

## Phonetics in the Field

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### 1. Phonetics in grammars

For many linguists the noticeable growth of interest in descriptive fieldwork over the past two decades or so has been a welcome development within our profession. In considerable part this phenomenon is linked to concern about language loss, reflected in, for example, the creation of the Endangered Languages Committee of the Linguistic Society of America, and research programs funded by the Volkswagen Foundation in Germany and the Hans Rausing Fund in Britain. Descriptive work has been undertaken both in association with efforts to reinvigorate the use of a language or out of a wish to document a disappearing resource for its cultural and scientific value. An increased interest in typological linguistics has further stimulated new descriptive work on lesser-known languages since typological studies require the broadest knowledge possible of how human languages differ one from another. The publishing industry has responded with new or relaunched grammar series, notably from Mouton de Gruyter, Routledge, and LINCOM EUROPA and there seems to be a renewed acceptance of the practice of writing a descriptive grammar as a doctoral dissertation in linguistics. Practical issues in field linguistics (e.g. Newman & Ratliff 2001, Vaux & Cooper 1999) and language maintenance (Hinton and Hale 2001) have also received more attention in the recent professional literature.

Although all this attention to descriptive linguistics is welcome it seems generally the case that little detail on specifically phonetic matters is provided in a typical grammar, nor is there much use of phonetic techniques to provide insights on other matters, such as adding precision to observations of phonological alternations or testing whether supposed syntactic ambiguities are actually disambiguated at the phonetic level. While syntactic patterns are documented with example sentences, often from natural discourse or texts, the phonetic facts are rarely if ever documented by the presentation of hard evidence.

In order to see if this impression was justified a survey of twenty grammars published or submitted as doctoral dissertations in the period of a dozen years from 1989 to 2000 was conducted. The grammars were selected to represent a wide range of language families broadly distributed around the world, as well as to sample some of the range of publishing sources and centers of research effort. The

languages represented are all 'minor' languages spoken by from a handful to some tens of thousands of persons. The grammars examined are listed in (1), which is arranged alphabetically by the names of the languages and includes also the language family, author, publication or submission date, and publisher or university. Full references are given at the end of the article.

(1) The sample of grammars examined.

Language	Family	Author and date	Publisher
Aleut	Eskimo-Aleut	Bergsland 1997	Alaska Native Language Center
Chalcatongo Mixtec	Otomanguean	Macaulay 1996	U. of California Press
Cubeo	Tucanoan	Morse & Maxwell 1999	SIL
Evenki	Tungusic	Bulatova & Grenoble 1999	LINCOM EUROPA
Kisi	Niger-Congo	Childs 1995	Mouton de Gruyter
Koiari	Trans-New Guinea	Dutton 1996	LINCOM EUROPA
Kolyma Yukaghir	Ural-Altaic	Maslova 1998	U. Bielefeld (Ph. D.)
Lavukaleve	E. Papuan	Terrill 1999	Australian National University (Ph. D.)
Lekeitio Basque	Basque	Hualde, Elordieta & Elordieta 1994	Universidad del Pais Vasco
Lezgian	N. E. Caucasian	Haspelmath 1993	Mouton de Gruyter
Lillooet	Salishan	van Eijk 1997	UBC Press
Meithei	Sino-Tibetan	Chelliah 1997	Mouton de Gruyter
Miya	Afro-Asiatic	Schuh 1998	U. of California Press
Nandi	Nilo-Saharan	Creider & Creider 1989	Buske
Nivkh	"Paleo-Siberian"	Gruzdeva 1998	LINCOM EUROPA
Oneida	Iroquoian	Abbott 2000	LINCOM EUROPA
Rapanui	Austronesian	Du Feu 1996	Routledge
Semelai	Austro-Asiatic	Kruspe 1999	U. of Melbourne (Ph. D.)
Sonora Yaqui	Uto-Aztecan	Dedrick & Casad 1999	U. of Arizona Press
Wardaman	Australian	Merlan 1994	Mouton de Gruyter

(2) presents an analysis of the proportion of each of these grammars directly devoted to discussion of the sound system of the language being described. The metric chosen is crude — the proportion of numbered pages devoted to phonetic and phonological topics as a percentage of the overall numbered page count — but this gives a reasonable idea of how much attention is given to these aspects of the language. This table is arranged in increasing order of these calculated percentages.

*Phonetics in the Field*

(2). Proportion of grammar devoted to phonological/phonetic topics.

Language	"Ph" content	Page count	"Ph" percent
Cubeo	5 pages on phonology	197	2.5%
Yaqui	15 pages on phonology	411	3.6%
Evenki	3 pages on phonology	64	4.7%
Lavukaleve	24 pages on phonology and morphophonology	486	4.9%
Rapanui	13 pages on phonology and morphophonology	217	6.0%
Oneida	4 pages on phonology	65	6.2%
Semelai	47 pages on phonology	729	6.4%
Yukaghir	41 pages on phonology	375	6.6%
Wardaman	46 pages on phonology	617	7.5%
Lezgian	43 pages on phonology	567	7.6%
Aleut	31 pages on phonology	360	8.6%
Nandi	15 pages on phonology	172	8.7%
Mixtec	27 pages on phonology	298	9.1%
Lillooet	35 pages on phonology	279	9.3%
Meithei	54 pages on phonology and tonal phonetics	539	10.0%
Nivkh	9 pages on phonology	66	13.6%
Koiari	12 pages on phonology	77	15.6%
Miya	65 pages on phonology	414	15.7%
Kisi	77 pages on phonology, incl 2 pages tonal phonetics	370	20.8%
Basque	73 pages on phonology, incl 12 pages of FO data	314	23.2%

The grammars vary in page count from 60-70 pages for some of the LINCOP EUROPA *Languages of the World/Materials* series to ten times this for some of those which were submitted as doctoral dissertations. This variation reflects both variation in richness of description as well as technical factors such as choice of type size and line spacing and decisions on pagination. The mean page count is 331. The mean number of pages explicitly devoted to phonetic/phonological topics is around 32 pages, hence the mean percentage of pages devoted to these topics is just under 10%. However only five of the twenty grammars devote more than one tenth of their pages to phonetic, phonological, or morphophonological issues and the harmonic mean is just 7.3%. Not surprisingly there is a tendency for those authors whose professional interests are more oriented towards phonology (e.g. Hualde, Schuh, Childs) to devote a greater proportion to this area. Schuh's and Macauley's grammars provide substantial additional information on certain phonological aspects in sections describing morphology (these pages are not counted in (2)). In the other grammars the morphological description adds little or nothing to the phonological insights provided, being concerned principally with matters such as affix shape and order, paradigm classes and so on.

All of these grammars provide an inventory of vowels and consonants, but only

9 of them furnish any evidence of the contrastive status of the segments listed. In the majority of cases the phonetic realizations of each of these units is described only by a categorical label and/or by the choice of a symbol for its representation. In 9 of the 20 grammars there is no commentary on phonetic realization of the segments going beyond the placement of a symbol on a labeled chart. The result is frequent ambiguity and imprecision. In at least 14 of the grammars there are one or more quite significant uncertainties about what kind of segment is intended by a symbol or label (some of these uncertainties will be described in a later section.)

Only three of the grammars include anything at all in the way of phonetic documentation. Two, those on Meithei and Kisi, include some exemplification of FO patterns in tones, and one, on Lekeitio Basque has some documentation of intonation patterns. Childs's grammar of Kisi also presents some data on vowel duration but is not specific on the number of measurements made. Apart from this there is no hard data on any phonetic characteristics of the language being described in these grammars. For most of these languages, as for the great majority of the world's languages, there is little or no specialist literature on their phonetics to fill the gaps.

The relatively short shrift given to phonological topics in these grammars is regrettable but the almost total neglect of phonetics, often to the point of even failing to provide clear descriptions of typical segmental realizations, is even more distressing. Factors in the current professional socialization processes of the discipline of linguistics partially account for this situation. Many modern linguists receive minimal training in phonetics, especially if they elect to specialize in syntax. Many doctoral programs in linguistics implicitly or otherwise encourage students to select an identity primarily as either a "Ph" (phonetics and phonology) person or an "S & S" (syntax and semantics) person. Since a good grasp of the syntax of a language is fundamental to writing a grammar, not surprisingly many of those who write grammars have their deepest professional education in syntax. For some, enough phonology to develop a workable transcription is the limit of their ambition in dealing with the sound system of the language.

But this is probably far from the only factor involved. It seems that the 'market' for grammars has changed in a significant way during the past century. In the earlier decades of the twentieth century a good proportion of the linguistic description being published was targeted at those who wished to actually learn to speak the language being described, including in the case of the more 'exotic' languages such people as anthropologists preparing for field work, missionaries, and colonial administrators. Also at this period phonetics and phonology were not divorced from each other, as they later became with the development of structural linguistic theories that treated the sound structure of languages as primarily a system of contrasts between abstract phonemes or features, and moreover one in which minimizing the number of entities involved was a highly prized goal. Consequently earlier descriptions often aim to provide enough guidance to enable a native speaker's pronunciation to be imitated and they avoid the reductionism which later structuralism encouraged.

### *Phonetics in the Field*

In the second half of the century, grammars are targeted primarily to an audience of professional linguists, phonology is regarded as a separate sub-discipline from phonetics, and language manuals take over the role that grammars used to play for those trying to learn to speak a language. Some grammars of the 1960's and 1970's, e.g. Carrell 1970, contain no phonetic information whatsoever and are largely impenetrable even to linguists trained a generation later. Although in the closing decades of the century, some of the major movements in phonology began to re-emphasize the phonetic foundation on which sound patterns rest, this concern is not reflected in any overall greater attention to phonetics in grammars of this period, as we have seen.

In the next section of this paper it will be argued that explicit phonetic documentation should be a basic part of any grammar which aims to give a general description of a language. The third section of the paper discusses briefly what phonetic properties should be the prime targets for investigation and exemplifies some of the techniques for obtaining appropriate data under field conditions.

#### **2. The need for phonetic documentation**

There are several reasons why a grammar should be regarded as incomplete when it lacks careful phonetic description and documentation. The first is that when segmental phonetic properties are only characterized by symbols and descriptive labels the results are often imprecise or ambiguous, or even uninterpretable. But in any case more than precise segmental descriptions are required. The phonetic properties of a language are the foundation for non-arbitrary patterns in its phonology. Morphemic or syntactic constituency, or the organization of phrases into larger phonological units may be indicated by phonetic boundary markers or other phonetic variations. Segments vary in context and interact with each other and with non-segmental properties in distinct ways in different languages, and this too is part of the grammar of the language. In short, languages have a "phonetic grammar" and the highlights of this should be covered in an overall grammar, just as the highlights of its syntactic and other more conventionally "grammatical" properties are covered.

The frequent use of ambiguous symbols and the occurrence of descriptions which are vague or worse is partly the fault of the standard frameworks of phonetic and phonological description, but is often aggravated by lack of precision by users. For example, the grid of categories and symbols provided by the IPA in its chart of consonants is unhelpful in a number of ways. A case in point is the column headed 'retroflex'. This term has been used for consonants with three fairly distinct articulatory configurations (Ladefoged & Maddieson 1996); one in which the underside of the tongue tip makes contact with the front part of the hard palate (e.g. as in Telugu or Arrernte), one in which the tongue tip makes contact a little behind the alveolar ridge (e.g. as in Hindi or the Norwegian 'retroflex' consonants written 'rd,' 'rn,' 'rs', etc); and one in which the articulation is a laminal post-alveolar (as in the 'retroflex affricates' of Polish and Mandarin). In fact, the way the IPA

consonant chart is laid out tends to discourage careful description of consonants in the coronal area as a whole. Distinctions of place (dental, alveolar, post-alveolar), tongue position (apical, laminal), and sibilance, which may be crucial, are among those conflated on the chart. A symbol such as /t/ or /s/ may casually be used without specifying the actual pronunciation that normally occurs.

A symbol may also be ambiguous if it has been employed with different values in different traditions. For example, the letter /c/ is used in the IPA for a voiceless palatal plosive, but in Americanist tradition it usually represents a voiceless dental or alveolar affricate. If an author fails to specify which tradition they are following the reader must infer or guess the answer, and will not always get it right.

Further problems can be caused by the use of labels that have never had a very specific meaning, or have had their meaning 'bleached' by being constantly (mis)used in imprecise ways. These include terms such as 'fortis' and 'lenis'. Unless it is explicitly spelled out, a reader does not know what mix of voicing, duration, amplitude, and other properties are intended to be conveyed by these terms. Similarly, when vowels are described as differing with respect to the phonological feature [ATR] it is rarely clear if the language truly has independent use of tongue root position among its vowel parameters or if this feature is being used essentially as a diacritic prop to disguise an inadequate set of vowel height features.

Individual grammars may add to problems of this general nature by using terms in vague or idiosyncratic ways, or in other ways failing to provide sufficient information. For example, in Merlan's Wardaman grammar the symbols /k, g/ are placed on a chart of consonants in a column headed "velar" but the text states that "velars are dorso-palatal." Does this mean that these are actually true palatal plosives similar to Hungarian /c, ʒ/, or fronted velars similar to Kwakw'ala /k, g/, or perhaps velars with a palatal offglide, /k<sup>i</sup>, g<sup>i</sup>/, similar to the palatalized velars of Hausa? In both the short Nivkh and Evenki grammars mentioned above, the symbol /h/ is placed in a column headed "pharyngeal." In Russian linguistic tradition pharyngeal and laryngeal segments are often grouped into a single category, but without further information, knowing this fact doesn't resolve the uncertainty of what /h/ is intended to represent in these cases. Laryngeal and pharyngeal segments are also very obscurely described in van Eijk's Lillooet grammar. Liquids are particularly often inadequately characterized. Dutton's Koiari description uses the symbol /r/ and provides no description of it beyond "vibrant" (it quite likely is a post-alveolar lateral flap). Bulatova & Grenoble's Evenki grammar uses the symbols /l/ and /r/ but does not describe their phonetic nature in any other way, and this imprecision is compounded by a proof-reading error which sees both these symbols placed on the chart of consonants in a column headed "bilabial."

Even when attempting to provide phonetic information, ambiguities often occur. Du Feu's Rapanui grammar describes glottal stops in intervocalic position as being pronounced as creaky voicing "which shows up as white noise on spectrograms." The problem here is that creaky voice does not have an acoustic pattern that is anything like white noise, which would be closer to a description of [h]. The reader

doesn't know whether Rapanui has creaky voice or an [h]-like pronunciation in the position being discussed.

Outside the sample of grammars examined above, a favorite example of a difficult-to-understand description of segments comes from Stell's (1972) discussion of the phonology of Nivakle (also known as Axluxlay or Chulupi), a Mataguan language spoken along the Argentine/Paraguay border. Stell gives puzzling descriptions of two segments transcribed as [x̠] and [k̠] and described respectively as "A voiceless oral dento-alveolar velarized lateral fricative (with simultaneous articulation of a voiceless velar fricative)" and "A voiceless oral dento-alveolar velarized lateral affricate (with simultaneous articulation of a voiceless velar stop)" (my translations). There are multiple unclaritys in both of these descriptions. The simultaneities claimed are extremely improbable, but it is unclear if what is being described are sequentially-complex elements, or perhaps laterals with a primary constriction at the velar place of articulation — the affricate maybe being similar in articulation to the velar lateral ejective affricate of Zulu.

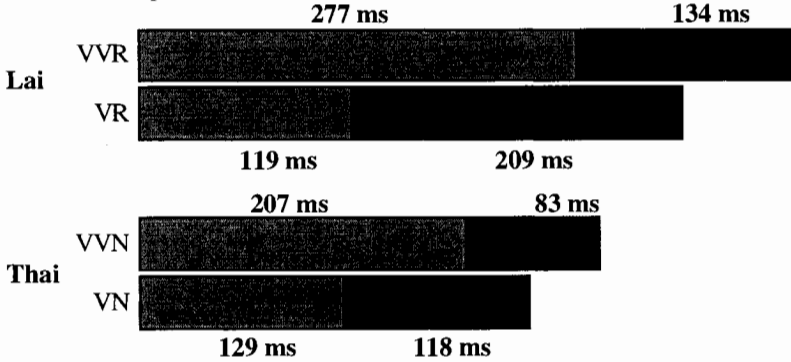
The frequent ambiguities and unclaritys in the literature provide a strong reason for wishing that field workers would do a better job of describing the phonetic properties of the languages they are working on. However, besides this rather negative argument there are very strong positive reasons to encourage closer attention to phonetics. Aside from the strictly contrastive distinctions that form the core of a phonological characterization of a language there are many other aspects of the sound pattern that must be correctly controlled by a native speaker and hence are part of what the speaker must learn in order to become fluent. In short, languages have a "phonetic grammar" as much as they have a syntactic one.

Consider the case of stop releases: languages differ in when a stop will ordinarily have an audible release. Tlingit requires an audible release of pre-pausal stops, whereas the audible release is often suppressed in this position in English. In Tlingit the first of two abutting stops within or between word boundaries also has an audible release in the great majority of cases if it is not homorganic with the second (Maddieson & Smith 1999). Thus in a phrase like /t̬eet kaa/ "white man" the final /t/ of /t̬eet/ is released before the closure for the velar plosive is made. On the other hand in an English phrase such as "white car" the velar closure for the initial plosive in "car" is almost invariably formed before the alveolar stop at the end of "white" is released (and that /t/ may also have its audible release further suppressed by an overlapping glottal closure).

There are also striking differences between languages with respect to the implementation of quantity contrasts, whether between long and short vowels or single and geminate consonants. Not only do languages differ in the ratios of long to short C and V durations but also in properties such as how durations of adjoining segments are adjusted in relation to quantity contrasts. Hakha Lai (Maddieson 2002) and Standard Thai (Mixdorff et al 2002) both show a compensatory duration pattern in which coda consonant durations are longer after a short vowel and shorter after a long vowel. But the pattern is more marked in Lai — final consonants after

short vowels in Lai are actually longer in duration than the preceding vowel — and hence following consonant duration can be expected to play a larger role in cuing the vowel quantity distinction in Lai than in Thai. Mean duration of long and short vowels (light stippling) and following sonorants (heavy stippling) from the two studies cited are shown in (3) (The Lai data include words with final nasals and laterals, the Thai data only final nasals).

(3) Duration compensation in coda sonorants in Hakha Lai and Thai.



A few of the phonetic patterns by which different languages differ can be briefly mentioned for exemplification. One is vowel-to-vowel coarticulation: languages differ in the extent to which one vowel affects the near edge of another across an intervening consonant. For example, in Eggon (a Platoid language in the Niger-Congo family) there is strong anticipation of V2 in V1 especially if V1 is unrounded and V2 is rounded (personal fieldwork). In Sotho, with a broadly similar 7-vowel system, there is little effect of this kind of one vowel on its neighbor (Manuel 1990). Languages also differ in the alignment of tonal targets with segmental landmarks. For example, Mandarin (Xu 1997) appears to have later target alignment than Thai (Gandour et al 1994), which in turn has later alignment than Lai (Maddieson 2002). To speak a language with native-like pronunciation, all such patterns in its “phonetic grammar” must be learned.

The phonetic patterns of a language also provide the foundation for non-arbitrary patterns in its phonology. For example, the tendency for the retroflex stops consonants to be absent from word-initial position in Australian languages has been noted often. This distributional restriction becomes understandable when the precise phonetic properties of these ‘retroflexes’ are understood: they are characterized by markedly shorter closure duration than other coronal stops and by a forward movement of the tongue tip in the releasing gesture, resulting in differences in onset and offset formant transitions. These cues to segment identity are not detectable when there is no preceding context (Anderson 2000).

There is often also phonetic marking of morphemic or syntactic constituency, of sentence type, and other aspects of varying levels of linguistic organization. For

### *Phonetics in the Field*

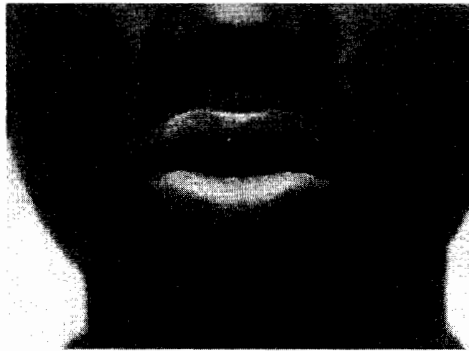
example, different degrees of final lengthening depending on the rank of a following prosodic boundary have been found in English and other languages (e.g. Beckman & Edwards 1990). Sentence types are frequently marked by intonation, and in some languages (e.g. French, Leggbo and Ghotuo) questions may be distinguished from statements by no other property.

All these considerations argue for greater care and more attention to be devoted to phonetic aspects of a language in a basic description.

### **3. Phonetics in the field**

Phonetic documentation as a part of field work has a considerable history. Classic field studies from the early decades of the twentieth century not infrequently include explicit evidence of articulatory or acoustic properties of the language studied. For example Goddard's (1907) work on Hupa includes a number of palatograms obtained using a moulded artificial palate in order to show details of the contact position of coronal consonants. Boas's grammatical outline of Tlingit (1917) included kymograms to show timing of aspiration and the relative fundamental frequency values of high and low tones. Doke's pioneering work in the 1920's on Shona includes photographs of the position of the lips in several sounds, including one to illustrate the so-called "whistling fricatives" reproduced here as (4). This clearly shows that the lips are not in a typical rounded position in these sounds (Ladefoged and Maddieson 1996).

(4) Lip position in Shona "whistling fricative" from Doke (1931)



The value of such documentation is twofold. First it enriches the description by providing more detail, but crucially it also provides evidence that can be independently evaluated. Thus, by including the photograph in (4) Doke does more than just show the lip position, he shows it in a way that can be scrutinized by others who can therefore decide for themselves if a description provided is appropriate.

The remainder of this section will discuss suggestions about what phonetic data

should be included in a field report, as well as reviewing some of the issues that phonetic investigation can address, exemplifying the phonetic investigations that can be readily carried out in field situations, and discussing some of the practicalities involved. An ideal to have in mind is to provide enough phonetic information that a reader would be able to sound like a native speaker. A grammar writer might imagine he or she is describing the speech of the last generation of fluent speakers and aims to do it well enough that their grandchildren will be able to learn to sound like them and react like them to hearing the language spoken. Like other ideals, this is unattainable, but serves as a goal to reach towards.

The target should be to show representative speech behaviors of the linguistic community. But simple exemplification of raw phonetic patterns is not helpful. Phonological perspectives, especially contrast, are required to provide the framework for organizing phonetic data into appropriate categorical form. The phonetic investigation should therefore address such matters as the basis of syntagmatic contrasts, the nature of contextual segmental (or tonal, etc) variability, and the phonetic marking of prosodic or other constituency relationships. Phonetic investigations begin with direct use of the visual and aural senses, followed by the collection of audio exemplars. They can also encompass acoustic, articulatory and perceptual investigations.

Sound recordings provide the most basic form of phonetic documentation. Recordings, especially of texts, also serve to record lexical, syntactic and other data. The recording environment and the type and positioning of the microphone used make more difference to resulting recording quality than the choice of recording medium and machine (Maddieson 2001). A recording of a single speaker intended for careful listening or acoustic analysis is often best made using a head-mounted microphone. The close-range pick-up minimizes background noise, and the speaker-to-microphone distance is kept fairly constant so that relative amplitudes are more faithfully preserved than when the speaker is free to move or turn away from a free-standing microphone.

To make a good recording one should seek the least reverberant environment free of continuous noise sources. In some situations this is likely to be an outdoor setting. Sound reverberates in closed spaces, especially when the surfaces (walls, floors) are smooth and hard. This can cause considerable problems, particularly when one wishes to make measurements in the time domain. Indoor spaces are often noisier than may initially be apparent. Human hearing can focus selectively on signals of interest and “tune out” a lot of background noise; a microphone picks up every sound in its range. An important skill to develop is to listen for any persistent interfering sources of sound, such as wind noise, a refrigerator running, building air-conditioning, noisy fluorescent lighting, traffic noise, etc, and eliminate or avoid as many as possible. Short-term noises — the crowing rooster, or single passing truck — are less of a problem than these persistent noise sources. You can always re-record an item if a short-term noise interrupts, but persistent noise overlays the entire recording.

*Phonetics in the Field*

Outdoor recording is illustrated in (5), taken during fieldwork on Wichí in collaboration with Marisa Censabella (photo courtesy of Jose Braunstein). Relatively constant levels of wind and insect noise, and intermittent bird calls and voices of other speakers were considerably muted by the use of the head-mounted short-field microphone worn by the speaker being recorded in the foreground, and reverberation was eliminated. A sample of the resultant waveform is shown in (6).

(5). Outdoor recording of Wichí at Lote 42, Las Lomitas, Argentina.



This waveform covers about three and half seconds and contains three repetitions of the word /t'u/ “grave marker.” The relative salience of the voice with respect to the background noise is apparent. The signal-to-noise ratio is good enough that quite precise measurements can be made of properties such as the timing of the glottal release and the onset of voicing after the initial ejective stops. Other available settings or different equipment would have yielded considerably less usable recordings.

(6). Sample of waveform (see text)

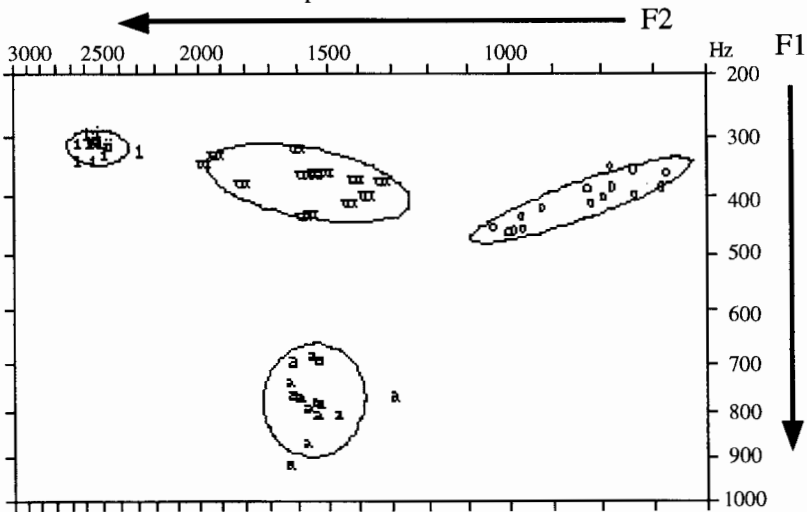


Analysis of timing and other acoustic properties is now easily performed by anyone with access to a personal computer using readily available commercial or free software. A certain level of experience is required to avoid the risks of misinterpretation, but linguists who may feel they lack this experience will find their

more phonetically-trained colleagues eager to assist.

Acoustic analysis is an especially good way to provide objective data on vowel quality as well as being an easy way to obtain accurate timing information. Basic information on vowel formant frequencies not only supports decisions on how to categorize vowels but also provides data on more gradient properties such as their relative positioning. A plot of the four vowels of Shipibo (Valenzuela et al 2001) in a perceptually-scaled two-formant space is shown in (7). Each symbol represents a single token while the ellipses enclose an area encompassing roughly 90% of the variance among tokens of each vowel type for this speaker.

(7). Acoustic distribution of Shipibo vowels



As (7) shows, the three non-low vowels are all quite distant from the single low vowel, but become progressively lower as one moves further back in the acoustic space. This provides much more subtle information on these sounds than is provided by, as here, choosing the symbols /i u a o/ to represent them. The reason for hesitation between representing the back rounded vowel with the symbol /o/ or with the symbol /u/ in the literature on this language becomes apparent.

As remarked earlier the articulation of coronal segments is often poorly described. A good way to document their articulatory position is to use the old-established technique of palatography, as well as linguography, its counterpart for seeing the part of the tongue involved in making the articulation. This is an easy field operation which subjects often find quite entertaining. Ladefoged (1997) describes how to do it in some detail, but a simple photograph of a sample palatogram can be sufficient to answer important questions. Recall the speculation, based on Stell's discussion of Nivakle, that this language might have velar laterals. Recent fieldwork employing a combination of acoustic analysis and palatograms

*Phonetics in the Field*

has been able to show that the segments given such ambiguous descriptions by Stell consist of less exotic alveolar laterals, as demonstrated in (8). The dark markings behind the teeth visible in the reflection of the palate in the mirror in the two pictures in (8) show where the tongue, painted with an olive oil and charcoal mixture, contacted the alveolar ridge in pronouncing the two words illustrated.

(8). Palatograms of Nivakle laterals

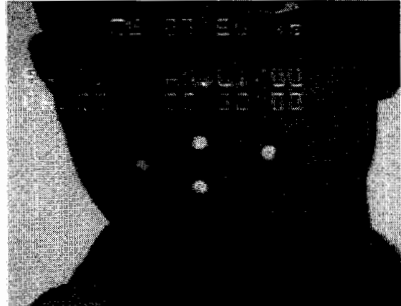
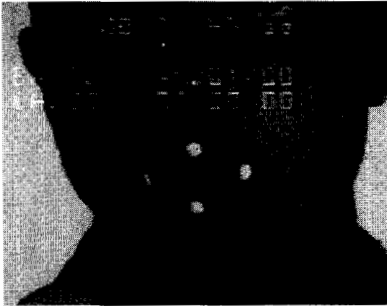


Nivakle /ekle/ "parrot" — simple sequence of /k/ + /l/



Nivakle /ʔa/ "fruit" — voiceless alveolar lateral fricative

9) Lip position in Avatime /ax<sup>w</sup>a/ "charcoal" (left) and /koʔe/ "farm" (right).

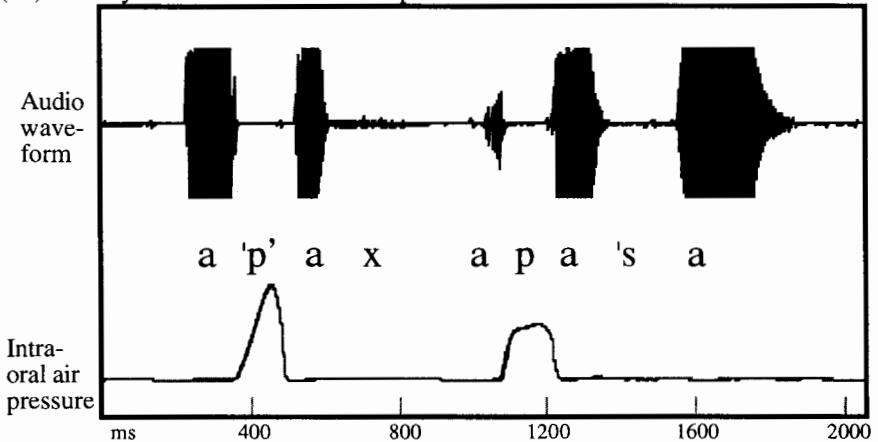


The pictures in (8) were filmed with a video camera, but direct video recording of a speaker in action is also a good non-invasive way to document certain articulatory movements, especially of the lips. A stabilized rather than hand-held camera and a constant camera-speaker distance greatly facilitate comparison across utterances, so a tripod or other device should be used and the speaker seated on a firm chair facing the camera, or at right angles to the camera for a side view. Position yourself in front of the speaker to keep his or her attention directed and cue what you want said without having the speaker look down to read. Putting small markers on the face makes it easier to track movements. If a ruler placed in the plane of the speaker's face is also filmed it then becomes possible to measure

distances between points and calculate the extent of movements. Two frames from a video study of Avatime (Maddieson 1998) are shown as (9). These show the maximum constriction of the lips in the consonants /xʷ/ and /ɸ/ and show how unlike each other these consonants are, although previously they had been described as both having a bilabial fricative component. The aperture between the lips is just 1.2 mm high in this token of /ɸ/ but is 5.3 mm high in the example of /xʷ/, during which the lips are also obviously protruded in a rounding gesture.

Most of the techniques used by phoneticians to track articulatory movements in detail, such as electromagnetic articulography or MRI imaging, are not adapted to use in field environments. However, comparatively simple computerized field units, such as the MacQuirer and PCQuirer from SCICON, are available to collect data on the aerodynamics of speech production. This data can provide valuable insights on articulatory timing, on laryngeal control, on airstream mechanisms in use, on nasalization, and so on.

(10). Aerodynamic data on bilabial stops in Nivakle.



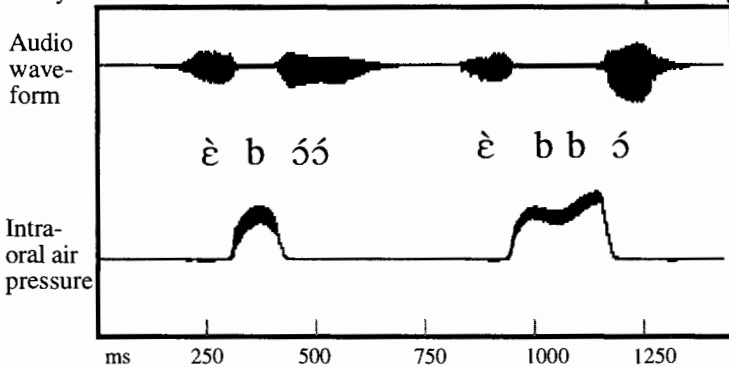
Among the many rather imprecise phonetic labels that are encountered is the term “glottalized.” When applied to stops this may imply use of the ejective mechanism, with the raising of the larynx creating the pressure behind the closure for an explosive release, or something quite different, such as the “glottalization” of voiceless stops in English, which blocks an audible release of the oral closure by preventing pressure building up behind it. Nivakle is one of many languages where stops have been described as “glottalized.” Air pressure behind the lip closure in bilabial stops was observed by having speakers say words while holding a thin plastic tube between their lips and recording the result to a computer using MacQuirer. Sample records of the words /a p' a x/ “snake” and /a p a 's a/ “your lips” are shown in (10). In the first of these, on the left of the figure, the pressure within the oral cavity builds up rapidly to a high level and declines as soon as the peak is

*Phonetics in the Field*

reached. By contrast, in the second word the pressure builds up to a lower peak but maintains an elevated level for a relatively extended time. The latter is the pattern commonly found in plosives, where the pressure increase comes from the nearly-constant driving force of the lungs. The more ‘ballistic’ pressure curve seen in the first word is the signature of an ejective stop, in which the pressure increase is generated by a short-term movement of the closed larynx upwards. Acoustic records also show the release of the glottal closure before the onset of the vowel. Together these data document that this word contains a true ejective stop.

Aerodynamic records sometimes reveal facts that are difficult to observe in other ways. In Leggbo, a Cross River language studied in the field methods class at UC Berkeley during the 2001-2 academic year, consonants have been classified as “fortis” and “lenis” (Bendor-Samuel & Sprea 1969). Work by myself and Julie Larson has shown that the consonants labelled “fortis” have about twice the acoustic duration of their “lenis” counterparts (where pairs exist), suggesting that a transcription as geminate vs singleton consonants is justifiable, as in the words /èbbó/ “branch” vs /èbóó/ “hand.” Aerodynamic records reveal something that cannot be seen in the acoustic data: the “fortis” closure in /èbbó/ has two separate pressure peaks, suggesting that it is organized more like a sequence of two separate segments than like a single lengthened one. This finding reinforces the case for considering that the “fortis” /bb/ is serving as both a coda and an onset.

(11). Aerodynamic records of “lenis” and “fortis” voiced bilabial stops in Leggbo.



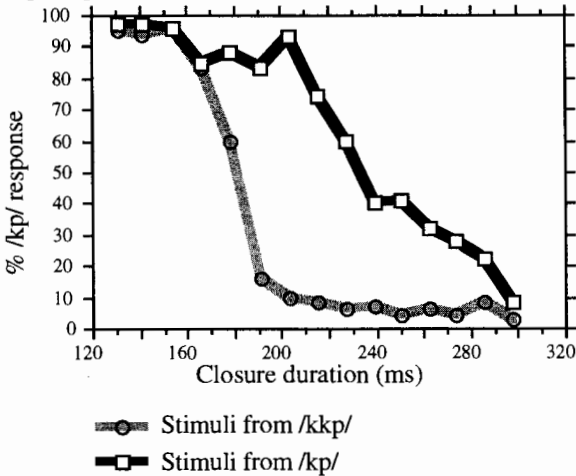
The final type of phonetic data that will be discussed relates to hearing and perceiving speech. Auditory processing of sound is broadly similar for all people (without significant hearing loss), but perceptual processes are greatly influenced by linguistic experience and are less universal. When a listener can see a speaker’s face there is also the influence of the visual information on perception to consider.

It can be quite easy to devise and carry out perceptual experiments in the field by presenting unaltered or edited recordings for listeners’ judgments. Such experiments can, among other things, search for native speakers’ impressions of perceptual similarity, explore which acoustic characteristics play a greater role than

others in cueing recognition, and test for the location of category boundaries. Common models for such experiments would include simply asking subjects to identify what they hear, having them assign a 'goodness rating' to stimuli, or asking if they can discriminate between two samples. Natural tokens or ones edited with software designed for the manipulation of sound can be used, depending on the target of investigation.

An experiment prepared by Julie Larson and administered in the field by Imelda Udoh was designed to examine if other properties of the "fortis/lenis" consonant pairs in Legbo besides the duration contribute to their identification. As part of this experiment, natural tokens of two minimally distinct items, /ɛkpa/ (a man's name) and /ɛkkpa/ "he paid" were edited by adding or removing some of the silent duration in the middle of the consonants closure (/kpa/ represents a fortis, or geminate, voiceless labial-velar plosive). Two continua were thus produced with consonant durations ranging from about 130 ms to about 300 ms, these end-points being the natural durations of the two original tokens. Properties of the consonant onsets and releases were not modified. If duration is the only parameter involved in the contrast, then tokens lengthened from /kp/ and tokens shortened from /kpa/ should both reveal the same critical duration value at which the preponderance of judgements switches from "lenis" to "fortis."

(12). Results of perceptual study of "lenis" /kp/ and "fortis" /kpa/ in Legbo.



Nine subjects gave their judgments as to which word they heard in response to each token. The results in (12) show that duration is only one factor that governs the perception of the distinction between these words. Lengthening /kp/ by about 100 ms switches its perception to /kpa/, showing that duration can be a sufficient cue to "fortisness," but shortening /kpa/ does not shift its perception to /kp/ until the duration is down to about 180 ms. Evidently other properties than duration

contribute to the distinction between these sounds. This finding in turn motivates a more extensive study of the acoustic and articulatory differences between such pairs to discover what these properties might be.

#### 4. Summary

The intent of these remarks is obvious — to encourage more attention to the description of the basic phonetic facts of the world's languages as part of the reviving interest in language diversity. The paper has attempted to do this both by showing where much linguistic data collection fails in this regard and by showing how easy it can be to do better. This author and many of his phonetician colleagues stand ready to help other linguists to take the plunge into documenting the phonetic patterns of the languages they study if that help is needed.

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*Phonetics in the Field*

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