{background from Chapter 1: students have been told about notions of 'grammar' and 'rule' without detailed explanation of what a rule is; about "cognitive symbol", and they will have some elementary understanding of the tradeoff between accuracy and usefulness as they relate to sound. Towards that end, they will have experienced https://languagedescriptions.github.io/IP3/ch1web.html – this includes a pdf draft of Chapter 1 – which presents an utterance of two Logoori words ('dog', 'new') and different ways of 'representing' these utterances (playable sound file, sequence of integers, waveform picture, spectrogram, ending with a table of F1, F2, F3 frequencies and the sound that can be resynthesized from just that information). The final conclusion of Chapter 1 is that to say anything sensible about language sound, we need an even-more symbolic and compact tool – a phonetic transcription. Segue into ch. 2, which is a practical study of what it means to 'transcribe' a language into a phonological dataset}

1.1. Introduction

The main point made in Chapter 1 is that phonology is about the analysis of language sound data, from the perspective of a sound being a discrete mental symbol. We reduce continuous physical sound from speech to a sequence of specialized symbols, the enumerable sounds of a language, ones which can be printed in a book or texted on a phone – a transcription. These transcriptional letters represent the cognitive symbols which a (mental) grammar operates on. Throughout this book and in all phonological analysis, you will be dealing with sequences of such written symbols, that is, language data. You should then wonder, how are these data created in the first place? All of the data in this book, and any other writings on phonology, originate from somewhere else, such as a book or article, sometimes a personal data repository. They were originally created by someone, using some analytical procedure. In this book, some of what you experience is a portion of my own personal data repository, which comes from some decades of study working with speakers of various languages of the world. Ultimately, phonological data come from a written source prepared by a person with personal experience in the language. The source may be something written by a native speaker scholar in the language, but the most enlightening case for us to consider is what happens when a specialist in field linguistics, one having no prior knowledge or preconceptions of the language, works with speakers of the language and learns enough about the language that they can provide us with data and analysis of the language, going from zero knowledge to publishable knowledge. The basis for all grammars (leaving aside grammars of long-dead languages which involve indirect guesswork about pronunciation) is the analysis of speech, which requires reducing physical speech to fixed symbols.

You might think that reducing language to a form which can be put in a book is a simple matter, we just use the standard spelling of words in that language. This won't work for many reasons. First, very many languages of the world are not written, and there is no standard spelling or even standardly-known script for the language. Second, as is well known from English (and many other languages), spelling conventions tend to be highly variable. The letter "c" means very different things in French, Chinese (Pinyin), Somali, Zulu, Turkish and Latvian. English spelling is particularly arbitrary, given the many ways of spelling the same vowel in "l**ee**k, l**ea**n, l**ie**n, L**e**na, l**e**nient, am**oe**ba". Languages in their written form very often leave out from spelling important aspects of

pronunciation that are of interest to phonology, such as the difference between the noun "**i**mport" versus the verb "imp**o**rt" (stress on the first versus second syllable). Furthermore, it would be impractical for a student to have to learn dozens of unfamiliar scripts in order to understand and analyze data like ብቅዓት, مَفْعُوْل, हाथी, դnղալ or 송아지. For this reason, linguists present data using a compact system of symbols which stand for the mental symbols that we believe underly language. Data is presented in the form of a transcription where each symbol has a standardized auditory definition. This chapter walks through the logic of converting physical speech into written symbols, where we start with no preconceptions about the language in question.

You were probably introduced to the present standard system, the International Phonetic Alphabet, in an introductory course. Two-thirds of that system is the IPA chart [inserted somewhere], which is a set of symbols and associated articulatory labels. The symbol [p] represents a voiceless bilabial plosive, which means that it is formed without vocal fold vibration, it has complete closure of both lips, and the lip closure is maintained throughout its production. It is not difficult for the researcher to verify these aspects of the production of [p] by observing the lips or feeling with your fingers for vibrations in the larynx, but without invasive physiological studies, it is difficult to directly observe the articulatory state of most language sounds, such as a voiceless epiglottal fricative (produced at the back of the throat). If we can't see what is going on when people speak, how can we have any idea whether to use [q], [ɢ], [ʀ], [ʁ], [ħ], [ʜ], [ʢ] or any of the other back-of-the-throat symbols, and how do we really know that is is a back-of-the-throat sound? Normally, we just ask the speakers who we are working with to say words and don't ask for instructios on how to articulate sounds. How do children learn how to articulate the sounds of their language, since they don't have access to x-ray or ultrasound machinery?

We do not generally decide on transcriptional symbols by invasive physiological inspection. A third factor, the auditory value of the transcriptional symbol, provides the necessary linkage that allows one to relate a particular language sound to an appropriate IPA symbol and its articulatory description. To put it simply, each IPA symbol has a distinct characteristic sound. The vowel [ɑ] sounds different from the vowels [ɛ] or [æ], and the consonant [n] sounds different from [ŋ]. One of the basic tools and necessary trainings of the field phonologist is what is conventionally known as "ear training", a course of study where one gains knowledge of this standardized sound-to-symbol relationship, where one develops the skill required to assign an appropriate phonetic symbol to a particular language sound.

Historically, transmission of knowledge of those sound-symbol standards was a bit haphazard, often reducing to crosslinguistic comparison. One might learn that [u] is "the vowel in English *s**u**per* or German *Z**u**g, Kr**u**g*", which is only helpful if you have experience with the right dialect of English or German, the one that I might be referring to. Much more useful was being trained by a expert teacher who previously received standard training from another previously-trained expert teacher, and who could accurately produce all of those sounds. Contemporarily, a simple solution is that you can consult online collections of reference pronunciations produced by experts in the IPA, found at https://www.internationalphoneticassociation.org/IPAcharts/inter_chart_2018/IPA_2018.html, a resource which we will rely on in this chapter. The four scholars providing reference

pronunciations there have extensive experience in the IPA, and we will treat these recordings as defining auditory standards for IPA symbols.

This chapter simply seeks to give you basic knowledge of how a field phonologist converts continuous speech into a set of discrete symbols, and does not aspire to teach you all of the requisite skills for doing this yourself, for all sounds in any language. Those are skills developed in a field methods course. We will consider some basic problems of symbol choice for vowels, because vowels are very easy in some ways (they can be prolonged and uttered alone, which aids hearing) and very difficult in other ways (they are highly variable). This chapter works in parallel with online materials <interactive page https://languagedescriptions.github.io/IP3/ch1web.html, zip file archive to be placed on Zenodo>.

The first preliminary exercise is to listen to the vowel recordings on the IPA web page at https://www.internationalphoneticassociation.org/IPAcharts/inter_chart_2018/IPA_2018.html. Calibrate your vowel experience by listening to all four speaker recordings at least for the vowels [i ɪ e ɛ æ a], so that you have experience with the standard pronunciations of these vowel symbols. Bookmark the table so that you can easily call up the reference recordings. The question to consider in listening to these recordings is, are the online reference pronunciations identical within a given symbol, or can you hear any differences?

The easy answer is that all of the recordings sound somewhat different from each other. At the same time, within the symbolic group, each of the recordings sound similar the other 3 recordings within the group, and each group collectively sounds different from the examples in other symbolic groups. I find all 4 recordings of [i] to be very similar, although I can hear differences in personal voice quality, and there are also uncontrolled differences in intonation (duration and pitch) which are not part of the defining nature of the [i] auditory samples. Pitch is clearly falling in the samples of [i] for JE and JH compared to PL and JW, but we just ignore that difference.

Likewise the samples of [ɪ] are highly similar within that group. The small variation within each symbolic group is not significant for the purposes of the field phonologist, what is important is the significant difference *between* the symbolic groups. As a whole, the [i] examples sound different compared to the [ɪ] examples, and the [e] examples as a group sound different from the [ɛ] examples as a group. Transcription is, at its core, the enterprise of detecting similarities in some respect, and setting aside differences in other respects. Of course, the ease with which you might hear differences also depends on the languages that you speak. A person speaking Quechua, Tamazight or Inuit (which have 3 vowels) will have a reduced native-language basis for distinguishing the 9 vowels of Sotho, compared to a speaker of English, which has a more-similar vowel system.

What underlies these differences in vowels is a physical difference (the primary one for vowels), namely the formant values. The first and second formants of these reference recordings of [i] are rather far apart, compared to those for [ɪ] where the formants are closer together. In a typical vowel chart, the placement of a particular vowel reflects these formant relations. When we say that one vowel sounds “higher” than another, this generally refers to the value of the first formant (F_1) – higher vowels have lower F_1, and the impression of differences in backness / frontness or rounding generally reflects differences of the second formant (F_2).

At this point, we are only considering auditory comparisons between a specific instance of a vowel in a specific language, in relation to a fixed standard. The problem that immediately arises in comparing an utterance in an actual human language to the standard samples is that specific language samples are typically outside the narrow range of variation encountered in the reference pronunciations. A typical American English [i] is not as high- and front-sounding as the reference samples for IPA [i], but American English [i] is still closer to reference sample [i] than to any other vowel. The Turkish vowel transcribed in IPA as [i] is physically midway between the Dutch vowel transcribed as [i] and the Dutch vowel transcribed as [ɪ]. The physical target for [i] in Turkish is different from the physical target for Dutch [i] or [ɪ] (see Ahn & Chodroff data: https://osf.io/t957v/files/osfstorage/656b65cd783ec60ebaeddc37). In selecting a vowel symbol, we aim to find the *closest* match. A vowel-category measurement in the form of an IPA symbol is not a numeric formant measurement, which we touched on in the first chapter.

To summarize, when a field phonologist begins the process of creating written data for a language, they start by comparing specific sounds of the language to fixed reference values. Those reference values are broad ranges, not exact points, and the fundamental question for the transcriber is "is the vowel in this utterance closer to standard sample [i], or is it closer to [ɪ]?", or some other applicable choice. Our next task is to actually do this, by discovering the vowels of Logoori (https://languagedescriptions.github.io/IP3/ch2_1web.html). Go to that page and do the set 1 exercises.

1.2. Logoori

Logoori is a member of the Bantu language family, spoken primarily in western Kenya. In this section we will be considering pronunciations from one speaker (EM), re-creating the experience of hearing and transcribing sounds of this language for the first time. Since he and I both speak English, we carried out our data-gathering sessions in English. I started out knowing nothing at all about the language, and he started out knowing nothing about the theory of language sounds. The simplest thing to do was for me to collect a bunch of words, asking EM "How do you say ___ in Logoori?", filling in various English words. In order to make the resulting data somewhat systematic, we start by asking for infinitives of a few verbs. This results in a short recording of 20 words. You presumably recognise that this is a very simplified and curated version of the field-phonologists's experience. One does not typically start research on a language by asking for a word meaning "to try to milk a cow that has little milk" or "to pick crops".

1.2.1. SET 1 RECORDINGS

In your version of learning to transcribe Logoori, you will use the online recordings, therefore go listen to the vowels in Logoori set 1. Write down all of the pronunciation details that you notice when you play back the recording, referring to the IPA reference recordings as a reminder of what the various symbols standardly sound like. This step is important because if, for example, you are a speaker of English, your experience with "e" and "o" is very different from the standard as defined for the IPA. After listening to the recordings a couple of times, we fill in our transcriptions, and line up our examples

according to what we think the second vowel in the word is, to check our judgment (see the second data display on the web page). We then arive at a list like (1) as a first approximation.

(1)	to prohibit	kugaja
	to know	kumana
	to shave	kovega
	to milk	kokeɾa
	to laugh	koseka
	to chop down	kotema
	to measure	kubima
	to press	kubina
	to destroy	kudiva
	to slaughter	kusinza
	to boil	kuviɾa
	to do	kokoɾa
	to make into pieces	kodona
	to get	konoɾa
	to point at	kosona
	to be rude	kufuɾa
	to grow old	kukuɾa
	to beat	kukuja
	to be tired	kuɾuha
	to bite	kuɾuma

We notice that the language has some kind of *r*, but it is different from English *r* (depending of course on what dialect of English you speak). We review the various r-like sounds of the IPA reference recordings, rejecting the approximant [ɹ] and the trill [r] as too different from what we hear with Logoori *r*, therefore we decide on the tap [ɾ].

The rationale in selecting these verbs in the infinitive is that we want to control variation and focus on one thing, the vowel of the second syllable. You probably noticed that the first syllable is very similar across words and you would be correct in guessing that there is a prefix, also all of these words (which are verbs in the infinitive) seem to end in the same vowel, but this is not important right now. What is important is, how do we choose the best vowel out of the 22 available in the chart?

Because of your (recently-acquired or refreshed) training in the auditory reference of the IPA vowel symbols, it should be very easy to narrow the possibilities for the word-final vowel to something in the "open" range of the chart. For the verbs 'to prohibit; to know', the second vowel clearly does not sound like the rounded vowels [œ, ɒ], and hopefully they do not sound to you like [æ]. The second vowels in the Logoori words 'to prohibit; to know' sound like each other, suggesting that they are in fact "the same vowel". They are closest to [a, ɐ, ɑ], and least like the other vowels. Now we encounter a classic, indeed defining, problem of transcription, which is that the Logoori vowel of these words is somewhere between these three IPA vowels, and it is difficult to judge closeness when the vowel in question seems to be equidistant from three points. However, after repeated listening, we may exclude [ɑ] as being the furthest from the

Logoori vowels in question. Simply for the sake of ease of typing and in order to make progress in creating data, we select [a] as the symbol for this vowel. After we have acquired and judged further examples, we may reconsider this choice: or we may stick with it.

Next we ask about the second vowels of 'to shave; to milk; to laugh; to chop down'. The most obvious choices are [e] and [ɛ], [æ] and [i] being too far off (that is my judgment, if your language has only two or three vowels you have have a different judgment, but the point of ear training and re-calibration according to the pronunciations on the IPA webpage is to overcome native language influences). Again, the Logoori vowel sounds (to my ear) most like [ɛ] rather than [e], therefore by the standard "which one does it sound closest to?", I would say [ɛ]. On the other hand, in the case of 'to do; to make into pieces; to get; to point at', the Logoori vowels sound equally close to (far from) [ɔ] and [o]. Rather than making a definitive decision as to vowel symbol, we commit to the idea of contextual uncertainty. Right now, we do not have enough experiential basis for making a strong claim that the vowel is definitely [ɛ] or [e], [ɔ] or [o]. Expedience therefore wins in this case, we will write the vowels as [e, o], but we will report that the quality of "e" in this language is close to IPA [ɛ].

The purpose of these transcriptions is to provide a convenient mnemonic that identifies which thing of the language we are referring to. If our intent is to say what the physical properties are for a certain vowel of Logoori, we directly measure those physical properties using phonetic tools, but to do that, we have to sort our examples according to which vowel *qua* category they contain. In a transcription, [e] is not a physical measurement, it is a perceptual hook to hang data on. We could decide to write the vowel with a unique symbol such as [Ǝ], but that defeats the purpose of using standardized symbols.

1.2.2. SET 2 RECORDINGS

The sounds of this language do not seem terribly difficult, but still we need to check our conclusions, to be sure that they hold up against new data. Therefore, we collect a second recording for some of first set of words, and add some new words to expand the contexts where vowels might occur, and to see what new sounds we can uncover. Now listen to and transcribe the recordings of set 2.

(2)

to know	kumana
to shave	kovega
to laugh	koseka
to measure	kubima
to destroy	kudiva
to boil	kuviɾa
to slaughter	kusinza
to point at	kosona
to make into pieces	kodona
to beat	kukuja
to bite	kuɾuma
to dig	kujava
to cook	kodeka

to be hard	kudina
to hunt	kuhiza
to get better	kohona
to gossip	komona
to strip leaves	konoɾa

The point of getting the same word two or more times is to reconfirm the impression which you gained from the first listening. We do not expect the pronunciation of a word to change when a speaker says the word a second time, although we do know from the two pronunciations of "economic" – [ikəˈnɔmɪk] and [ɛkəˈnɔmɪk] – that multiple pronunciations of a single word are a possibility. Each repetition of a word in our collection sounds essentially the same as the other recording of the word.

It is true that sometimes one recording sounds louder than another recording, some recordings of a word sound faster than other recordings, and sometimes there is more random nose in a recording. The second example of *kumana* 'to know' is a little louder than the first, likewise *koseka* 'to laugh', and the first recording of *kuɾuma* 'to bite' is louder but the second is faster. **These are non-linguistic physical facts about sound recordings**. We are only looking for consistent linguistic facts that should be encoded in our symbol choices.

A thing that this review reveals to us is that we may have missed an important difference about what defines word differences in the language. This difference should strike you as you work down the online list. The recordings *kujava, kumana, kugaja* are overall similar despite differences in consonants, then suddenly *kotema* sounds very different – there is some kind of "emphasis" difference. Then *kodeka* sounds somehow different from *kotema*. We can group *kujava, kumana, kugaja, koseka* together as sounding similar in terms of whatever this property is, *kotema, kokera* and *kovega* as another group, and maybe *kodeka* as a possible third type.

At this point, we cannot be certain that this is a linguistic property, it might be a random characteristic potentially afflicting any spoken word. Speaking against the theory that this is random speech behavior is the fact that both of our recordings of the words *kumana, koseka, kovega* (which occur twice in the collection so far) are the same in terms of this emphasis, suggesting a linguistic pattern that should be included in the transcriptions. On the other hand, the two examples of *kovega* are not **as** different from the others as *kotema* is. We don't leap to any final conclusion at the moment, again we simply note that there may be some additional property needing to be integrated into our transcriptions.

1.2.3. SET 3 RECORDINGS

Therefore, as usual, we expand our database by gathering more data, leading us to Set 3.

(3)

kugaja	to prohibit	kujaɾa	to sue
kugaja	to prohibit	kuhana	to give
kokeɾa	to milk	kuhana	to close
kotega	to trap	kudaja	to demand payment

kotema	to chop down	koɾeta	to bring
konoɾa	to strip leaves	kudina	to be hard
kohona	to get better	konoɾa	to get
kuɾuma	to bite	kodoɾa	to pick up
kukuɾa	to grow old	komona	to gossip
		kukuza	to die
		kojeɾa	to be allergic, to sag (a house)
		kojeka	to sag (not a house)
		kohеɾa	to inhale

Going into this new set of words, we are paying special attention to this puzzling "emphasis" property in the expanded online collection. It is now clear that the differences are not random, they are consistently associated with particular words. In fact, we have a few pairs of words that seem to be the *same* in terms of consonants, yet they also seem to be different words with different emphasis patterns: 'to get' versus 'to strip leaves'; 'to give' versus 'to open'. We turn a randomly-ordered set of recordings on the webpage into a more-analyzed collection with three divisions that share similarities in this mysterious "emphasis".

We will continue to call these Group 1, Group 2, Group 3, and after reviewing the full collection again (online, go listen), we add Group 4 words which sound *like* Group 1 in part, yet they are still different. The problem which we are facing here is that unlike segments such as [a], [u], [m], [f], [θ], there are no defined auditory reference values for comparison. What cause this percept of different kinds of "emphasis" is relative differences between the vowel segments of the words in terms of two phonetic properties: pitch and duration. In the case of Groups 1 and 2, the three syllables of the word are more or less the same in terms of duration, but in Group 3 and Group 4, the second syllable is longer by about 75%, compared to the second syllable of Group 1 and 2. In terms of IPA symbolization, this would mean that Loroori has both long and short vowels, thus in [kugaja, kosona] the vowels are all short but in [komo:na, kono:ɾa] the second vowel is long. Long segments aren't defined by a specific number of milliseconds of duration, they are defined by how they differ from otherwise identical short segments in their duration.

The other syllable-emphasis property which we noted relates to voice pitch. Comparing online words in Group 1 versus Group 2, you will notice that pitch goes up on the second syllable in Group 2, but in Group 1, the voice starts at its highest point and then goes down. In fact, sometimes the voice stays rather high on the first and second syllables in Group 2 only dropping sharply at the last syllables, whereas in Group 1 there is a gradual drop across all syllables (we may notice other differences between the first and second syllables, but they are sporadic in the data and rather than trying to solve everything at once, we focus on the biggest and most stable difference that characterizes the four sub-groups).

There are two different ways of understanding this voice-pitch difference. One is that the language uses tone, the other is that words may differ in terms of their stress. If we think of this difference in terms of stress, we might transcribe 'to laugh' with stress on the first syllable as [ˈkoseka] and 'to shave' as stress on the second syllable as [koˈvega]. But we might also transcribe these words with tones, [kòsèkà] and [kòvégà]. While

segmental distinctions like voicing, nasality and palatality as encoded by various IPA symbols are predominantly based on different physical property of production (vibration of the vocal folds, airflow through the nose, fronting and raising of the tongue), the difference between "stress" and "tone" is much more abstract, and is mostly based on phonological function, rather than their physical method of production (although there was a historical belief that stress was "about" distinctive breathing patterns in language, stress and tone are both physically manifested primarily via modulation of the frequency of vibrations of the vocal folds). In fact, the question of whether a language has tone or stress is so complicated and tied up with phonological analysis that we will simply decline to make a decision in this chapter, and defer the answer to future research (for the curious reader, the tone analysis clearly wins in terms of phonological analysis).

Befitting the degree of uncertainty that we have as to what this "emphasis" is, we will rely on just two symbols, the long mark ":" which distinguishes long from short vowels – [kuja:ɾa] 'to sue' – and an acute accent for higher pitch that distinguishes [kókéɾa] 'to milk' from [koseka] 'to laugh'. One last note regarding this "emphasis" property: you hopefully noticed that the quality of the pitch-raising in group 2 words like [kókéra] 'to get better' is different from that of group 3 words like 'to cook' which have a long vowel. In words like [kókéɾa], pitch remains high throughout the second syllable but in [kodê:ka] it starts high then falls within the syllable, using the standard circumflex diacritic for "falling tone".

A fieldworker may use various technological aids to bring out a sound difference, in case simple listening does not yield perceptual clarity. One such technique, with examples on the web page, is to stretch a speech sample in time, to make it easier to notice changes that are obscured by the normal speed of speech. A non-technological version of this technique is to ask the speaker to pronounce the word very slow so that you can hear better. Sometimes this works, sometimes the speaker distorts the production in other ways. In this instance, the speaker was able to stretch his pronunciation out.

When we report our facts of the language, we pick a convenient transcriptional convention and explain as best we can the reasons for picking one notation rather than another. In this instance, I have chosen to use a tonal notation where the difference between H pitch and Falling pitch is preserved in the notation. More information about pronunciation is preserved in the data when you write [kokéɾa] and [kodê:ka] rather than [koˈkeɾa] and [koˈde:ka]. We may decide to eliminate that information in our transcription if we later find that it isn't actually essential, but we cannot restore it if we never recorded it in the first place. The problem with [koˈkeɾa] and [koˈde:ka] as transcriptions is that this gets rid of an audible and systematic fact of pronunciation – falling pitch in the latter case – and we are not yet ready to dispose of that information.

1.2.4. REVISED TRANSCRIPTIONS

At this point, we revise our earlier transcriptions to include the new-found facts about vowel length and high or falling tone.

(4) kuhana to close
kujava to dig
kudina to be hard

kufuɾa	to be rude
kudina	to be hard
kuɾuha	to be tired
kukuja	to beat
koseka	to laugh
kuviɾa	to boil
kumana	to know
kosona	to point at
kudiva	to destroy
kugaja	to prohibit

kúkúza	to die
kótéga	to trap
kókóɾa	to do
kóvéga	to shave
kóhóna	to get better
kúkúɾa	to grow old
kónóra	to strip leaves
kódóna	to make into pieces
kókéɾa	to milk
kótéma	to chop down
kúɾúma	to bite

kódô:ɾa	to pick up
kóɾê:ta	to bring
kódê:ka	to cook
kúhâ:na	to give
kúsî:nza	to slaughter

kuja:ɾa	to sue
kuda:ja	to demand payment
kuhi:za	to hunt
kubi:na	to press
koje:ɾa	to be allergic
koje:ka	to sag
kohe:ɾa	to inhale
kubi:ma	to measure
kono:ɾa	to get
komo:na	to gossip

In listening to these examples, you may have noticed that the consonant [j] sounds different in this language from what you are probably used to, certainly by comparison to English. The consonant [j] in Logoori has what seems to be a very light “coloring” of [ð], [l] or [ɹ] – something that makes it sound different. The examples are collected into one table on the web page, which you should review along with the reference pronunciations for [j] on the IPA webpage, plus some examples from North Saami.

In listening to the reference samples of [j], also compare the pronunciation of [ʎ]. You will notice that the pronunciations by the four expert speakers of both [j] and [ʎ] on the IPA page are all very similar. A number of Romance languages have [ʎ] as a distinctive sound – the Logoori version of [j] does not sound like the [ʎ] of Catalan, those dialects of Spanish which have it, Cuzco Quechua or North Saami (examples on the web page), which are languages where [ʎ] is a distinctive sound. This is an example of the point discussed above, that IPA symbols are not exact acoustic measurements, they are idealized centers of auditory regions which cover a range of actual pronunciations in human languages. In the case of [j] versus [ʎ], the reference pronunciations that we have are so close together that we cannot say that Logoori [j] is definitely more like IPA [j], or more like IPA [ʎ] (which is why the pronunciation of [ʎ] changes to be the same as [j] in so many languages). Since we generally lack a clear reference point for the pronunciation of [ʎ] versus [j] and since any experience that we may have had with Romance languages, Saami or Quechua point to [ʎ] as being very different from what we hear in Logoori, it would be misleading to the reader to write 'to dig' as [kuʎava], therefore we will stick with [kujava], but will also include a note in our description (grammar book) that the pronunciation is a bit different. A non-standard but common practice for conveying the special quality of [j] in Logoori is to write it with the dental diacritic, thus [kuj̪ava]. The ultimate solution to the problem of conveying this information about the special nature of Logoori [j], which is now fairly easy to implement given current technology, is to make samples available online so that you can hear words of Logoori, and perhaps compare them to words of Saami.

1.2.5. SET 4

Phonological field work is a continual process of gathering pronunciations, listening carefully and noting what you hear as best you can, listening again to make sure that all of "the same sounds" do indeed sound the same, and to be sure that the things that sound different do indeed sound different, rechecking any apparent anomalies. For the sake of this final Logoori exercise, we will expand our database a little bit just to make sure that we have a good grasp of our hypothesized vowels. We ask for a new set of words (check the webpage), you should listen and transcribe what you hear in Set 4. Initially, it seems that we have the following.

(5)	kukuɾa	to scrub
	kuku:na	to make a face
	kuku:na	to walk majestically
	kuɾi:nda	to watch
	kuɾî:ŋga	to fold
	kuɾuma	to make car engine sound
	kuɾu:mba	to push
	kuɾu:ŋga	to season
	kusi:ŋga	to give a bath
	kútúɾa	to leave
	kutuɾa	to smelt iron
	kútû:ɾa	to unload

kútú:za	to spit
kuvi:da	to sprinkle on medicine
kuvî:ka	to store a thing
kuvi:ŋga	to be pregnant (cows)
kuvi:ŋga	to thatch a roof
kúvína	to dance
kúvísa	to hide something
kúvíta	to pass
kúvúna	to harvest
kúvúɾa	to lack

But we notice in careful listening that the vowels *u* and *i* in these examples do *not* all sound the same, even factoring in vowel length and tone differences. We become *quite* aware of this when our speaker points out that 'to make a face' and 'to walk majestically' are pronounced differently, and we see other cases of different words that we were writing the same way, like 'to be pregnant' and 'to thatch'. Sometimes speakers ignore such differences, sometimes they notice them and make comments. Sometimes speakers think that a word with two meanings must be pronounced differently. We cautiously process the suggestion, allowing that maybe the words are not different in pronunciation, or maybe they are: the key is to be aware that there is some evidence of a difference in pronunciation. We gather together all of our new and old examples of *i* and *u* and do comparative listening, again on the web page. By grouping the examples first according to the vowel (our tenative vowels *i* versus *u*), then the preceding consonant, finally the following consonant, we have the recordings arranged so that the most-similar words are placed together, which allows us to better detect an otherwise subtle vowel distinction.

This review convinces us that there are two kinds of *i* and *u*, going beyond the aforementioned tonal or vowel length differences. Because of the words 'to make a face' and 'to walk majestically' which sound different but are *almost* the same, we have a good reason to believe that there are at least two more vowels in the language. Focusing on those two words and reviewing the IPA reference examples for vowels, we suspect that there may be a difference between [u] and [ʊ], an idea that gains support with [kukuja] 'to beat' and [kukuza] 'to die', where the vowel in the second syllable sounds different between these words. We then see that [kúrúma] 'to bite' and [kuruma] 'to make a car engine sound' not only have different tones, they have different vowel qualities in the second syllable. We also notice a pair of words with supposed [i], 'to be pregnant' and 'to thatch a roof', where the quality of the second vowel is different but the consonants, tone and vowel length are the same, which gives us a further point of reference for distinguishing the vowels of Logoori. We arrive at the conclusion that the language has the vowels [i, ɪ, u, ʊ] plus long versus short and high or falling toned examples of many of these vowels. It may be unclear in some cases which vowel we have, but we now understand that what we thought formerly were just [i,u] must be distinguished for being [i,ɪ] or [u,ʊ].

(6)	kubi:ma	to measure
	kubi:na	to press
	kudiva	to destroy

kúsîːnza	to slaughter
kuvɪra	to boil
kufura	to be rude
kúkúra	to grow old
kukuja	to beat
kuɾuha	to be tired
kúɾúma	to bite
kuhiːza	to hunt
kudina	to be hard
kúkúza	to die
kɔkuɾa	to scrub
kuɾiːnda	to watch
kuɾuma	to make car engine sound
kuɾuːŋga	to season
kusiːŋga	to give a bath
kútúɾa	to leave
kútûːra	to unload
kuviːda	to sprinkle on medicine
kúvîːka	to store a thing
kívína	to dance
kívíta	to pass
kúvúna	to harvest
kúvúra	to lack
kukuːna	to make a face
kukuːna	to walk majestically
kuɾîːŋga	to fold
kuɾuːmba	to push
kutuɾa	to smelt iron
kútûːza	to spit
kuviːŋga	to be pregnant (of cows)
kuviːŋga	to thatch a roof
kúvísa	to hide something

With our new awareness of the fact that the language has [i] and [ɪ], [u] and [ʊ], we would naturally re-check the pronunciation of *u* in the prefix [ku]. Listening to [kukɔːna] ‘to walk majestically’, [kukɔja] ‘to beat’, [kúkɔ́ɾa] ‘to grow old’, [kúɾɔ́ma] ‘to bite’ versus [kukuːna] ‘to make a face’, [kukuɾa] ‘to scrub’, [kúkúza] ‘to die’, [kuɾuma] ‘to make car engine sound’, we notice that the vowel of the first syllable in the first set of words sounds the same as the second-syllable vowel – but this is also true of the second group of words. This is a bit of a predicament, which we will have to investigate at some point in greater depth, not not right now.

To summarize our results for transcribing words in Logoori, and the relation of transcription to phonological analysis, analysis requires the reduction of speech to fixed categories with consistent referents – a range, not an exact point, with minimal overlap with other vowel categories. If we intend to physically measure the formants of vowels, we can only address issues of “average formant value” or “significantly different” if we

can sort vowels into abstract categories such as [e], [ɪ], [i] which define the items which the average is based on. With a categorization of vowels such as we have performed, we can then ask what the mean value of F_1 or F_2 is for [e], or whether the mean formant difference between [e] and [ɪ] is statistically significant. Without an initial categorization, phonological and phonetic analysis is impossible.

Because we do not know the categories in advance, we have to be able to revise our analysis, to recover possibly lost information coming from an inadequate transcription. If the information that we have preserved about the language is a set of transcriptions like [kukuja] 'to heat', [kukuza] 'to die', [kuvuɾa] 'to lack', [kutuɾa] 'to unload', [kukuna] 'to make a face', we cannot later discover that these words differ in terms of vowel quality, length and tone. Recovery is possible only if you can re-evaluate pronunciations, which in this case is possible because we have sound recordings. It is also possible (but less efficient) for the field-worker to recover from errors by re-eliciting previous inadequately transcribed data. Very often, we do not have such recordings, and with the increasing extinction of languages over time, rechecking is impossible so some of these losses are permanent. Field phonologists therefore (should) strive to make their transcriptions as accurate as possible, by creating what is known as a "narrow transcription", which contains the maximal level of detail about pronunciation. This serves as the basis for later analysis, and possibly reduction in the number of transcribed distinctions, once we are certain that particular facts are absolutely recoverable given a phonological analysis. As an example discussed in the next chapter, even though English has aspirated, voiced and voiceless consonants, the difference between aspirated (**t**op) and unaspirated (s**t**op) can be predicted by rule. In order to *discover* the rule, we have to initially record that information, before we can erase it as being predictable.

We did not definitively resolve the question of [e ~ ɛ] and [o ~ ɔ], and might simply end up saying that this is an area of uncertainty (meaning that one should not leap to firm conclusions about the phonetics of these vowels in Logoori based on a transcriptional choice). We might also take a brief look at more data at the end of the chapter.

{next section: Tigrinya and variable coarticulation}