for registering false differences in loudness, for example, as the speaker turns their head while recording or they hold the microphone at different distances from their mouth while speaking.

Care must be taken too to ensure that the recording volume on your recording device is set to maintain a clear signal to noise ratio (see ____ for a discussion of this ratio). That is, you do not want the recording volume so high that you get distortion at the upper ranges of speaker volume. But you also want the volume high enough so that the speaker's voice easily drowns out all ambient noise. The goal, visually, is to produce high-quality spectrograms, such that formants, vocal chord vibrations, nasalization traces, etc. are clearly visible. If the recording is well-controlled and in a silent environment, words will be separated on the spectrogram by white, clear space. This is almost never possible to achieve in the field environments, though approximating this ideal should be the goal.

When recording among the Banawa in 2004, I was delighted to collect the best natural conversation between two speakers that I had ever collected in all of my field research in the Amazon. Two language teachers, Sabatao Banawa and Bido Banawa, sat in front of me in a small study just out of the Banawa village (kindly provided for our use by SIL member Ernest Buller). Each wore a headset with a high-quality microphone. I recorded them onto a professional digital recorder (). I even recorded the entire session on digital video, which provided additional high-quality audio back-up as well, since most camcorders have superb microphones. Two things happened when we returned from the field, however. First, someone broke into our project office in Manchester and stole a valuable computer, and all of our video recordings from the entire first year. So I lost the video record. Next, as I looked at the audio recording of the conversation, I noticed a high-frequency band of noise going through the entire conversation. It turned out to be a cicada that I had not heard while recording, because I was so focussed on collecting the actual conversation. A bit disappointing. Nevertheless, the cicada and other ambient noise were relatively easy to work around because the signal-noise ratio was good.

An ideal addendum to your laboratory sessions would be to video-record all of them so as to capture at least all the words and expressions (facial, body posture, hand gestures) of the teacher. It would also be useful to record yourself at the same time. Your own actions, interactions, and reactions can be useful in determining the kind of

feedback you might inadvertently be giving the language teacher (e.g. frowns, smiles, furrowed eyebrows, crossed arms, face in hands, etc.). All recordings should include a preface of the linguist speaking, giving at least the following information: date and time of recording, speaker name, location, objective of this recording, speaker gender and age, speaker dialect, and speaker's level of bilingualism. Ideally, this tape should be a stand-alone document that any other linguist could use, e.g. students looking for thesis projects. Remember: backup all data files immediately and keep copies in a different building from the originals.

Palatography and linguography

Ladefoged () gives an excellent set of suggestions for field palatography. He suggests painting tongues or palates with either purified charcoal or the scrapings from burnt toast mixed with olive oil. These can be painted on the subject's palate (for linguography 'writing on the tongue') or tongue (for palatography 'writing on the palate') with a never before used or sterilized paintbrush, approximately 0.5 – 1.0 inches in width.

In my fieldmethods class at the University of Manchester, a couple of undergraduate students became enthusiastic about palatography and their fieldwork papers showed excellent palatograms. One of the students decided, however, that olive oil + burnt toast scrapings tasted 'yucky' so she used softened chocolate and butter. She got reasonable palatograms doing this. However, the disadvantage to tasty 'paint' is that it produces more salivation, smearing the palatogram and thus generally producing less useful results. So bad-tasting palatographic 'paint' may be better for science.

Linguography marks the palate and then photographs the subsequent markings on the tongue after the word or syllable has been pronounced. Palatography marks the tongue and then photographs the palate.

To photograph subjects' tongues and palates, use a high-resolution digital camera. Have the subject stick their painted tongue out and use a mirror to photograph the palate.

Airflow and air pressure (these are not the same thing) studies can also be useful in the field for more carefully examining supraglottal pressure and nasal airflow. The data collected from such studies can be essential in distinguishing stops from continuants, nasal sounds from oral sounds, and any other contrast involving the source and direction of airflow (e.g. pharyngeal vs. pulmonary air, etc.) or air pressure. For example, variations in air pressure can indicate increased or decreased energy in production of sounds and can be used, for example, to distinguish stressed vs. unstressed syllables. Greater airflow with lesser air pressure can, to give another example, indicate difference in phonation types (e.g. normal vs. 'breathy' voice). Ladefoged (2004, 55ff) has an excellent discussion of methodology in recording and measuring airflow and air pressure. There is a cost in undertaking such studies and that is the purchase and transport to the field of the equipment necessary to do the recordings. Such equipment these days is greatly reduced in bulk from what earlier field phoneticians had to contend with, but it still entails greater expense and inconvenience. Nevertheless, the more urgent the documentation of a particular language, the greater the argument for taking a range of phonetic equipment from the outset of field research on that language. Otherwise, my suggestion is that high-quality digital recordings and phonological analysis should take place for the first couple of

sessions, to be followed later by phonetic field analysis. For most of what the average field linguist wants to do they can learn to do it themselves, and they should. On the other hand, if there is money in the budget and you can find a willing phonetician, it could be useful to have an expert along to help you with your recordings and measurements for phonetic analysis.

In my own case, as I have mentioned before, I had the extreme privilege of having perhaps the world's greatest phonetician, Peter Ladefoged, accompany me to the Pirahãs, the Banawas, the Wari's, and the Oro Wins. But Peter wanted to come for two reasons. The first was to document the phonetics of endangered Amazonian languages for which there were at least initial phonological analyses. But the second was to check out some of the things I had been saying in the literature about Pirahã and Banawa stress. As I picked Peter up at the Porto Velho airport in Rondonia, Brazil, I felt like I was about to be audited by the US's Internal Revenue Service. I felt sure that my analyses were correct, yet at the same time, I knew that Peter Ladefoged would be concerned about the facts and not about what disproving everything I had said would do to my reputation! On the one hand this was a good feeling, as a scientist. But as a person I was tense. When Peter got off the plane and I was helping him to the car with his bags (and portable phonetics lab), he said that two of his colleagues had '... asked me to check out very carefully what you say about Pirahã stress because they are skeptical of your analysis.' And yet at the same time that I was concerned about whether my earlier statements would really stand up (paranoia), I was pleased that someone was taking this research seriously enough to check it out. Ultimately, the stress and tone that Peter identified in all the relevant words was what Everett & Everett (1984) had predicted. Thus Pirahã stress became a more widely accepted and important part of crosslinguistic stress studies. But the point is that replicability is a crucial part of science and having your results checked independently is a service to your own research and to the scientific community as a whole, even if your 'auditor' is perhaps not quite as distinguished as Peter Ladefoged.

The analysis of the entire grammar rests on the foundation of phonetics. If the phonetic quality of your data is poor, then everything from the morphology to the semantics is suspect.