The phonemes

when it all began there were
fricatives for all tongues
but it was a confused world
of hissing and hushing
so the sound said,
let there be nasals
and mum fell on everything
hissing, hushing, and humming, how boring
said the sound
so he ordered some action
and there came the plosives
hopping, stepping and stumbling
not bad, the sound said, yet i could think of better
so he ordered jumping affricates from africa
made of chained plosives and fricatives
the sound
took one look at his creation and
smiled
loving it all
but then came the grumbling, because the
fricatives, plosives and chained affricates claimed
they were voiceless - ssssss!
and the sound called them
obstruents, for being so insolent
yet he granted their wish
and gave them voiced cognates
thus satisfying them

...but that was only the beginning!

jonas n.a. nartey

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A STUDY IN PHONEMIC UNIVERSALS - especially concerning Fricatives and Stops

Jonas N. A. Nartey

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Gogo,

mikɛ wɔgbekɛ̃bii aʃĩ lala nɛɛ̃ miĩ̃da bo ʃĩ.

tʃio, tʃio, tʃio

kɔli,

mĩsɔ̃ tʃo ko nɔ̃

kɔli,

okɛɛ mba tre bo

kɔli,

mĩba mba tre bo

kɔli,

miĩ̃ya miĩ̃ya lɛ

kɔli,

okɔ tɛ mĩ yi sɛ

gbãŋ,

mĩhũ mĩkɔ tʃo ohĩŋmɛi

gblu,

oofo

yafo bɛ mlĩ hão,

ọola

lala bɛ mli hão.

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To Willie Martin, I say, thank you an awful lot.

Finally, I am grateful to the NIH grant NS09780-08 for their financial support.

And to Anna Smith I say, "this is only the beginning."

ABSTRACT OF THE THESIS

A study in phonemic universals - especially concerning fricatives and stops

by

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Master of Arts in Linguistics
University of California, Los Angeles, 1979
Professor Peter Ladefoged, Chairman

This thesis attempts to formulate certain assumptions about phonemic universals - especially those sounds referred to in phonological theory as true consonants. The phonemic inventories of 317 of the world's languages chosen on a genetic basis, are analyzed for universal tendencies in phonemic distribution.

This thesis consists of five chapters. The first chapter very briefly introduces the data base and its contents. The second chapter, which is loosely divided into two parts,presents the fricative inventories and the universal hypotheses based thereon, and attempts to provide phonetic explanations for the said hypotheses - based on current works in the field. The third chapter treats plosives and affricates in a similar way.

Chapter four takes a new look at Ferguson's (1961) assumptions about nasals - based on the new data - providing phonetic explanations where necessary. The fifth chapter brings all three classes of sounds together in a review of some current phonological theories of markedness.

Introduction

Ferguson's (1961) nondefinitional assumptions about nasals gave rise to a whole string of articles either in support or refutation of the hypotheses contained in the paper. While we are not claiming that all of the said assumptions were well founded, we need to point out that such explicit assumptions are a *sine qua non* for a young science such as Linguistics - if only for the fact that they make linguists search for data in an attempt to disprove them.

If the linguist making such assumptions happens to know the systems of all languages of the world, the said assumptions would then be statements of facts and not mere working hypotheses. But it is impractical - at least in the next generation or two - to think of knowing all systems of all languages! In fact, because of the death of languages it is always impossible to know all (past) languages. What is evident is that the nearest we can come to statements of facts is when our assumptions are based on carefully sampled languages. It is for this reason that we may not want to base such assumptions on Ruhlen's (1976) sample, and, even to take assumptions based on the Stanford Archives with a grain of salt. As pointed out below, these two samples are inadequate.

1. The UCLA Database

To solve part of the problem cited earlier, the UCLA Phonetics Lab members set up a phonemic data base consisting of the phonological segments of 317 languages[1] (see appendix G). The languages were selected mainly on a genetic basis. Thus a language is included in the sample if it is one of one or more members of a major division of a family of genetically related languages. By this definition, both Ruhlen's and the Stanford Archives' samples of languages are over-represented in West Europe as well as North America,and under-represented in Australia, South America, and parts of Africa and Asia.[2]

Included in the data base are the phonemes - by which we mean the primary allophone of each phonological unit - of each language. While this does not allow us to answer phonetic questions such as, "What proportion of languages use a phonetic segment which is a labialized voiced palatal fricative?", we are able to answer phonological questions of the sort, "What proportion of languages use a labialized voiced palatal fricative distinctively?" The justification for our present interest is that given a set of sounds one should be able to predict the relative frequency with which they are likely to occur in natural languages. This would help us formulate assumptions about synchronic versus diachronic status of phonemes in languages which we are investigating.

In order to achieve a uniform level of description for all sounds in all the languages in the data base certain steps were taken. For example, if there was reason to believe that a segment should be further analyzed into already existing segments in a given inventory, such a segment was left out. This issue is a choice between cluster or unit interpretation. In the interest of making a uniform decision a cluster interpretation was assumed, even when this interpretation was at variance with traditional accounts of the language. Based on the same principle, a language was said to have only segments A, B, C, D, E, even though our sources (see appendix H) would claim both short and long occurrences (i.e. A, A:, B, B:, C, C:, D, D:, E, E:) of all the segments. Where there was a clear case of unmatched segment duration, as in A, B, B:, C, C:, D, E, such segments were coded exactly as shown. In this way, when retrieving information about these segments, we could answer two different kinds of questions, namely those about phonetic quality, and those about duration.

In addition, this thesis further collapses dental and alveolar places of articulation except if both occur in the same languages - before making any statements regarding the universal tendencies of phoneme distribution. This was found necessary because our sources were not very reliable in distinguishing between segments in these two regions. For example, of the 273 /s/ phonemes in table 1 of the fricative chapter, 36 were specified as dentals, 72 as alveolars, while the remaining 165 were not adequately specified for their precise place of articulation to be known. We hope, by collapsing all three, to eliminate errors due to the inclusion of one to the exclusion of the other. (A recent study by Bright (1978) shows that the majority of sibilant sounds in most Californian aboriginal languages have been mis-classified - especially sounds in the region in question above. Bright suggests that the sibilant he represents with [s̪] had been inconsistently transcribed as [s] or [š] in earlier works.) Due to the same question of reliability of sources, sounds made with the body of the tongue were forced into the fourway grouping - palatal, palato-alveolar, velar and uvular. As a result, even though certain segments in some languages were labeled "pre-velar", we classified them as either palatal or velar depending on the distribution of the sounds, the description of the articlator or whatever was available. Similarly sounds labeled as "alveo-palatal" were classified as either alveolar or palato-alveolar. Note, however, that we attempt to preserve all the phonetic details in appendices B, D,and P. Thus appendix C lists GÃ, for example, as having /p b t d k g kp gb tʃ dʒ/ while appendix D explains that /p/ and /k/ are more aspirated than the other voiceless phonemes,and /t/ is more dental than /d/.

The following three chapters deal with fricatives, plosives and affricates,and nasal consonants separately. The final chapter treats all three classes of sounds together.

II. Fricatives for all Tongues

While numerous informal statements have been made about the universal tendencies of fricatives, no one has made any attempt to *show* these to be true or false. For example Fromkin and Rodman (1978) state, "If a language has fricatives (most do), it will have an /s/." (p. 331), and Bright (1978) states, "It is natural for a language to have at least one sibilant, namely a voiceless alveolar [s]. Languages like Hawaiian, which lack even this single sibilant, are rare (cf. Hocket 1955:108)." (p. 39); even though these statements are mostly true, there is no published research on which these remarks could be based, except some of what Hockett may have said. Where research justifying such statements has been attempted at all, it was secondary to something else,mostly generalizations about stop phonemes (Gamkrelidze, 1978 int. al.).

That the time is past due for the demonstration of such tendencies among fricatives can be seen from this year's (1979) Spring conference of the Acoustical Society of America, where out of 14 papers presented at the consonant session (FF), 7 were reports of experiments involving fricatives. We hope that the following statements will help provoke more interest in the phonetic and phonological studies of fricatives.

All but one of the eleven statements following are based on frequency counts, the one exception is a diachronic statement based on synchronic observations. The statements are mostly in the form of universal tendencies with various exceptions noted. Where necessary, the appropriate degree of statistical significance is noted. Also, phonetic explanations based on current research are provided.

The division of the statements reflect the major classes of fricatives, namely: primary fricatives and fricatives with secondary articulations or similar modifications such as labialization (eg. /sʷ/ as opposed to /s/) and velarization (eg. /ʒ̴/ as opposed to /z/). Due to the various controversies involving the production and classification of /h/, it has been left out of the main study and mentioned by itself.[3]

II. a) Primary Fricatives (PF)

Definition: We adopt Ladefoged's definition of fricatives, namely: those speech sounds produced by the "narrowing of two articulators so as to produce a turbulent airstream" (Ladefoged, 1971, p. 46). This definition excludes the sounds usually represented by the phonetic symbol[h], sometimes referred to as "glottal fricatives". These sounds are best regarded as voiceless vowels.

Of the 317 languages in our data base, 296 have at least one phoneme the primary allophone of which is a primary fricative. This is a very significant number (Chi Square Prob. .0001). A further observation showed that

of the 21 languages without a primary fricative, 15 are Australian languages, 3 are Indo-Pacific, 2 Austro-Thai, and 1 South Amerindian (see Appendix A). This would suggest that the lack of a primary fricative is primarily an areal/genetic phenomenon in the Australian languages. This suggests that there is a near-universal governing the structure of phonological inventories given as statement (1), below.

1. There is a highly significant tendency for languages to have at least one primary fricative.

The most frequently occurring primary fricative in our data is /s/ (see Table 1). Also, among the 42 languages with only one primary fricative, 36 have /s/ (Table 2)[4]. This number, being very highly significant at the .0001 level (Chi Square), suggests the following statement.

2. If a language has only one primary fricative its primary allophone is most likely to be /s/.

The second highest occurring primary fricative in our data is /ʃ/, with a frequency of 143 as opposed to 132 occurrences of /f/. This might be taken to suggest that the second fricative phoneme in a language with only two primary fricatives would be /ʃ/. An analysis of the data proved the contrary. Among the 58 languages with only two primary fricatives, the most dominant pattern is /f,s/ with 17 occurrences, followed by /s,ʃ/ with 11 occurrences, while the rest follow no clear pattern (see table 2). Based on the occurring patterns, therefore, we shall suggest the following universal tendency:

3. If a language has only two primary fricatives, the second one is most likely to be /f/.

We now wish to take a look at the structure of the inventories as a whole. Here we notice that the most common pattern among languages with three primary fricatives is /f,s,ʃ/. When these three are not present, we find that languages with 3 primary fricatives prefer the pair /s,ʃ/ over the pair /f,s/ by 19 to 9. Among the 45 languages with four primary fricatives, the subset /f,s,ʃ/ occurs 11 times, as opposed to 6 times for the set /s,ʃ,x/, which is also the second most frequent pattern among languages with only three primary fricatives. The most frequent pattern among languages with four primary fricatives is /f,v,s,z/. This, with 8 occurrences, also happens to be the most common subset of four fricatives in the languages with five primary fricatives. Among the languages with six primary fricatives, the most common set of five primary fricatives, /f,v,s,z,ʃ/, also happens to be the most common subset. And the most common subset of six primary fricatives /f,v,s,z,ʃ,ʒ/ among languages with seven primary fricatives is the most common set among languages with six. The foregoing observations suggest that the elaborate systems tend to reflect the structure of the simple systems. In the most complex systems (for example languages with 9 or more primary fricatives), "missing" sounds tend to be replaced by other sounds from the same category. Thus a language lacking /f/

Table 1. Frequency of Occurrence

Voiceless				Voiced			
Sound			Frequency	Sound			Frequency
	"s"	- 165			"z"	- 60	
s	s̲	- 36	- 273	z	z̲	- 10	- 94
	s	- 72			z	- 24	
ʃ			- 143	ʒ			- 53
f			- 132	v			- 67
x			- 75	ɣ			- 31
ɔc			- 29	ʁ			- 14
ɸ			- 20	β			- 31
ʂ			- 33	ʒ̊			- 12
θ			- 17	ð			- 20
s̤			- 13	z̤			- 2
ç			- 12	ʃ̤			- 8
ħ			- 10	ʕ			- 3
ʃ̤			- 2	ʒ̤			- 0
				ɾ̤			- 3

h = 196

Table 2. Basic system types - primary fricatives (see appendix A)

Type	Number of Languages	Type	Number of Languages
0 ---	21	3G /fðs/ --	2
		3H /sʃʒ/ --	2
1A /s/ ---	36	3 miscel. --	29
1B /β/ ---	2	4A /fvsz/ --	11
1C /f/ ---	2	4B /fszʃ/ --	3
1D /ɣ/ ---	2	4C /fvɸʃ/ --	2
2A /fs/ ---	17	4 miscel. --	27
2B /sʃ/ ---	11	5A /fvszʃ/ --	4
2C /sx/ ---	5	5B /fszʃʒ/ --	3
2D /sz/ ---	3	5C /fvszɣ/ --	2
2E /vs/ ---	3	5 miscel. --	22
2F /ss̤/ ---	3	6A /fvszʃʒ/ --	6
2G /βs/ ---	2	6 miscel. --	16
2H /ɸs/ ---	2	7A /fvszʃʒx/ --	3
2I /fʃ/ ---	2	7B /fvszʃʒɣ/ --	3
2 miscel. ---	11	7C /fszʃʒɔcʁ/ --	2
3A /fsʃ/ ---	6	7 miscel. --	15
3B /sʃx/ ---	4	8 miscel. --	11
3C /sʂx/ ---	3	9 miscel. --	5
3D /sʂʃ/ ---	3	11 miscel. --	3
3E /szʂ/ ---	2	14 miscel. --	1
3F /fvs/ ---	2		

would have /Φ/, another labial sound of very low intensity. This tends to maintain the structure at the lower levels (see table 3).

Table 3 shows a broad break-down of primary fricatives by places of articulation. One interesting observation here concerns central versus lateral fricatives. When we compare the frequency of central alveo/dental fricatives to that of lateral alveo/dental fricatives, we find that the latter are outnumbered 10 to 1. This seems to suggest that irrespective of the fact that laterals can only be made at a few places of articulation, fricative phonemes prefer a central to lateral articulation. We note also that back fricatives are less frequent than front ones, and that retroflex fricatives are very rare.

Table 3. Frequency of occurrence by place of articulation (with alveo-dental central and lateral fricatives separated).

Labial	Alveo/dent. Central	alveo-dent. Lateral	Retro.	Palat.	Velar	Uvul./ Pharyn.
250	404	44	20	216	106	56

A possible explanation for the patterns of frequency of primary fricatives found is that those which have the greatest acoustic energy are prefered before those with less. Strevens (1960) has attempted to measure relative acoustic energy of fricatives using the following means. Thirteen phonetically sophisticated subjects' productions of the voiceless fricatives [Φfθsʃçxɔɔchʰ] were subjected to a spectrographic analysis. Results from Strevens' measurements indicate that the voiceless fricatives in question can be divided into three groups (front, mid, back) corresponding to their various places of articulation. [s] topped the list in relative intensity. Goldstein (1977b), mostly using data from Miller and Nicely (1955) provides some evidence in support of the idea that intensity and perceptual salience are related, and suggests that on general grounds, perceptual salience would seem to be a desirable attribute of a linguistic system. These hypotheses together with the fact that the tip of the tip of the tongue (used in the production of [s]) is the most mobile organ of articulation would seem to provide adequate explanation for the high frequency of /s/ in our data. /s/ proves to be the most "efficient" fricative by combining articulatory ease, perceptual salience and acoustic superiority. This is what seems to make it the most desirable among all the fricative phonemes.

Table 4 compares the rank order of relative intensity of voiceless fricatives (based on Strevens) and the frequency of occurrence of voiceless primary fricatives (our data)[7]. A rank order correlation of the two columns was not significant ($r = .452$). This would suggest that simple acoustic salience is not predictive of the frequency of occurrence in our data. A close look at the table, however, reveals the following - a very low intensity sound is usually inserted between each 2 pairs of fricatives on the relative intensity scale.

Table 4[6]. Relative intensity versus frequency of occurrence of voiceless fricatives.

	Relative Intensity	Frequency
1.	s	s
2.	ʃ	ʃ
3.	ç	f
4.	x	x
5.	ɔc	ɔc
6.	θ	Φ
7.	f	θ
8.	Φ	ç

The exception to this involves /ç/ which is dropped all the way to the bottom of the frequency column. This unusual behaviour of /ç/ may indicate that it is the most difficult sound to make articulatorily. If this is so, it is understandable that languages would tend to avoid it. We would now attempt to explain the overall correlation.

Goldstein (1977b, c, int. al.) shows that inherent phonetic ambiguity enhances the error rate in perceptual experiments. Applied to the present study, it would mean that the closer the phonetic relationship between two or more fricatives the more confusable the said fricatives are. This suggests that /s/ and /ʃ/, for instance, would be more easily confused with each other (being both high intensity 'mid' sounds) than either one with /f/ (a low intensity 'front' sound) due to their acoustic similarities. Also, /Φ/ and /f/, due to their articulatory similarities would be more confusable than either one and /s/. Since speech aims for maximum communication languages would tend to separate the most confusable units. This then would seem to explain the insertion of /f/, a very low intensity sound, between /ʃ/ and /x/, (table 4). The choice of /fs/ over /sʃ/ as the most common pattern among languages with only two primary fricatives would, therefore, be in line with the theory of maximum dispersion.

In terms of articulatory distance we could say that the 'front' fricatives /Φfθ/ are used to break the continuum of mid-back sounds, hence after the two sounds made with either the blade or tip of the tongue we have the labio-dental sound before we move on to the main body of the tongue. But even here we find that articulatory ease plays a very important role in the choice of 'front' sounds. The structure of the mandibles is such that the movement of the lower jaw places the lower lip more easily in the proximity of the upper teeth than with the upper lip. Thus /f/ would require less productive energy than /Φ/ and hence its preference over over the latter.

Another reason why /f/ is comparatively common despite its low acoustic salience may be that it is easily distinguishable by eye. Learning to speak involves looking as well as listening. Children (and languages) may well find it easier to learn (and maintain) a pattern in which one element is clearly visually distinct.

II. a)2 Voicing in fricatives

Out of a grand total of 1,096 primary fricatives in the 317 languages, 758 are voiceless leaving only 538 voiced ones - a difference that is very highly significant at the .0001 level (Chi Square). This difference in overall frequency is reflected in the structure of individual inventories, suggesting the following:

4. In a given language the number of voiceless primary fricatives is highly likely to be greater than the number of voiced ones.

There are 17 exceptions to this in the data base, given in table 5.

Table 5. Languages with more voiced primary fricatives than voiceless ones.

Language	Inventory	Language	Inventory
Evenki	/βsz/	Angas	/fvsz∫ʒɣ/
Kunjen	/fðɣ/	Turkish	/fvsz∫ʒɣ/
Saek	/vsɣ/	Aleut	/ðʒxɣɔcʁ/
Igbo	/fvszɣ/	Georgian	/βsz∫ʒɔcʁ/
Kpelle	/fvszɣ/	Tuva	/fvs̱ẕ∫ʒɣ/
Mazahua	/szɬ∫ʒ/	Vietnamese	/fvszɬxɣ/
Mazatec	/βðs∫ɣ/	Cheremis	/βfszð∫ʒxɣ/
Mixtec	/βðs∫ʒ/	Margi	/vszɬɮ∫ʒçjxɣ/
Chukchi	/zɬɣ/		

By far the majority of languages that have voiced primary fricatives also have the voiceless equivalent of those primary fricatives. This suggests the following:

5. The presence of a voiced primary fricative in a language is highly likely to imply the presence of its voiceless equivalent.

Exceptions to this statement include those in table 5 as well as GADSUP and ROTOKAS /β/, MAUNG and TIWI /ɣ/, and a few others. The most dominant patterns favour an excess of voiceless primary fricatives while even number patterns from 4 and above tend to favour pairs of cognate voiceless and voiced primary fricatives. The most frequent unpaired voiced primary fricative is /β/, followed by /ɣ/. This fact accounts for the unexpectedly high ranking of /β/ and /ð/ in the frequency counts in table 1, where /β/ outnumbers /Φ/, and /ð/ also outnumbers /θ/. Apart from these exceptions, the rankings

of voiceless fricatives and voiced fricatives coincide with respect to place of articulation. A rank order correlation between the frequency of occurrence of voiceless primary fricatives and the voiced ones was at the very highly significant level of .0001 ($r = .9284$). The relatively high frequency of occurrence of /β/, like /f/, is attributable to visibility.

Despite the highly significant correlation between the voiceless and voiced frequencies, voiced fricatives are in general less frequent than their voiceless counterparts. The explanation might again be sought in the domain of perceptual salience. We suggest that voiceless fricatives are perceptually more salient than voiced ones. Even though Strevens (1960) did not have measurements for the voiced fricatives, he nevertheless suggested that,"in voiced fricatives for a given air-pressure the *air flow* is less than for the voiceless items, since the breath stream is being interrupted and reduced in flow by the action of the vocal cords. For a given air-pressure the acoustic intensity of the hiss component of voiced fricatives is inherently less than that of corresponding voiceless items." This then would go to explain the results of perceptual salience in Goldstein (1977b), where the class of voiced fricatives - particularly /ð/ - was found to have the highest error rate in a number of perceptual studies of English (some of which are cited below). All these studies show that voiced fricatives are less salient, or more confusable, than voiceless fricatives.

Pickett and Rubenstein (1960) did a study on the perception of consonant voicing in noise. The consonants, /pbtdfvsz/, were recorded in monosyllabic frames and played back to listeners (a) as recorded or (b) masked with white noise, or (c) masked with low frequency noise. The most interesting portion of their results shows that while the consonants are most confused in low frequency noise, "the absence of voicing in the alveolars, /t/ and /s/, was perceived much better than in the labials, /p/ and /f/." Wang and Bilger (1973) did another perception study this time using all the English consonants, including liquids and glides, in nonsense monosyllables also in varying noise conditions. Their results seem to show that in CV syllables the order of saliency among the following eight fricatives is /s/, /ʃ/, /z/, /f/, /v/, /ʒ/, /θ/,/ð/. This is similar to our frequency count in table 1 with the one switch in positions between /z/ and /f/. This may be due to the fact that in laboratory confusion studies there are no visual cues as there are in most real language situations. Again, it is clear that perceptual salience is a good predictor of the frequency of occurrence among the fricatives in our data.

Let us go back to the question of general distribution of primary fricatives in our data. As mentioned earlier, the primary fricatives in our data tend to fall in groups that can be given labels including their articulatory and acoustic properties. Table 6 presents the following grouping based on the said properties: Front (consisting of labial and interdental fricatives) / Mid (consisting of dento-alveolar through the palatal regions) / Back (consisting of velar through pharyngeal regions), Sibilant / Non-Sibilant, Lingual /

Non-Lingual, and Central/Lateral. Here we note that the intersection of positive values of the three features 'mid', 'sibilant' and 'lingual' yields the most desired primary fricative, /s/.

Table 6. Frequency of occurrence by place, sibilance and linguality.

FRONT	287	MID	647	BACK	162
SIBILANT	624		NON-SIBILANT		472
LINGUAL	846		NON-LINGUAL		250
CENTRAL	1052		LATERAL		44

A possible reason for the comparatively rareness of back primary fricatives in our data might very well be found in the clumsiness (or at least the massiveness) of the back of the tongue (which is also the main articulator of most of these sounds) in comparison with the tip of the tongue and the lips. This point can be justified by reference to the data on the rapidity of articulatory movements (Hudgings and Stetson) which shows that the back of the tongue is the least mobile articulator.

A study by Singh and Black (1966) among four language groups (Arabic, English, Hindi and Japanese) indicates that while sibilants /sz∫ʒ/ tend to be more confused one with another, they are also the most salient by far perceptually, compared with the non-sibilant groups. In this study the following sounds /p b t d k g dʰ kʰ gʰ s z ∫ ʒ ʒʰ f v θ ð h t∫ dʒ l r rʰ m n/ were recorded by a speaker of each of the languages mentioned. Since some of the sounds are absent in some of the languages, all the speakers were drilled in unfamiliar sounds before the recording session. Test subjects for the perception task were drawn from all four language groups. A very interesting aspect of the results is that place of articulation emerged before voicing as perceptually salient. This would reinforce the occurrence of at least three voiceless primary fricatives before a voiced one in our data. This study is of particular interest to us because unlike most other perceptual studies a linguistic distortion (rather than a mere acoustic one)was used.

Still on general distribution of primary fricatives, the number of PFs in a given language are plotted against the number of languages in figure 1. From the results shown in the figure we suggest the following.

6. The preferred number of primary fricatives in a given language is two.

The slope on this curve rises till 2 from where it falls steadily except that the number of languages with 7 primary fricatives is slightly higher than those with 6 (23:22). Also, there is no language in our base with 10, 12 or 13 primary fricatives.

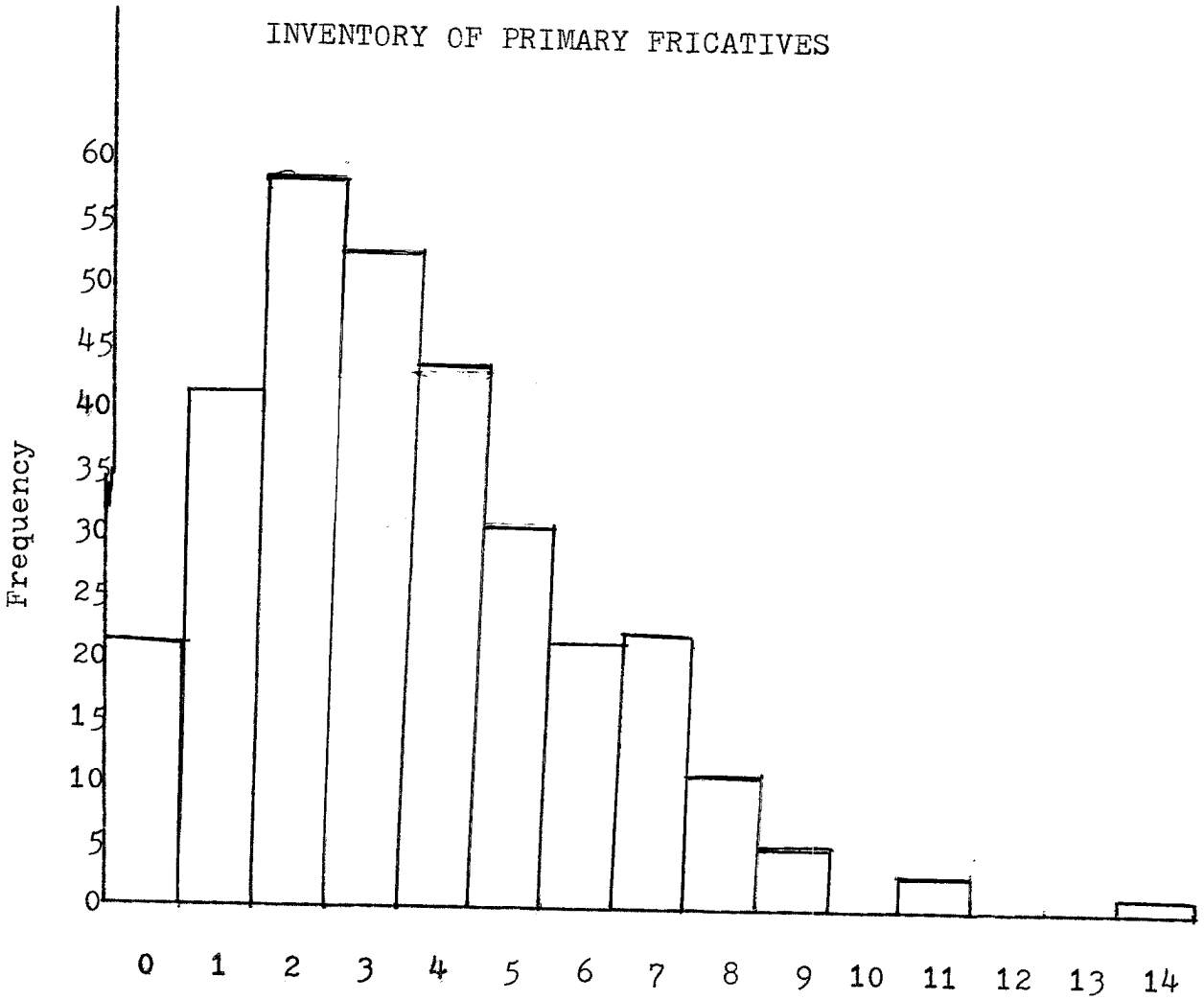

Figure 1. Number of primary fricatives.

II. a)3 Fricatives versus stops

And now we look at the relationship between stops and fricatives. By stops we refer only to those sounds made with complete occlusion of the pulmonic egressive airstream. Here we note that the vast majority of languages in the base have equal numbers of, or more stops (i.e. plosives and affricates together) than they have fricatives. Of course the facts change when we consider plosives and affricates separately. This observation instigated the suggestion of statement (7).

7. In a given language the number of primary fricatives is very unlikely to be greater than the number of plosives and affricates together.

There are a dozen exceptions to this statement, namely: ALEUT, AZERBAIJANI, CHEREMIS, E. ARMENIAN, EGYPTIAN ARABIC, GREENLANDIC, GUARANI, KABARDIAN, KURDISH, MAIDU, SOCOTRI, and ZULU. If we counted all the stops and fricatives produced by the different airstream mechanisms there would be no exception to the rule. For example, NAMA would then have as many as 26 stops. Also, even though MAIDU is listed as having no primary plosive phoneme (i.e. made with pulmonic egressive airstream mechanism), it has as many as 10 secondarily articulated stops. Some of the patterns among the deviant languages are as follows:

GUARANI

p		t	k	tʃ
f	v	ð s̪	s	xɣ

CHEREMIS

p			t		k		ts	tʃ
β	f	ð	s	z	x	ɣ		ʃʒ

GREENLANDIC

p	t̪	k	q̠	ts	
βf	s̪ ɬ	x	ɔc	ʃʃ	

t	k	q̠	ts	
ð	xɣ	ɔcʁ	ʃʒ	

In terms of places of articulation there seems to be a trade-off between stops and fricatives among the irregular languages mainly, and all languages in general, so that even though KABARDIAN has no velar fricative it has a velar stop. GUARANI also seems to make up for a palatal fricative with the palato-alveolar affricate.

(Note that due to the rare nature of lateral fricataives (see tables 1 and 2) all the statements in the foregoing discussion are limited to central (i.e. non-lateral) primary fricatives.

II. b) Secondary fricatives (SF)

Definition: A secondary fricative is a fricative produced with extra contributions from articulators other than those involved in the production of a primary fricative, or by similar modification of the primary fricative. This may be the (simultaneous) coupling of the nasal cavity to produce nasalized sounds, the rounding of the lips to produce labialized sounds, or the raising of the back of the tongue to produce velarized sounds. Modifications may also be effected in the phonation types, such as the vibration of the vocal cords at only one end to produce laryngealized sounds. By their very nature, some secondary fricatives may be analyzed as clusters. Hence a palatalized voiceless labiodental fricative /fʲ/ may be regarded as a cluster of the fricative /f/, and the glide /j/. Wherever this analysis was synchronically justified, our data treated such complex sounds as sequences of two separate phonemes.

There are nine types of secondary fricatives in our inventory, exemplified as follows:

labialized	eg.	/sʷ/
palatalized	eg.	/sʲ/
(pre)nasalized	eg.	/nz/ and /z̃/
aspirated	eg.	/sʰ/
pre-aspirated	eg.	/ʰs/
glottalized	eg.	/s'/ and /ˀs/
velarized	eg.	/s̴/
laryngealized	eg.	/s̰/
pharyngealized	eg.	/s/ ˤ

The problem with glottalized fricatives is that there may be several types that are not adequately distinguished in the sources. Both nasalized and prenasalized fricatives have been reported by our sources, the difference being that with the nasalized sound (usually the voiced fricatives) there is simultaneous velopharyngeal opening with the actual articulation of the fricative, whereas the velopharyngeal opening in the prenasalized fricatives occurs in the period before the actual articulation of the primary fricative.

8. No language has secondary fricatives unless it also has primary fricatives.

The above statement does not admit any exceptions as far as our data is concerned. In fact, all languages in our data base having one or more secondary fricatives also have, specifically, the phoneme /s/. The most striking examples of this are revealed by languages like WANTOAT /s nz/, and KOREAN, SIONA and S. NAMBIQUARA /s s̰/. Among the 296 languages having fricative phonemes, only 41 have secondary fricatives (in addition to their primary fricatives).

KURDISH, MARGI and PASHTO, for instance, each have as many as eleven primary fricatives without allowing a single instance of secondary fricative. Mostly languages tend to add secondary fricatives only after they have utilized at least *three* places of articulation (see table 7c) for primary fricatives, or at least two places of articulation with at least one pair of cognate voiceless/voiced primary fricatives.

9. The number of secondary fricatives in a given language is never greater than that of primary fricatives.

So far there are no exceptions to this statement in our data.

We now wish to tackle the question of the origin of fricatives. Our general observation is summed up in (10) below:

10. Secondary fricatives are the results of diachronic developments from clusters.

A number of our sources gave various arguments why a given secondary fricative should be treated as a cluster of two segments. (Wherever we found their arguments to be synchronically unfounded we treated such segments as single units.) For example, labialized and palatalized fricatives in KABARDIAN were miraculously reduced to clusters by one source (Stanford Archives), basing their arguments on historical facts. This and our knowledge of various synchronic forms such as the clusters produced from the interaction of tones and the reduplication rules in Adaŋme (Nartey 1979) attest the fact that secondary fricatives are the results of diachronic developments from clusters. An exception to this might well be the aspirated fricatives in many languages with an aspirated/unaspirated contrast in stops. Generally there is no real basis for a cluster analysis in these cases. (Yet, historically such cases may also arise from clusters eg. prenasalized fricatives may evolve into aspirated fricatives eg. MIAO.)

II. b) 2. Types of secondary fricatives

The following, in order of frequency, are the tupes of secondary fricatives in our data (see appendix B). The numbers in parenthesis following the type name represent the actual frequency of occurrence. LABIALIZED (39), PALATALIZED (29), PHARYNGEALIZED (11), LARYNGEALIZED (5), NASALIZED (5), VELARIZED (4), EJECTIVE (3), ASPIRATED (2), PRE-ASPIRATED (2). A further frequency count revealed the velar place of articulation as the most likely (fricatives) to be labialized, while the most likely fricative to be palatalized is the dento-alveolar one.

Tables 7A, B, C, respectively, present the manners and places of articulation as well as the interaction between the two. (Note that the manner here, even though referring mainly to the secondary distinctions, also refers voicing.) We would have expected that there be a trade-off between the two, in that languages using fewer places of articulation would tend to have more secondary (manners) fricatives. What we found, on the contrary, is a near direct-proportional increase between the two. A rank order correlation between the number of places and the number of manners of articulation was highly significant at the .005 level (r = .899).

Table 7. Number of languages with (A) number of places of articulation, (B) number of manners of articulation (the possible categories are: Voiced, Labialized, Palatalized, Pharyngealized, Laryngealized, Nasalized, Velarized, Ejective, Aspirated, and pre-aspirated), and (C) interaction between place and manner.

A. Places of Articulation

Number of Place	Freq.	Percent
1	62	20.946
2	77	26.014
3	68	22.973
4	48	16.216
5	23	7.770
6	4	1.351
7	1	0.338
8	0	0.000

B. Manners of Articulation

Number of Manner	Freq.	Percent
1	128	43.243
2	120	40.546
3	20	6.757
4	10	3.378
5	2	0.676
6	2	0.676
7	0	0.000
8	1	0.338

C. Interaction between place and manner of articulation

Place	Manner							
	1	2	3	4	5	6	7	8
1	44	16	2	-	-	-	-	-
2	46	29	1	-	1	-	-	-
3	23	35	7	2	-	1	-	-
4	8	26	6	6	1	1	-	-
5	6	11	3	2	-	-	-	1
6	-	3	1	-	-	-	-	-
7	1	-	-	-	-	-	-	-

II. c). The Phoneme /h/

Due to the general disagreement between phoneticians as to the place of articulation of /h/ (as well as its classification), we intentionally left it out of the fricatives. Strevens (1960) sums up this way,'/h/ is the subject of some controversy. It is thought by many that the turbulent air-flow is produced somewhere in the larynx; others believe "cavity-friction" to be generated throughout the vocal tract. The exact mechanism is not clearly understood.' Ladefoged (1971) does not call it a fricative at all, instead he includes it among the approximants (p. 122). Even though there are some languages where phonological patterns argue for /h/ as a member of the fricative class[7], it is mentioned here in passing more for the sake of tradition than anything else.

The first striking thing we noted was that /h/ is rare compared to the fricatives. We also observed that the vast majority of languages having /h/ also have some (other) fricative(s), suggesting the following:

11. A language is very unlikely to have /h/ unless it also has a primary fricative.

Only 3 languages out of the 317 (BARASANO, HAWAIIAN, and RORO) violate this statement. The converse of this statement is simply not true, since only 193 (or 65.2%) of the languages having primary fricatives also have /h/. This leaves 103 out of a possible 296 languages (a good 34.8%) having primary fricatives without /h/. In addition, /h/ does not seem to go with any of the basic patterns (voiced/voiceless, front/mid/back, lingual/non-lingual, sibilant/non-sibilant distributions) cited earlier. This is a very good reason for excluding /h/ from the general class of fricatives.

III. Universals of oral stops: a stumbling affair

We define oral stops as those speech sounds made with complete occlusion in the oral cavity while maintaining velic closure. This definition would include both plosives (made with sudden release, e.g. /p,d/) and affricates (made with delayed or fricative release, e.g. /pf,dz/). By this definition we are aware of no single instance of a study of universals in the area of stops. There have been a number of universal studies on plosives (for example Gamkrelidze (1973, 1974), Sherman, (1975), int. al.), but even these studies have been limited to three areas of articulation, namely labial, alveolar and velar. Studies such as Pierce (1957) that look at more than three places of articulation are also limited in the genetics of languages covered. As far as we are concerned this is the only study on all forms of stops (plosives, *double articulated stops, and affricates*)[8] made at all places of articulation, and based on a large and *valid* sample of natural languages (see the discussion in II above).

As in the part on fricatives, the statements of universal tendencies are based on frequency counts, and are so divided as to reflect the two major classes, namely: primary oral stops and oral stops made with secondary articulations or similar modifications. Two of the statements are based on diachronic observations of languages. Due to the fact that the glottal stop /ʔ/ is not easily modified in the way the other stops are, it has been left from the main study and discussed by itself.

III a). Primary oral stops (POS)

Definition: Those speech sounds made with a pulmonic airstream and a complete closure of two articulators (as in the single articulations /p,t/) or four articulators (as in the double articulations /kp,gb/). The release of such sounds may be sudden (as in the plosives /p,t/) or delayed (as in the affricates /pf,ts/). For reasons discussed in (IIIc) below, The sound represented by the phonetic symbol [ʔ], usually referred to as the glottal stop is excluded from this definition. As will be discussed later, aspirated stops are not regarded as primary stops.

316 out of 317 languages in our data base have at least one phoneme, whose primary allophone is a primary oral stop. In fact, 315 of these languages have a minimum of three primary oral stops (see Appendix C). The exceptions are HAWAIIAN, with two primary oral stops (and a glottal stop) and MAIDU, with no primary oral stops at all (since all the primary allophones of MAIDU stops are either aspirated or have a glottalic airstream mechanism). The very highly significant nature of this observation (Chi Square .0001) suggests statement (12).

12. Languages usually have at least three primary oral stops.

/t/, /k/, and /p/, respectively, are the most frequent occurring primary oral stops in our data (see table 8). This is true regardless of whether aspirated stops are included or not. Based on the above as well as the very highly significant observation that among the 19 languages with only three primary oral stops 12 have /ptk/ (Chi Square .0001), we suggest the following (see table 9):

13. If a language has only three primary oral stops, their primary allophones are most likely to be /ptk/.

Here, as with the fricatives, we suggest that the more acoustically salient the stop sound the better its chances of being chosen as a phoneme by natural languages. Results of studies by Truby (1957, 1959), among others, and especially the series of experiments by members of the Haskins Laboratory (most of which are summarised in Lieberman (1977), indicate that the two most reliable acoustic cues for the perception of stop consonants are, the formant

transitions in adjacent vowels and the noise burst accompanying the stop (often referred to as the 'stop burst'). The first of the two has been studied extensively in the labial, alveo/dental, and velar sounds. Unfortunately, none of the other stop sounds has received much attention from researchers. This biased attitude may be explained by the striking difference between the frequencies of occurrence of /ptk/ and /bdg/, and the rest of the voiceless and voiced plosives, respectively (see table 9). Lieberman (1977 p. 155 writes:

> "Computer-implemented modeling studies show that quantal effects occur for consonantal vocal tract configurations when the primary constriction is in one of six positions. Three of these positions - the labial, dental, and velar positions - occur, for example, in the stop consonants [b], [d], and [g] of English (Perkell, 1969). The other three possible quantal positions, which involve constrictions closer to the larynx, occur in other languages. The acoustic signals that result from these quantal positions are resistant to articulatory sloppiness and have well-defined spectral properties. They correspond with the traditional "points of articulation" or "place features" of traditional phonetic theory (Müller, 1848; Jones, 1932)."

Lieberman's account of the six quantal positions is a bit confusing as he later mentions "retroflex" as one of the three places "closer to the larynx". The overall picture, however, is that the six include labial, dental, retroflex, velar, and two pharyngeal positions.[9]

Perceptual studies by Stevens and Blumstein (1977), indicate that the retroflex [ʈ] is less perceptible than the non-retroflex [t] and [k]. In this study, the authors synthesized appropriate stop bursts and formant transitions in monosyllables using the stop sounds mentioned above. These were played to listeners to identify. Results revealed [ʈ] as the least reliably identifiable. This may explain its rare occurrence in our data, since we have already established that perceptual salience is the single most reliable predictor of frequency of occurrence.

III, a) 2. Plosives versus affricates

We observed that the vast majority of languages having an affricate among their primary oral stops also have at least three plosives, thus suggesting (14) below:

14. If a language has an affricated stop, it is most likely that it also has (at least) three plain stops (or plosives).

Table 8. Frequency of occurrence - primary oral stops.

8A plosives

Voiceless			Voiceless Aspirated		Voiced		
Sound	Frequency				Sound	Frequency	
t "t"	125				d "d"	89	
t̪	80				d̪	53	
t̠	84				d̠	48	
t		292	t^h	93	d		190
k		284	k^h	79	g		180
p		276	p^h	79	b		200
q		41	q^h	10	ɢ		5
c		52	c^h	15	ɟ		28
ʈ		30	$ʈ^h$	7	ɖ		24
k͡p		21			g͡b		23
p͡t		1	$p͡t^h$	1	bd		0
t͡c		1			dɟ		0
t͡k		1	$k͡t^h$	1	dg		0

Total voiceless plosives = 999 ? = 150 Total voiced plosives = 650

8B affricates

tʃ		152	$tʃ^h$	35	d		79
ts		100	ts^h	30	dz		27
tʂ		9			dʒ		2
ʈs		7	$ʈs^h$	2	ɖz		3
pf		3	pf^h	1	bv		1
tʃ		3	$tʃ^h$	1	dʒ		0
kx̠		1			g̠		0
kʂ		1			gʐ		0

Total voiceless affricate 276 Total voiced affricates = 112

Table 9. Basic system types - primary oral stops (see appendix C)

Type		Languages
0	-	1
2 /pk/	-	1
3A /ptk/	-	12
3B /bdg/	-	2
3 miscel.	-	5
4A /ptkt∫/	-	22
4B /ptck/	-	9
4C /ptkts/	-	4
4D /bdgdʒ/	-	2
4E /bdɟg/	-	2
4F /pbtk/	-	2
4 miscel.	-	13
5A /ptktst∫/	-	8
5B /btdkg/	-	5
5C /ptkqts/	-	3
5D /pbtkts/	-	3
5E /ptkqt∫/	-	2
5F /pbtkt∫/	-	2
5G /p̪t̪t̪k/	-	2
5 miscel.	-	25
6A /pbtdkg/	-	19
6B /p̪t̪t̪ck/	-	3
6C /pbtdkts/	-	2
6D /ptkqtst∫/	-	2
6 miscel.	-	22

Type		Languages
7A /pbtdkgts/	-	4
7B /pbtdkgdʒ/	-	3
7C /pbtdktst∫/	-	3
7D /pbtdkgts/	-	3
7E /btdkgt∫dʒ/	-	2
7 miscel.	-	14
8A /pbtdkgt∫dʒ/	-	14
8B /pbtdkgtst∫/	-	8
8C /pbtdkg͡kp͡gb/	-	6
8D /pbtdcɟkg/	-	6
8E /pbtdkqtst∫/	-	2
8 miscel.	-	15
9A /pbtdkgtst∫dʒ/	-	3
9B /pbtdkgqt∫dʒ/	-	3
9 miscel.	-	12
10A /pbtdt̪d̪kgt∫dʒ/	-	7
10B /pbtdkg͡kp͡gbt∫dʒ/	-	5
10C /pbtdcɟkg͡kp͡gb/	-	3
10D /pbtdkgtsdzt∫dʒ/	-	3
10E /pbtdcɟkgt∫dʒ/	-	2
10 miscel.	-	11
11 miscel.	-	6
12 miscel.	-	3
13 miscel.	-	1
14 miscel.	-	3

The only expcetions to this are SWAHILI (with /pkt∫/), WASHKUK (with /tkt∫/), WICHITA (with /tkts/), BEEMBE (with /p t pf ts/), and ZUNI (with /p t ts t∫/). This could be due to acoustic reasons. Fant (1960) shows that the bursts of [p], [t], and [k] are acoustically similar to the fricatives [f], [s], and [x], respectively. Also, perceptual studies such as van Heuven (1979) show that fricative sounds are heard as fricatives or their cognate affricates, depending on their duration. In his study, van Heuven used the fricative [∫] in sentence frames that admitted both [∫] and [t∫], varying such parameters as rise time, steady state duration, and decay time. He found the study state duration as the major factor controlling listeners' judgment for [∫] or [t∫] (75% of the response variance). As a result of possible confusions, therefore, languages would tend to avoid having pairs of sounds like t/ts and p/pf as much as possible. And this is exactly what is reflected in the frequency count.

The most frequently occurring primary affricate is /tʃ/. In addition, most of the languages with only one affricate have /tʃ/. This leads us to suggest the following statement:

15. If a language has only one primary affricated stop, its primary allophone is most likely to be /tʃ/.

Acoustic and perceptual salience would suggest /ts/, but as showed above, /ts/ is more likely to be confused with /t/ and /s/ than /tʃ/ is. Once again in order to maintain maximum dispersion languages would tend to choose /tʃ/ over /ts/. Another reason for the high frequency of /tʃ/ may be due to the unstable nature of the various palatals.

Let us now go back to table 9 to review the structure of the entire inventory of primary oral stops. A comparison of the varous patterns indicate that the simple structures are, on the whole, reflected in the more elaborate systems (see appendix C). For example, out of the 54 languages with only four primary oral stops, 42 have /p t k/ as a subset. This is a very highly significant number. Also, among the 50 languages having only five primary oral stops, 14 languages have /p t k tʃ/, the most frequent pattern among languages with only four primary oral stops, as a subset, as opposed to 4 occurrences of /p t c k/, the next most frequent.

In table 10 we present a break-down of the primary oral stops by place of articulation. (By their very nature of production - utilizing two separate places of articulation - double articulated stops are excluded from this table.) One interesting observation is the almost non-existence of labial, velar, and pharyngeal affricates. This is attributable to articulatory difficulty.

Table 10. Frequency of occurrence by place of articulation (excluding double articulated stops).

	Labial	Alveo/Dent.	Retro.	Palat.	Velar	Uvular
Plosive	476	482	54	80	464	46
Affric.	4	138	13	231	2	0

III a. 3. Voicing in primary oral stops

A comparison between the voiced and voiceless stops reveals 762 of the former and 1276 of the latter. This very highly significant difference suggests the following:

16. In a given language the number of voiceless primary oral stops is nearly always greater than the number of voiced ones.

Exceptions to this statement include: WAPISHANA /b d g tʃ/, CHUAVE, KIOARI, SHILHA, SOCOTRI, and SONGHAI, each with /b t d k g/, ADZERA /b d g ts dz/, IRISH /t̪ d̪ d tʃ dʒ/, and TAMA /b t̪ d̪ ɟ k g/. It has been shown that it is more difficult to maintain voicing during obstruents due to back pressure from the oral closure. We would therefore suggest that one of the main reasons for there being more voicless stops than voiced ones is articulatory ease. Also, voiced stops seem to be more easily confusable than voiceless ones (Goldstein, 1977; Singh, 1966; Singh and Black, 1966; Miller and Nicely, 1955; among others).

A great majority of languages in the data base having voiced stops also have a voiceless one made at the same place of articulation, thereby suggesting the following:

17. The presence of a voiced primary oral stop in a language is highly likely to imply the presence of its voiceless equivalent.

There are a few exceptions to this statement, namely those mentioned in the discussion of (16) as well as the following: SELEPET and TUNICA /b d g/, BERTA and TURKISH /b d g dʒ/, BRETON and KLAMATH /b d ɟ g/, LAK /b d g G/, NORWEGIAN /b d̪ ɖ g/, ALAWA /b d ɖ ɟ g/, MONGOLIAN /b d g dz dʒ/, and PERSIAN /b d̪ g G tʃ dʒ/. Of course, if one considered aspirated stops as voiceless, then the number of languages that are exceptions is reduced to about three. For the sake of consistency, however, aspiration is treated as a secondary articulation.

Mostly among the even number patterns we find the sounds in pairs consisting of the voiced/voiceless cognates. Hence the most frequent patterns among languages with six, eight, and ten primary oral stops are, respectively, /p b t d k g/, /p b t d k g tʃ dʒ/, and /p b ṭ ḍ t d k g tʃ dʒ/. Results of almost all the perceptual studies cited above point to the emergence of place of articulation before voicing distinction. This is in line with our frequency count thus far. A rank order correlation between the frequencies of voiced and voiceless primary oral stops was very highly significant at .0001 ($r = .967$).

Let us take another look at the question of general distribution of primary oral stops. Table 11 attempts to summarise the various break-downs in our data. Here we note that plosives are, by far, the most popular oral stops followed by affricates, while double articulated stops are the least preferred. In fact, a close look at the data in appendix C reveals double articulated stops as an areal/genetic phenomenon, mostly with West African languages. We note also that 'mid' sound still dominate in the front/mid/back division. But a comparison with the fricative frequency (see table 3) shows a relatively larger number of 'back' stops. This may be attributed to /k/ (a back stop) being one of the most frequent primary oral stops. It may be difficult for the tongue to make the precise articulatory movements required for a fricative in this area, but the grosser gestures involved in making a stop seems comparatively easy.

Table 11. Frequency of occurrence by place, linguality, sibilance, and centrality.

	Front	Mid	Back
Plosives	476	616	510
Affricates	4	382	2

	Lingual	Non-lingual
Plosives	1126	476
Affricates	384	4

	Sibilant	Non-sibilant
Affricates	371	17
Plosives	-	-

	Central	Lateral
Affricates	376	12
Plosives	1649	0

Cumulative Frequency		
Plosives	-	1602
Affricates	-	388
Double articulates	-	47

The figures from the very bottom of table 11 are so striking that they deserve statement (18) below:

18. In a given language, the number of primary oral affricates will be less than the number of primary oral plosives.

This statement does not admit any exceptions.

To sum up the discussion on the general distribution of primary oral stops, let us look at figure 2 below. There we see that the preferred number of primary oral stops is four. We state this observation as (19):

19. The preferred number of primary oral stops in a given language is between four and eight.

A passing but very appropriate comment is that languages prefer even numbers of primary oral stops to odd numbers.

III. b) Secondary oral stops (SOS)

Definition: A secondary oral stop is a stop made with extra contributions from articulators other than those involved in the production of a primary oral stop (e.g. lip rounding to produce labialized stops). Also included in the secondary oral stops are those stops that are either preceded or followed by a short period of nasal closure (as in the nasalized sounds), or voiceless vowels (as in the aspirated sounds). For the purposes of this thesis, any stop made with a non-pulmonic egressive airstream (e.g. pulmonic ingressive, glottalic egressive or ingressive, and velaric ingressive or egressive), are classified as secondary oral stops.

There are twelve types of secondary oral stops in our data, as shown below:

Ejective	e.g. /p'/
Implosive	e.g. /ɓ/
Click	e.g. /ʖ/
Affricated click	e.g. /ǂ/
Labialized	e.g. /pʷ/
Palatalized	e.g. /pʲ/
Pre-nasalized	e.g. /mb/
Nasal released	e.g. /bm/
Aspirated	e.g. /pʰ/
Pre-aspirated	e.g. /ʰp/
Velarized	e.g. /b/
Laryngealized	e.g. /b̰/
Pharyngealized	e.g. /p̤/
Pre-glottalized	e.g. /ʔp/

From the data it is apparent that languages that have any of the secondary stops mentioned above also have primary oral stops, thus motivating (20) below.

20. A language is highly unlikely to have secondary oral stops unless it also has primary oral stops.

There is one exception to this statement - MAIDU with /pʰ ʃ tʰ ɓ kʰ cʰ p' t' c' k'/. Why a language should have as many as ten secondary stops without a single primary one is not very clear. A possible explanation may be that MAIDU stops are the prime example of the theory of maximal dispersion, whereby the more

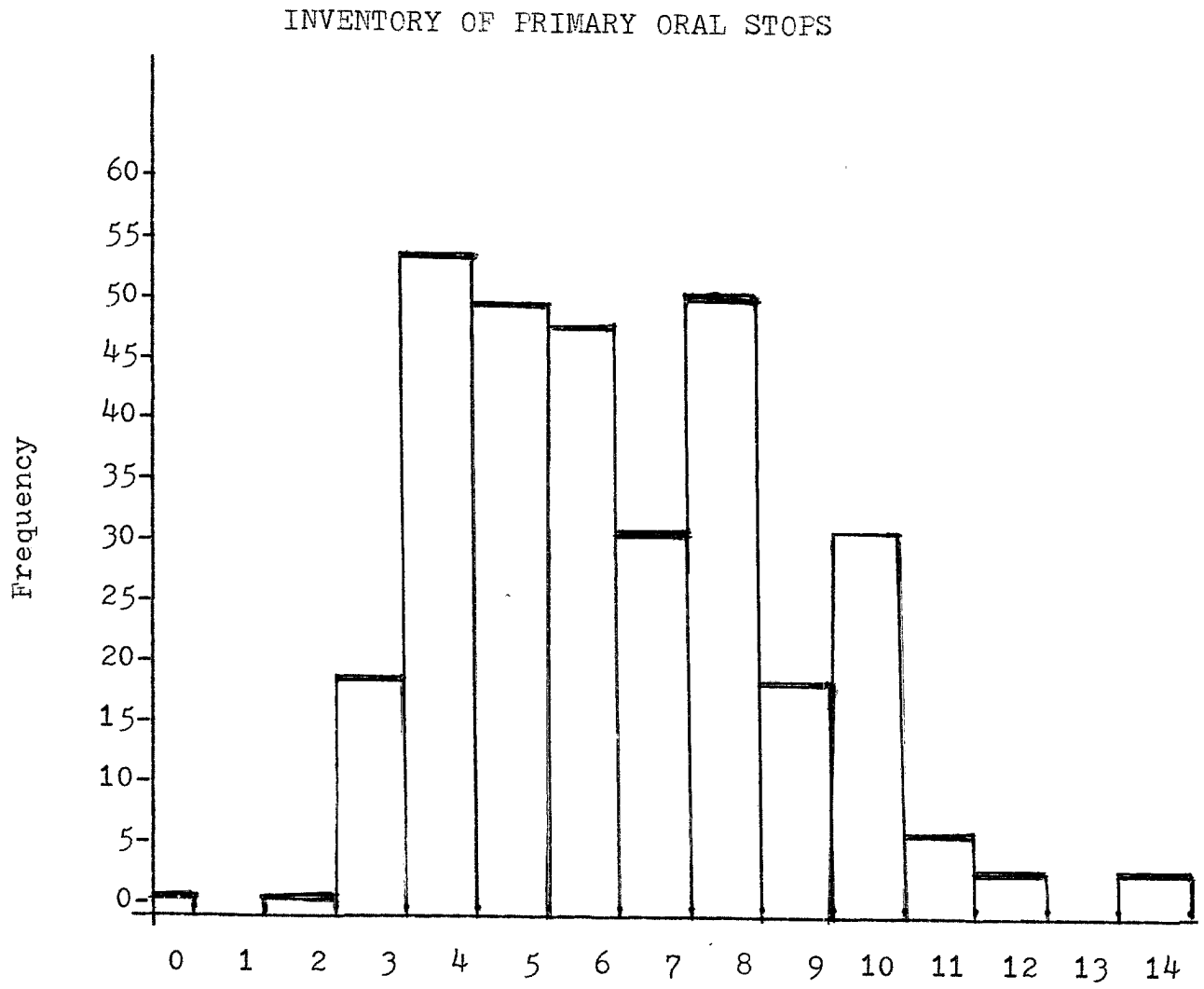

Figure 2. Number of primary oral stops.

exaggerated the differences between the various sound classes the better their perceptual salience! But as Ladefoged (1971) pointed out, there are various degrees of aspiration and until we have measurements of the degree of aspiration among the MAIDU stops (in comparison with other languages), we cannot make any further comment on this issue.

We observed from the data (see appendix D) that the majority of languages have far more primary oral stops than secondary oral stops. This observation is summarized as statement (21) below.

21. The number of secondary oral stops in a given language is not likely to be greater than that of primary oral stops.

With 53 (or 16.7%) exceptions, this is our most violated statement. The most remarkable is !XŨ with as many as 76 secondary oral stops (i.e. clicks) and only 10 primary oral stops. All the exceptions are listed in table 12, showing first the number of primary oral stops then the number of secondary ones.

Table 12. Languages with more secondary oral stops than primary ones. The figures in parenthesis after the languages represent the number of Primary/ Secondary oral stops.

Tunica	(3/5)	Beembe	(4/5)	Maidu	(0/10)
Taishan	(4/6)	Siona	(4/6)	Hakka	(4/6)
Turkish	(4/6)	Zuni	(4/7)	Washkuk	(3/8)
Swahili	(3/8)	Lungchow	(4/7)	Berta	(4/7)
Dakota	(4/8)	Irish	(5/7)	Korean	(4/8)
Wichita	(3/9)	Changchow	(4/9)	Lakkia	(5/8)
Wiyot	(5/8)	Tolowa	(5/9)	Quechua	(5/10)
S. Nambiquara	(3/12)		E. Armenian	(5/10)	
Bulgarian	(6/10)	Georgian	(5/11)	Hupa	(5/11)
Jingpho	(6/10)	Klamath	(4/12)	Zulu	(4/12)
Ngizim	(8/9)	Lithuanian	(8/9)	Hausa	(7/10)
Navajo	(6/12)	Squamish	(7/12)	Otomi	(8/12)
Egyptian Arabic	(7/11)		Nambakaengo	(3/15)	
Nootka	(7/13)	Kabardian	(7/14)	Quileute	(10/12)
Mazahua	(6/16)	Acoma	(8/14)	Tigre	(6/17)
Chipewyan	(7/16)	Jaquaru	(8/16)	Amharic	(10/14)
Kwakiutl	(6/19)	Igbo	(8/17)	Nama	(3/25)
Telegu	(11/17)	Punjabi	(10/20)	Lak	(4/31)
		!XŨ	(10/76)		

III. b) 2. Types of secondary oral stops

The types of secondary oral stops found in our data are shown in table 13 together with their frequencies. (The total number of stops in the base - primary and secondary - is 3,308.)

Table 13. Primary and secondary oral stops and their frequencies of occurrence.

Primary voiceless plosives - 999		Primary voiced plosives - 650		Primary voiceless affricates - 276		Primary voiced affricates -112	
Aspirated	- 446	Ejective	- 292	Labialized	-134		
Nasalized	- 82	Click	- 80	Implosive	- 70		
Palatalized	- 67	Breathy	- 47	Velarized	- 31		
Pharyngealized	- 8	Pre-aspirated	- 8	Nasal released	- 6		

Note that affricated ejectives and affricated clicks have been collapsed with ejectives and clicks, respectively.

Tables 14A, B, C, represent the relationship between frequency of occurrence and the manners and places of articulation. From table 10C, especially, we notice that as the number of places of articulation increases, so does the number of secondary modifications. Like our observation on fricatives, this result is surprising.

Table 14. Number of languages by (A) number of places of articulation, (B) number of manners of modification (these include: voiced, aspirated, ejective, labialized, nasalized, click, implosive, palatalized, breathy, velarized, pharyngealized, pre-aspirated, and nasal-released), and (C) interaction between place and manner.

A. Place of articulation

Total number of Place	Freq.	Percent
1	0	0.000
2	1	0.315
3	67	21.136
4	132	41.640
5	75	23.659
6	38	11.987
7	4	1.262

B. Manner of articulation

Total number of manner	Freq.	Percent
1	30	9.464
2	112	35.331
3	59	18.612
4	56	17.666
5	20	6.309
6	20	6.309
7	7	2.208
8	5	1.577
9	4	1.262
10	3	0.946
28	1	0.315

C. Interaction between place and manner of articulation

	Manner										
Place	1	2	3	4	5	6	7	8	9	10	28
1	-	-	-	-	-	-	-	-	-	-	-
2	1	-	-	-	-	-	-	-	-	-	-
3	6	33	8	11	4	4	1	-	-	-	-
4	12	43	27	23	11	7	3	3	3	-	-
5	7	25	18	12	2	3	2	2	1	3	-
6	4	10	6	8	3	5	1	-	-	-	1
7	-	1	-	2	-	1	-	-	-	-	-

About the origin of secondary oral stops, even though our base does not have any information on the topic, we gathered enough from our sources to enable us to make the following statement:

22. Secondary oral stops, apart from borrowings, are the results of diachronic developments from clusters.

There is enough reason to believe that, for example, the pre-nasalized stops of West African languages developed from vowel deletions. Zulu clicks are examples of large scale borrowing from the Khoisan languages around it (Louw, 1976).

III. c). The phoneme /?/

Even though almost every language makes phonetic use of the so-called "glottal stop" - mostly to break vowel clusters - its phonemic use is not very widespread. It is excluded from the primary oral stops on both phonetic and phonological basis.

Phonetically, we have no grounds for arguing that /?/ is a speech *sound*. Ladefoged (1975) puts this in a dramatic way: "A *glottal stop* is the sound (or, to be more exact, the lack of sound) that occurs when the vocal cords are held tightly together." (p. 46). Phonologically, we note that /?/ does not go with any of the patterns discussed earlier, namely: front/mid/back, lingual/non-lingual, voiced/voiceless - this final pattern being redundant by its mere phonetic implication.

23. No language has a glottal stop unless it also has a primary oral stop.

There is no exception to this statement. The converse of this statement is significantly false. Among the 316 languages with primary oral stops, less than half (150) have glottal stops.

IV. Let there be nasals: a new look at an old conjuration

Since Hockett's (1955) survey, and Ferguson's (1961) "assumptions about nasals", a number of papers have been dedicated to the nasals of natural languages. The most forceful of these papers have come out since the Phonological Archiving Project at Stanford University. This is due to the fact that the said project's language samples were more reliable than any others before it.

This paper takes another look at the application of Ferguson's assumptions on nasal consonants in natural languages, on the basis of our more recent and empirically better sample of languages (see discussion in (1) above). At the time of writing the size of the sample is 317 languages. We are convinced that due to the nature of the sampling this is by far the most reliable available, and hence the one on which any valid claims (or refutations) of Ferguson's assumptions could be made.

The discussion in this paper is restricted to nasal consonants (NC), excluding nasal vowels (NV), etc. which Fergusson also discussed. By definition this would include all consonants made with *complete* closure in the oral cavity. Only contrastive nasal consonants are considered, marginal ones being left out. Also, assumptions based on diachronic issues are left out of this since our base is more concerned about inventory type questions.

As indicated, we shall examine Ferguson's assumptions one after the other (as appearing after the small Roman Numverals).

A. Primary nasal consonants (PNC)

Definition: (And here we quote directly from Ferguson, p. 56). A PNC is a phoneme of which the most characteristic allophone is a voiced nasal stop, that is, a sound produced by a complete oral stoppage (e.g. apical, labial) velic opening, and vibration of the vocal cords.

i. Every language has at least one PNC in its inventory.

Our data (see appendix E) reveals 8 languages without primary nasal consonants. These are: ACHUMAWI, APINAYE, BARASANO, HAKKA, MURA, PUJET SOUND, QUILEUTE, and ROTOKAS.

Both Hockett and Ferguson admitted that there were at least three Salishan languages without primary nasal consonants,[10] yet at the time of Crothers'

(1975) paper, all languages in the Stanford Archives were reported as having primary nasal consonants (106 languages at the time). The probability of having primary nasal consonants is very highly significant (Chi Square .0001). But since it is not absolute, we would like to re-state (i) as (24) below:

24. There is a very highly significant tendency for languages to have at least one primary nasal consonant.

Ferguson's second universal is

ii. If in a given language there is only one PNC, it is /n/, that is, its most characteristic allophone is apical.

Of the 8 languages in our data having only one primary nasal consonant, 6 have /n/. This again is very significant but by no means absolute, since TAORIPI, one of the exceptions, has /m/, and MIXTEC, the other exception, has /ŋ/. Other possible exceptions cited in the literature include Yoruba (Ladefoged, 1968), Halkomelem Salish (Thompson and Thompson, 1972), and of course the controversial Winnebago (Hockett, 1955). In the light of these, we wish to modify (ii) as follows:

25. If a language has only one primary nasal consonant, its primary allophone is most likely to be /n/.

Table 15 reveals the various distributions of primary nasal consonants among the 317 languages in our data base. Here, we note that /m/, being the second most frequent primary nasal consonant, is in line with Ferguson's (iii) below.

iii. If in a given language there are only two PNC's the other one is /m/, that is its most characteristic allophone is labial.

Table 15.

n	"n" - 180 n̪ - 74 n - 53	- 307	m - 301		ŋ - 169		
ɲ		125	n̪ - 21		m̆ɲ - 8		
			ŋ - 1				

In fact, out of the 99 languages in our data having only two primary nasal consonants, only one, WAPISHANA /m ɲ/, violates this statement. (Of course 13 of the 98 complying languages specifically have dental nasal consonants, but that should not pose any problem as we already pointed out in (I) above.)

On the question of general structure of nasal inventories, we note that the basic simple structures recur almost always in the more complex ones. The problem is with languages having five or six primary nasal consonants. Since there are only a few languages in these categories (see table 16), regional variations become reflected in the system more so than the main universal tendencies, hence in 5A we find 4 West African languages, whereas in 6A there are 6 Australian languages.

Table 16. Basic system types - primary nasal consonants.

Type	Languages	Type	Languages
0	- 8	4A /m n ɲ ɳ ŋ/	- 76
1A /n/	- 6	4B /m n n̪ ŋ/	- 4
1B /m/	- 1	4C /m n ɳ ŋm/	- 2
1C /ŋ/	- 1	4D /m n n̪ ɲ/	- 1
2A /m n/	- 97	5A /m n ɲ ɳ ŋm/	- 4
2B /m ɲ/	- 1	5B /m n n̪ ɲ ŋ/	- 4
3A /m n ŋ/	- 64	5C /m n̪ n ɲ ŋ/	- 2
3B /m n ɲ/	- 28	5D /m n̪ n n̪ ŋ/	- 2
3C /m n n̪/	- 3	5 miscel.	- 3
3D /n̪ ɲ ŋ/	- 1	6A /m n̪ n n̪ ɲ ŋ/	- 6
		6B /m n n̪ ɲ ɳ ŋm/	- 1

For a possible explanation of the various patterns, we again suggest perceptual salience. Studies by Ohala (1974), Fujimura (1962), Fant (1960), Malécot (1960), House (1957), among others indicate that acoustically, the spectra of nasal consonants are not very distinct from one another compared to other sets of consonants. Malécot (1960) used a tape-splicing method to separate and recombine the nasal consonants [m,n,ŋ] from monosyllabic recordings involving the vowel [æ]. The nasal consonants were recorded in both syllable initial and final positions. The recombined syllables were then played to listeners for [m], [n], or [ŋ] judgements. Results show that in both positions [ŋ] was very often confused with both [m] and [n]. This being so we would expect languages to make more use of both /m/ and /n/ than /ŋ/ - which is exactly what we find in our inventory (see table 15). Malécot concluded that even though nasal resonances served as cues for place of articulation, formant transitions in adjacent vowels were the most important cues

for place judgements. His results further indicate that when listeners rely on nasal resonances alone they are likely to perform best on place judgements involving [m]. Considering the fact that transition cues are most efficient with dento/alveolars, the close match between /m/ and /n/ in our inventory (301:307) is hardly surprising.

Cheng (1972) studied the frequency of eighteen Chinese dialects and seemed to have come out with the suggestion that the most dominant syllable final nasal consonant is /ŋ/. But as pointed out by House (1957), due to the overt acoustic similarity of [ŋ] and nasalized vowels, it alternates more often with them than any other nasal consonant. In fact, in a similar, but more rigidly controlled survey, Zee (forthcoming) indicates that Chen's earlier findings were unfounded. Zee's results are in line with House's findings as well as results of perceptual studies cited above and below.

IV. a) 2. Primary nasal consonants versus obstruents

From our observation it was apparent that the number of obstruents (together) in each language is greater than the number of primary nasal consonants. This is in agreement with Ferguson's (iv) below:

> iv. In a given language, the number of PNC's is never greater than the number of obstruents.

There are a few cases where the primary nasal consonants do not correspond to the places of articulation of the obstruents. Two of these are showed below.

AUCA:

p b	t d		k g
m	n	ɲ	ŋ

EFIK:

b	kp	t d	k
		f s	
m		n ɲ	ŋ

Results from perceptual studies indicate that nasals, as a class, are more confusable than the oral sounds (Nartey, 1978; Singh, 1970; Ahmed and Agrawal, 1969, int. al.) In Singh (1970), syllables containing 22 English consonants were recorded by a speaker each of English and Hindi. The syllables were then truncated at the transition of the consonant to the vowel and played to speakers from each of the languages for identification. Results show that test subjects took much longer to decide on nasal sounds than most oral sounds. Ahmed and Agrawal (1969) used 29 initial and 31 final Hindi consonants in their listening tests. Their results indicate that while nasality is a strong feature word initially, it is a very weak feature word finally. This would seem to contradict Ohala (1971) who suggests that the greater velic opening at word

final position accounts for there being more contrasts among nasal consonants in this position.

Let us take another look at the general structure of primary nasal consonants: Here we note that by their very nature, only one broad break-down is possible for nasal consonants, namely: front/mid/back. Below is the result of such a break-down:

FRONT	302	MID	453	BACK	169

Since by the very definition of *nasal consonant* it is impossible to produce one behind the velic area, the figures for 'BACK' were expected. In fact, the articulatory constraints are the main reason we find only six contrasting places of articulation among nasals as opposed to seven and nine among oral stops and fricatives, respectively. Also, results of controlled learning situations seem to indicate that nasal consonants are more liable to be lost from final consonant clusters than obstruents (Wright, 1975).

In testing the psychological reality of the nasal-obstruent morpheme structure condition in English, Wright taught the first of an eight-member gang the nonsense words [gownp], [ðʌŋd], and [ǰumg]. The member then taught these to the second, who also taught them to the third member, etc. Results showed that the nasal consonants in [gownp] and [ǰumg] (both of which violate the syllable structure of English) had been lost in the learning process. It could be argued that the unfamiliarity of the consonant clusters was the main reason for the simplification in these two "words". But the fact still remains that the lost sounds were both nasals.

Figure 3 is a summary of the number of primary nasal consonants per a given language. Based on this summary we propose the following:

26. The preferred number of primary nasal consonants in a language is between two and four.

IV. b) Secondary nasal consonants (SNC)

Definition: (Here again we quote directly from Ferguson.) An SNC is a nasal consonant phoneme the most characteristic allophone of which is *not* a simple voiced nasal. In many cases a phone type which may be analyzed as an SNC may alternatively be analyzed as a cluster (e.g., /hn/, /mb/).

vi. No language has SNC's unless it also has one or more PNC's.

So far three languages in our base defy this assumption. These are APINAYE, BARASANO, and HAKKA. All these languages, however, have phonetic primary nasal consonants as allophones of other phonemes, e.g. in APINAYE

INVENTORY OF PRIMARY NASAL CONSONANTS.

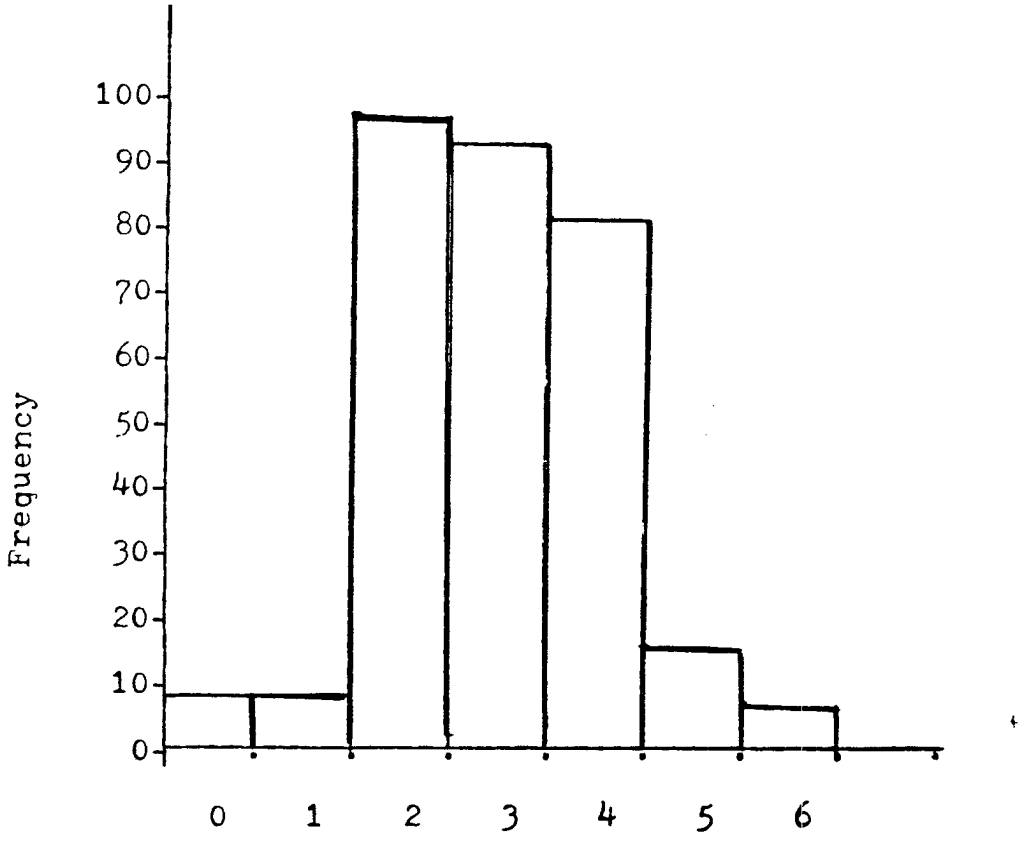

Figure 3. Number of primary nasal stops.

[m n ɲ ŋ] are allophones of /mb nd ɲj ŋg/, respectively. In the light of the exceptions noted above, we wish to re-state (vi) as the following:

27. A language is very highly unlikely to have secondary nasal consonants unless it also has one or more primary nasal consonants.

One interesting point is, languages tend to have secondary nasal consonants only if they include in their inventory an /n/. Hence all the languages with one or more secondary nasal consonants also have some form of /n/. (This is the same thing we found among fricatives where an /s/ seemed to be a "prerequisite" for a secondary fricative.)

vii. In a given language the number of SNC's is never greater than the number of PNC's.

Some 25 languages (about 8.5% of the total number of languages having nasal consonants) violate this. These include, HINDI-URDU, KLAMATH, NAMA, OTOMI, MAZATEC, NGIZIM, SARA, LAKKIA, MAZAHUA, KANURI, PAEZ, WANTOAT, IRISH, SUI, WASHKUK, NAMBAKAENGO, SENADI, and !XU (see appendix F). We need to point out that sometimes analyzing a sound as a cluster of two primary or a unit secondary phoneme(s) is very difficult. For example, we chose to include /g/ among the primary stops of TEKE even though it always occurred prenasalized [ŋg], because of the fact that the nasal represents a separate prefixed morpheme in the few words with /g/. On account of the exceptions mentioned above, we find it absolutely necessary to modify (vii).

28. In a given language the number of secondary nasal consonants is unlikely to be greater than the number of primary nasal consonants.

vii. In a given language the frequency of occurrence of SNC's is always less than that of PNC's.

Our data is not in the position to provide answers to questions such as (vii). But cases like APINAYE, and HAKKA where the primary nasal consonants seem to be allophones of the secondary nasal consonants would seem to violate this assumption. (In any case, we suspect that such violations are extremely few.)

IV. b) 2. Types of secondary nasal consonants

In table 17 we present the types of secondary nasal consonants found in our data together with their frequency counts.

Table 17. Secondary nasal consonants and their frequency counts.

Nasalized obstruents	484	Laryngealized	43	Voiceless	38
Palatalized	21	Labialized	16	Breathy	11
Pharyngealized	9	Nasal released	6	Velarized	4

Here we note that nasalized obstruents are, by far, the most frequent form of secondary nasal consonants. We note also that nasal consonants are very rarely velarized. This last observation is most likely to be an articulatory constraint, in that if the velum is lowered it leaves little room for the tongue to be raised.

Table 18 sums up the relationship between place and manner of articulation of nasal consonants in our data. (Note that manner here refers uniquely to the various forms of secondary articulations cited.) From the table we find the types of modification to the primary nasal consonants (steadily) increase as the places of articulation increase. This is in accord with our findings for fricative and oral stop consonants.

Table 18. Frequency of occurrence by place and manner of articulation.

	Manner					
place	1	2	3	4	5	6
1	6	2	-	-	-	-
2	81	12	2	-	-	-
3	69	20	2	2	2	-
4	68	15	3	-	-	-
5	7	3	1	5	-	1
6	6	1	-	1	-	-

V. How marked are the "marked" segments?

It seems appropriate in closing to make an overview of the last three chapters. When we do we notice certain similarities among some of the statements. For example, statements (2), (13), and (25), all have one thing in common - same place of articulation. This, as we have shown, is no accident. The sounds in question are all made with the most mobile organ of articulation - the tip of the tongue - at the acoustically most superior place - the alveo/dental region (Stevens, 1961; int. al.). These, coupled with the very significantly high perceptual salience of sounds made in this acoustic chamber, would then account for these similarities. In the light of the above we propose the following universal tendency:

29. If a language has only one place of articulation for a given type of consonant it is most likely to be the alveo/dental region.

The closest we came to bearing out this statement completely is MAIDU with only /s/ for a primary fricative, and /n/ for a primary nasal consonant. As far as we are concerned there are no clear cut exceptions to this statement since every language in our base has an alveo/dental sound of one class or another. Individual class exceptions have already been discussed. The very striking nature of this realization may encourage proponents of the theory of markedness to suggest the alveo/dental region as the least "marked" place of articulation.

Another phenomenon that needs commenting on is voicing. Here we eliminate nasal consonants before any discussion as one of the requirements of a primary nasal consonant is that it is *voiced*. Here also, we find that the striking similarity between statements (4) and (16) deserve a statement, as in (30) below.

30. There is a very highly significant tendency **for languages** to have more voiceless obstruents than voiced ones.

The next statement is directly related to (30), and is as follows:

31. The presence of a voiced obstruent in a given language is most likely to imply the presence of its voiceless cognate.

Exceptions to this statement have been discussed under statements (5) and (17) above.

And now we take a final look at the general structure of consonant phonemes. As we noted earlier, languages tend to employ three strategies in choosing their phonemes, namely - articulatory ease, acoustic intensity, and perceptual salience. Of the three, we believe that perceptual salience has the uppermost hand. Because when all is said and done, people want to be able to communicate with the least amount of confusion. We are, of course, aware that our choice of a maximal dispersion hypothesis conflicts with a theory of markedness (Gamkrelidze, 1978; Greenberg, 1966; Hockett, 1955; Jakobson, 1941; Trubetzkoy, 1939, int. al.), but we simply do not believe that the choice of phonemes is a matter of mere 'gap-filling', whereby "empty slots (gaps) appear in place of marked members of oppositions, as cells, as it were, which would be filled by marked members of relation;" (Gamkrelidze, 1978; p. 13).

A very appropriate closing note that we hope would sum up this study is given as statement (32):

32. The preferred set of consonants in a given language is:

p t k tʃ

f s

m n

Footnotes

1. Of the 317 languages the phonological systems of only 148 were contributed from scratch by the members. The rest were critically selected (and sometimes reanalysed) from data in the Stanford Archives.

2. For the details of this and the discussion below, see Ian Maddieson ("Phonological generalizations derived from the UCLA Phonological Segment Inventory Database.")

3. We shall, however, do a couple of comparisons later on involving /h/.

4. The three-way break down for /s/ and /z/ represent unspecified, dental, and alveolar, respectively. For reasons discussed earlier, we found it necessary to collapse all three figures. This is also reflected in the patterns (table 2) except where a language has 2 out of the 3.

5. /ʃ́/ represents a voiced palatal fricative.

6. Due to reasons cited earlier, /h/ is dropped from Strevens's data (left column). The pharyngeal fricative /ħ/ is also dropped from the right column. This allows us to use only matching pairs.

7. For example, we are aware of certain dialects of HAUSA where /h/ replaces /Φ/, which in turn had developed from /p/.

8. The inclusion of the underlined also for phonological patterning.

9. For a comment on Lieberman's account see Ladefoged's review of the Lieberman book in *Language* 54.4: 920-922. (1977).

10. Ferguson's statements were all based on the "all-or'none" principle, and hence the seeming contradiction.

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Appendix A

Primary Fricative Patterns - with dental and alveolar places of articulation collapsed.

1A /s/		1B /β/
Ainu	Nimboram	Gadsup
Amoy	Pawaian	Rotokas
Barasano	Sara	
Batak	Sebei	
Dani	Sepepet	
Daribi	Seneca	1C /f/
Fuchow	Siona	Maori
Itoma	S. Nambiquara	Setani
Iwam	Suena	
Javanese	Sundanese	
Kashmiri	Tagalog	
Kharia	Tamang	1D /ɣ/
Klamath	Temein	Maung
Korean	Tucano	Tiwi
Maidu	Wantoat	
Malay	Wichita	
Mundari	Yulu	
Mura	Zoque	

Appendix A (continued)

2A /fs/
Adzera
Akan
Chamoro
Chuave
Diola
Efik
Hakka
Island Carib
Kadugli
Taoripi
Teke
Telefol
Temne
Thai
Ticuna
Yao
Yaqui

2B /sʃ/
Arabela
Chatino
Guajiro
Khasi
Koma
Maasai
Ojibwa
Sedang
Siriono
Tunica
Tzeltal

2C /sx/
Dafla
Nama
Shasta
Tonkawa
Yana

2D /sz/
Boro
Kunimaipa
Mabuiag

2E /vs/
Lelemi
Nambaikaengo
Yagaria

2F /sṣ/
Malayalam
Papago
Sa'ban

2G /βs/
Carib
Kaliai

2H /ɸs/
Fasu
Yareba

2I /fʃ/
Kefa
Taishan

2 Miscel.
Abipon /xɦ/
Bengali /sç/
Cham /sˤ/
Ket /sʃ/
Khmer /sɧ/
Koiari /fð/
Kota /vṣ/
Kurukh /sɔc
Nyangi /s̱ɬ/
Tavgy /ðs/
Yukagir /sʁ/

Appendix A (continued)

3A /fs∫/

Kunama
Lappish
Luo
Nera
Nubian
Wappo

3B /s∫x/

Delaware
Jaquaru
Jivaro
K'ekchi

3C /sɬx/

Hupa
Nez Perce
Tiwa

3D /sɬ∫/

Totonac
Wiyot
Zuni

3E /sʒɬ/

Ao
Jingpho

3F /fvs/

Beembe
Songhai

3G /fðs/

Katcha
Moro

3H /s∫ʒ/

Totontepec Mixe
Wapishana

3 Miscel.

Acoma /s∫s̻/
Alabama /Φsɬ/
Amahuaca /θsx/
Apinaye /vsʒ/
Araucanian /Φθs/
Asmat /fsj/
Bariba /fsz/
Beja /fs̲s/
Campa /βs∫/
Cashinahua /s∫̻∫/
Cayapa /Φs∫/
Chontal /sʒ∫/
Chukchi /zɬɣ/
Evenki /βsz/
Garo /sçj/
Hamer /sz∫/
Hopi /vss̻/
Kan /Φsç/
Kewa /Φsx/
Kunjen /fðɣ/
Lakkia /fθɬ/
Mursi /θs∫/
Ostyak /s∫ɬ/
Saek /vsɣ/
Sinhalese /Φs̲∫/
Squamish /s̲∫ɔc/
Toma /fsɦ/
Wolof /fsɔc/
Yurak /ðsx/

Appendix A (continued)

4A /fvsz/

Bisa

Changchow

Dagbani

Dan

Doayo

Gbeya

Logbara

Malagasy

Tampulma

Tsou

Zande

4B /fsz∫/

Awiya

Bambara

Kullo

4C /fvɬ∫/

Lungchow

Po-ai

4D /fs∫x/

Manchu

Somali

4 Miscel.

Achumawi /s∫xɔc/

Berta /fθs∫/

Bribri /sz∫x/

Chacobo /βsṣ∫/

Finnish /fvs∫/

Goldi /βsjx/

Guahibo /fvsx/

Gunnuna-Kena /s̲∫çx/

Haida /ɬçxɔc/

Hausa /ɓsz∫/

Japanese /sz∫ç/

Irish /sçxɣ/

Kanakuru /sɬʒɣ/

Lahu /fv∫ʒ/

Luiseno /vṣ∫x/

Luvale /fs∫ʒ/

Moxo /βfs∫/

Norwegian /fs∫ç/

Puget Sound /sɬ∫ɔc/

Punjabi /fs̲z̲ṣ/

Rukai /vθðs/

Telegu /fsṣ∫/

Tiddim /vszx/

Tlingit /sɬxɔc/

Washkuk /ɓβs∫/

Yay /fvθs/

Yuchi /ɓsɬ∫/

Appendix A (continued)

5A /fvszʃ/

Amo

Birom

Ga

Swahili

5B /fszʃʒ/

Amharic

Maba

Tigre

5C /fvszɣ/

Igbo

Kpell

5 Miscel.

Ashluslay /fsxʃɬ͡x/

Basque /fsʂʃɔc/

Brahui /fvszɬ/

Burmese /θðszʃ/

Fur /fszʃɬ/

Ik /fszɬʒ/

Iraqw /fsɬʃx/

Karak /fs̪sxʃ/

Kwakiutl /sɬçɔcħ/

Mazahua /szɮʃʒ/

Mazatec /βðsʃɣ/

Mixtec /βðsʃʒ/

Mongolian /ɸβʃçx/

Otomi /ɸ̈szʃx/

Paez /ɸ̈βsʃɣ/

Pomo /fsʃxɔc/

Quileute /sɬʃxɔc/

Russian /fvs̪z̪x/

Tacana /βðr̆ʂʃ/

Tarascan /ɸfsʃx/

Wintu /fθsxɔc/

!xũ /szʃʒx /

French

Hungarian

Romanian

6A /fvszʃʒ/

Senadi

Tarok

Yakut

Atayal /βsʒxɣħ/

Amuesha /βszʃxɣ/

Cofan /βfsʃjɣ/

Dakota /s̪z̪ʃʒxɣ /

Diegeuna /βs̪ʒ̪sʒx/

Dizi /βfszʃʒ/

Kanuri /ɸfszʃx/

Kirghiz /βfszʃx/

6 Miscel.

Lithuanian /vszʃʒx/

Mandarin /fsʂz̤çɔc/

Muiane /ɸβsʃʃx/

Nootka /sɬʃxɔcħ/

Ocaina /ɸ̈βsʃʒx/

Quechua /ɸ̈βðsʃɣ/

Tabi /fθðszʃ/

Tolowa /sʂɬʃxɣ/

7A /fvszʃʒx /	7B /fvszʃʒɣ/	7C /fszʃʒɔcʁ/
Breton	Angas	Hindi-Urdu
Bulgarian	Turkish	Tuareg
German	Tuva	

7 Miscel.

Aleut	/ðʃʒxɣɔcʁ/	Navajo	/szɬʃʒxɣ/
Chipewyan	/θðszʃxɣ/	Persian	/fvszʃʒɔc/
Chuvash	/fszʃʒçx/	Shilha	/fszʃʒxɣ/
Georgian	/βszʃʒɔcʁ/	Spanish	/βfθðs̲xɣ/
Gilyak	/fszxɣɔcʁ/	Sui	/ɸszʃxɣʁ/
Guarani	/fvðs̲sxɣ/	Vietnamese	/fvszʧxɣ/
Karen	/θszʧʃxɣ/	Zulu	/fvszɬʧʃ/
Lak	/szʃʒxɔcħ/		

8 Miscel.

Albanian	/fvθðs̲z̲ʃʒ/
Bashkir	/fvθszʃʒx/
Burushaski	/fszs̲z̲ʃɔcʁ/
E. Armenian	/fvszˇʃʒɔc/
Ewe	/ɸβfvszhç/
Greek	/fvθðszxɣ/
Greenlandic	/βfs̲ʃʃɬxɔc/
Hebrew	/fvszʃʒxʁ/
Khalaj	/fvszʃʒjx/
Neo-Aramaic	/βfszʃʒɔcʁ/
Ngizim	/fvszɬʧʃʒ/

9 Miscel.

Azerbaijani	/fvszˇʃʒxɣ/
Cheremis	/βfszðʃʒxɣ/
Komi	/fvszʃʒçʃx/
Egyptian Arabic	/fθðszʃɔcʁħ/
Socotri	/fszɬʧʃʒɔcʁ/

11 Miscel.

Kurdish	/fvs̲z̲sʃʒxɣħç/
Fashto	/βfszɬs̲z̲ʃʒɔcʁ/
Margi	/vszɬʧʃʒçʃxɣ/

14 Miscel.

Kabardian	/fvs̲z̲ɬʧʃʒçʃɔcʁħç/

Appendix B

Inventory of all fricatives - all languages

Ø Fricatives

Alawa
Andamanese
Arabana-Wanganura
Aranda
Auca
Bamjalang
Bardi
Burera
Dera
Dieri
Gugu-Yalanji
Hawaiian
Kariera-Ngarluma
Malakmalak
Maranungku
Nasioi
Nunggubuyu
Nyangumata
Roro
W. Desert
Wik-Munkan

1A /s/

Ainu
Amoy
Baransano
Batak
Dani
Daribi
Fuchow
Itonama
Iwam
Kharia
Klamath
Maidu
Malay
Mundari
Mura
Nimboram
Pawaian
Sara
Sebei
Selepet
Seneca
Suena
Sundaese
Tagalog
Temein
Tucano
Yulu
Zoque

1B /s̲/

Javanese
Tamang

1C /β/

Gadsup
Rotokas

1D /f/

Maori
Sentani

1E /ɣ/

Maung
Tiwi

2A /fs/

Adzera
Chamoro
Chuave
Diola
Efik
Hakka
Island Carib
Kadugli
Taoripi
Teke
Telefol
Temne
Ticuna
Yao
Yaqui

2C /sz/

Boro
Kunimaipa
Mabuiag

2D /sṣ/

Korean
Siona
S. Nambiquara

2E /vs/

Lelemi
Nambaikaengo
Yagaria

2H /fʃ/

Kefa
Taishan

2I /sṣ/

Malayalam
Sa'ban

2J /s̲x/

Shasta
Yana

Appendix B continued

2B /sʃ/
Arabela
Chatino
Guajiro
Khasi
Koma
Maasai
Sedang
Siriono
Tunica

2F /βs/
Carib
Kaliai

2G /Φs/
Fasu
Yareba

2K /sx/
Dafla
Nama

3A /fsʃ/
Kunama
Lappish
Luo
Nera
Nubian
Wappo

3B /sʃx/
Delaware
Jaquaru
Jivaro
K!ekchi

3C /szɬ/
Ao
Jingpho

3D /fvs/
Beembe
Songhai

3E /fðs̱/
Katcha
Moro

3F /sɬs̱/
Totonac
Zuni

3G /sʃʒ/
Totontepec Mixe
Wapishana

2 Miscel.

Abipon /xʜ/
Bengali /sɕ/
Cham /s̻ʃ̻/
Kashmiri /sʃʲ/
Khmer /sʒ/
Koiari /fð/
Kota /vs̻/
Kurukh /sɔc/
Nyangi /s̱ɬ/
Papago /s̱s̻/
Tavgy /ðs̻/
Thai /fs̱/
Tzeltal /s̱ʃ̻/
Wantoat /sɳz/
Wichita /ss:/
Yukaghir /sʁ/

3 Miscel.

Acoma /s̱ʃs̻/
Akan /fsɕw/
Alabama /Φsɬ/
Amahuaca /θsx/
Apinaye /vsʒ/
Araucanian /Φθs/
Asmat /fsʃʸ/
Bariba /fsz/
Beja /fs̱s/
Campa /βsʃ/
Cashinahua /sʃʃ/
Cayapa /Φs̻ʃ̻/
Chontal /sʐʃ/
Evenki /βsz/
Garo /sɕʃʲ/
Hamer /szʃ/
Hopi /vss̱/
Kan /Φs̻ɕ/
Ket /ssʲʃʲ/
Kewa /Φsx/
Kunjen /fðɣ/
Lakkia /fθɬ/
Mursi /θsʃ/
Nez Perce /sɬx/
Ostyak /sʃɣ/
Saek /vsɣ/
Toma /fsʜ/
Tonkawa /s̱xxʷ/
Wiyot /s̱ɬʃ/
Wolof /fsɔc/

Appendix B (continued)

4A /fvsz/
Bisa
Changchow
Dagbani
Dan
Doayo
Gbeya
Logbara
Malagasy
Tampulma
Tsou
Zande

4B /fsz∫/
Awiya
Bambara
Kullo

4C /sɬxxʷ/
Hupa
Tiwa

4D /fvɬ∫/
Lungchow
Po-ai

5A /fvsz∫/
Amo
Birom
Swahili

4 Miscel.

Achumawi	/s∫xɔc/
Berta	/fθs∫/
Bribri	/sz∫x/
Chacobo	/βs∫∫/
Chukchi	/sjžɬɣ/
Goldi	/βsjx/
Guahibo	/fvsx/
Gununa-Kena	/s̻∫çx/
Lahu	/fv∫ɣ/
Luvale	/fs∫ʒ/
Manchu	/fs̻∫x/
Moxo	/βfs∫/
Norwegian	/fs∫ç/
Ojibwa	/ʰssʰ∫∫/
Rukai	/vθðs/
Sinhalese	/Φs̻s̻:∫/
Somali	/fs∫x/
Telegu	/fsʂ∫/
Tiddim	/vszx/
Yay	/fvθs/
Yuchi	/Φsɬ∫/

5B /fvszɣ/
Igbo
Kpelle

5 Miscel.

Ashluslay	/fs∫xɬɔc̃/
Basque	/fsʂ∫ɔc/
Brahui	/fvszɬ/
Burmese	/θðsz∫/
Finnish	/fvs∫s:/
Fur	/fsz∫ɣ/
Ik	/fszɣɮ/
Kanakuru	/sʒʒɣǰʒ/
Karok	/fs̻s̻∫x/
Luiseno	/vʂ∫xxʷ/
Maba	/fsz∫ʒ/
Mixtec	/βðs∫ʒ/
Mongolian	/Φβ∫çx/
Otomi	/Φsz∫x/
Pomo	/fs∫xɔc/
Punjabi	/fs̻z̻ʂ̻s̻:/
Squamish	/s̻∫xʷɔcɔcʷ/
Tacana	/βðʂřʃ/
Tarascan	/Φfs∫x/
Washkuk	/ΦΦʷβs∫/
Wintu	/fθsxɔc/
Yurak	/ðsxðjsj/
!xu	/sz∫ʒx/

Appendix B (continued)

6A /fvszʃʒ/
French
Romanian
Senadi
Tarok

6 Miscel.

Kanuri	/Φfszʃx/
Kirghiz	/βfszʃx/
Mandarin	/fsszçɔc/
Mazatec	/βðsʃɣjʒ/
Muinane	/Φβsʃjx/
Ocaina	/Φβsʃʒx/
Puget Sound	/sɬʃxʷɔcɔcʷ/
Quechua	/Φβðsʃɣ/
Tabi	/fθðszʃ/
Tlingit	/sɬxɔcxʷ/

Atayal	/βsʒxɣh/
Amuesha	/βszʃxɣ/
Cofan	/βfsʃjɣ/
Dakota	/s̪z̪ʃʒxɣ/
Dizi	/βfszʃʒ/
Gã	/fvszʃʃʷ/
Haida	/ɬçxɔcɔcʷxʷ/
Hausa	/ΦΦjszsʃ/
Hungarian	/fvs̪z̪ʃʒ/
Japanese	/szʃs:s:ç:/

7A /fvszʃʒɣ /
Angas
Turkish

7B /fvszʃʒx/
Breton
German

7 Miscel.

Aleut	/ðʃʒxɣɔcʁ/
Chivash	/fszʃçʒx/
Dieguena	βs̪ʒsʒxxʷ/
Georgian	/βszʃʒɔcʁ/
Gilyak	/fszxɣɔcʁ/
Hindi-Urdu	/fszʃʒɔcʁ/
Iraqw	/fss ɬʃxxʷ/
Kwakiutl	/sɬçxʷɔcɔcʷh/
Mazahua	/szƛʃʒsʰs'/

Navajo	/szɬʃʒxɣ/
Persian	/fvszʃʒɔc/
Quileute	/sɬʃxɔcxʷ ʷ/
Spanish	/βfθðs̪xɣ/
Tolowa	/sṣɬʃxɣxʷ/
Tuva	/fvs̪z̪ʃʒɣ/
Vietnamese	/fvszƛxɣ/
Yakut	/fvs̪z̪ʃʒs̪ /
Zulu	/fvszɬƛʃ/

8 Miscel.

Albanian	/fvθðs̪z̪ʃʒ/
Bashkir	/fvθszʃʒx/
Burushaski	/fszs̪z̪ʃɔcʁ/
E. Armenian	/fvszř̪ʃʒɔc/
Ewe	/ΦβfvszɦG/
Greek	/fvθðszxɣ/
Greenlandic	/βf:s̪ʃjx:ɬɔc:/
Hebrew	/fvszʃʒxʁ/
Iai	/θβfθðsʃx/

Irish	/ΦjβjΦs̪ʃjçxɣ/
Karen	/θszƛsʰʃxɣ/
Khalaj	/fvszʃʒʃ̈x/
Neo-Aramaic	/βfszʃʒɔcʁ/
Ewe	/ΦβfvszɦG/
Ngizim	/fvszʃʒɬƛ/
Noothka	/sɬʃxɔcxʷɔcʷɦ/
Sui	/Φszʃxɣʁx/
Tuareg	/fszʃʒɔcʁz̈̈/

9 Miscel.

Azerbaijani	/fvszřʃʒxɣ/
Chipewyan	/θðszʃxɣxʷɣʷ/
Guarani	/fvðsxɣxʷɣʷ/
Komi	/fvszʃʒçjx/
Paez	/ɸβsn̂ẑʃʃǰŋʒɣn̂ʃɣ/

10. Miscel.

Cheremis	/βfðszsʲʃʒxɣ/
Lithuanian	/vszʃʒxvǰsǰʃǰʒʲ/
Tigre	/ff:ss:zz:ʃʃ:ʒʒ:/

11 Miscel.

Bulgarian	/fvszʃʒxfʲvʲsʲzʲ/
Kurdish	/fvszsʃʒxɣɦç/
Margi	/vszʃʒɬɮçjxɣ/
Pashto	/βfszɬszʃʒɔcʁ/
Russian	/fvszxfʲvʲsʲzʲʃʒ/
Socotri	/fszɬɮs'ʃʒʃ'ɔcʁ/

12

Amharic /ff:ss:zz:ʃʃ:ʒʒ:sʷsʷ:/

16

Shilha /fszʃʒxɣszf:s:ʃ:ʒ:x:ɣ:z:/

17

Lak /szʃʒxɔcɦʃʷxʷɔcʷs:ʃ:ʃʷ:x:xʷ:ɔc:ɔcʷ:/

19

Kabardian /fvszʃʒçjʔcʁɦ:ɬɮxʲxʷɣʲɔcʷʁʷ/

23

Egyptian Arabic /ff:θðss:zz:ʃʃ:ɔc:ɔc:ʁʁ:ɦɦ:ðss:z:ħħ:z/

Appendix C. Primary oral stops - with dental and alveolar places of articulation.

Ø - Maidu

2 - Hawaiian /ʔk/

3A /ptk/

Arabela	Dan	Daribi	Pasu
Iwam	Kaliai	Maori	Nama
Nambakaengo	Pawaian	S. Nambiquara	Taoripi

4A /ptkʧ/

Amahuaca	Ainu	Amuesha	Apinaye
Asmat	Dakota	Delaware	Guajiro
Guarani	Karok	Khmer	Korean
Lungchow	Luvale	Maasai	Mixtec
Ojibwa	Po-ai	Shasta	Siona
Spanish	Taishan		

4B /ptck/

Ao
Gugu-Yalanji
Malakmalak
Nyangi
Wik-Munkan
Burera
Karen
Maranungku
Sebei

4C /ptkts/

Changchow
Fuchow
Hakka
Tonkawa

4D /bdgdʒ/

Berta
Turkish

4E /bdɟg/

Breton
Klamath

4F /pbtk/

Nasioi
Roro

4 miscel.

Aleut	/tkqts/	Banjalang	/ptgtʃ/	Beembe	/ptpfts/
Gadsup	/ptdk/	Hopi	/ptkq/	Lak	/bdgɢ/
Norwegian	/bɖɖg/	Rotokas	/ptkg/	Seneca	/btkdz/
Sentani	/ptdk/	Wapishana	/bdgtʃ/	Zulu	/ptkdʒ/
Zuni	/pttstʃ/				

5 A /ptktstʃ/

Chacobo
Jivaro
Cheremis
Kan
E. Armenian
Paez
Georgian
Wiyot

5B /btdkg/

Chuave
Koiari
Shilha
Socotri
Songhai

5C /ptkqts/

Atayal
Chukchi
Greenlandic

5D /pbtkts/

Lakkia
Tsou
Yurak

5E /ptkqtʃ/

Abipon
Quechua

5F /pbtktʃ/

Alabama
Siriono

5G /pt̪tṭk/

Tiwi
W. Desert

5 miscel.

Achumawi	/ptkqdʒ/	Adzera	/bdgtsdz/
Akan	/bdgtçdj/	Alawa	/bdɖɟg/
Bardi	/pt̪ṭck/	Efik	/ptckq/
German	/bdg̈pfts/	Gilyak	/ptckq/
Hupa	/tcqtstʃ/	Irish	/t̪d̪dtʃdʒ/
Javanese	/pt̪tkts/	Ket	/btdkq̣/
Kirghiz	/ptq̣tstʃ/	Kunjen	/pt̪ṭck/
Luiseno	/pt̪kq̣tʃ/	Maung	/pt̪ṭk͡t͡c/

Appendix C (continued)

Mongolian	/bdgdzdʒ/
Nez Perce	/pt̪tkqɔc/
Ostyak	/ptɕkts̪/
Tamang	/pt̪kt̪sts/
Totontepec-Mixe	/ptdkg/
Mura	/pbtkg/
Nyangumata	/ptt̪kg/
Saek	/pbt̪dk/
Tolowa	/ptkt̪stʃ/

6A /pbtdkg/

Auca	Barasano	Bisa	Boro
Carib	Chatino	Dafla	Dera
Finnish	French	Garo	Kanakuru
Koma	Mabuiag	Nimboram	Telefol
Tucano	Wantoat	Yagaria	

6B /pt̪tt̪ck/

Arabana-Wanganura
Aranda
Nungu-Buyu

6C /pbtdkts/

Guahibo
Thai

6D /ptkqtstʃ/

K'ekchi
Totonac

6 miscel.

Araucanian	/pt̪tktʃtʃ/	Ashluslay	/ptktstʃkɬ/
Azerbaijani	/ptckt͡ʃdʒ/	Bulgarian	/bdgtst͡ʃdʒ/
Campa	/ptcktstʃ/	Dieguena	/pt̪tkɢt͡ʃ/
Itoma	/pbtdkt͡ʃ/	Jingpho	/ptktsp͡tk͡t/
Kariera-Ngarluma	/pt̪tt̪cg/	Khasi	pbtdkdʒ/
Kullo	/bkgtst͡ʃdʒ/	Kwakiutl	/ptcqt͡ʃtɬ/
Mandarin	/ptkts̪st͡ʃ/	Mazahua	/ptkgtstʃ/
Navajo	/ptktstɬt͡ʃ/	Nera	/ptdkgdʒ/
Persian	/bdgɛt͡ʃdʒ/	Somali	/bdḍgɢt͡ʃ/
Tama	/bt̪d̪jkg/	Tuareg	/btj̈kgɢ/
Yareba	/btdkgdz/	Yay	/pbtdck/

7A /pbtdkgts/

Rissoam
Tagalog
Tiddim
Zoque

7B /pbtdkgdʒ/

Batak
Fur
Sara

7C /pbtdktstʃ/

Cashinahua
Chontal
Moxo

7D /pbtdkgtʃ/

Island CArib
Tiwa
Yaqui

7E /btdkgt͡ʃdʒ/

Hausa
Nubian

7F /pt̪kqtstɬt͡ʃ/

Nootka
Squamish

7 miscel.

Angas	/bdcɟgtʃdʒ/	Beja	/bʈʈḍkgdʒ/
Cham	/pbtdʈcḳ/	Chipewyan	/ptkʦtstɬtʃ/
Kabardian	/bḏgqtsdzqɔc/	Kota	/bʈḍḍḍgdʒ/
Kunama	/bʈḍcɟkg/	Kunimaipa	/pb̈tḍkgɢ/
Luo	/bdgtʦdʐtʃdʒ/	Mazatec	/pbtktstʃtʃ/
Ocaina	/pbtdkgdz/	Sa'ban	/pbtdgtʃdʒ/
Suena		Tacana	/pbtdktʦtʃ/

8A /pbtdkgtʃdʒ/

Andamanese	Bambara	Burmese	Evenki
Goldi	Igbo	Japanese	Kanuri
Khalaj	Manchu	Sedang	Ticuna
Yakut	Yana		

8B /pbtdkgtstʃ/

Bashkir	Bribri	Chuvash	Lappish
Otomi	Tarascan	Tuva	Tzeltal

8C /pbtdkgk͡pg͡b/

8D /pbtdcɟkg/

8E /pbtdkqtstʃ/

Bariba	Dan	Diola	Kefa	Lithuanian	Sui
Doayo	Gbeya	Malay	Mursi		
Kpelle	Zande	Ngizim	Tabi		

8 miscel.

Acoma	/bdɟkgdzdẓdʒ/	Chamoro	/pbtdkgtsdz/
Dieri	/pʈʈdʈḍcḳ/	Dizi	/btdʈkgtʃdʒ/
Egyptian Arabic	/pbtdkgqdʒ/	Greek	/pbtdkgtsdz/
Haida	/ptkcʠtɬdʐtʃ/	Jaquaru	/ptckqtstʃtʃ/
Kadugli	/pbʈḍḍckg/	Maba	/btdʈḍjkg/
Moro	/pbʈʈkgtʃdʒ/	Sunanese	/pbʈḍjkgtʃ/
Temme	/pbʈʈdkggb/	Tigre	/btdkgtstʃdʒ/
Wolof	/pbtdcɟkqɔc/		

9A /pbtdkgtstʃdʒ/

Amoy
Hebrew
Romanian

9B /pbtdkgqtʃdʒ/

Kurdish
Lahu
Neo-Aramaic

9 miscel.

Gununa-Kena	/pbtdkʠtstʃtç/	Hamer	/pbtdcɟkgts/
Katcha	/bʈḍtdcɟkg/	Lelemi	/btḍkgk͡pg͡btsdz/
Papago	/pbʈḍḍkgtʃdʒ/	Pomo	/pbʈḍtkgʠts/
Rukai	/pbʈḍʈḍkgts/	Tavgy	/pbtdcɟkgkx/
Temein	/pbʈḍtdɟkg/	Wappo	/pbʈḍtkgtstʃ/
Wintu	/pbtdkqtɬtʃdʒ/	Yukaghir	/pbtdɟkgʠtʃ/

10A /pbtdʈɖkgtʃdʒ/

Bengali
Brahui
Kharia
Malayalam
Mandarin
Punjabi
Sinhalese

10B /pbtdkgk͡pg͡btʃdʒ/

Amharic
Dagbani
Ga
Logbara
Tarok

10C /pbtdcɟkgk͡pg͡b/

Birom
Senadi
Tampulma

10D /pbtdkgtsdztʃdʒ/

Ik
Yuchi
!xũ

10E /pbtdcjkgtʃdʒ/

Cofan Muinane

10 Miscel.

Cayapa	/pbtdcɟkgtstʃ/
Ewe	/pbt̪d̪kgk͡pg͡btsdz/
Iraqw	/pbtdkgɋk͡pg͡bts/
Kashmiri	/pbtdʈɖkgtsdz/
Kurukh	/pbtdʈɖcjkg/
Malagasy	/pbt̪d̪kgʈsɖzʈsɖz/
Margi	/pbtdcɟtsdztʃdʒ/
Quileute	/pbtdkgqtstɬtʃ/
Teke	/pbtdkgpfbftʃdʒ/
Yao	/pbt̪d̪cjkgtsdz/
Yulu	/pbt̪d̪ckgk͡pg͡bdz/

11 miscel.

Amo	/pbtdkgk͡pg͡btstʃdʒ/
Basque	/pbtdcɟkgtststʃ/
Hindi-Urdu	/pbt̪d̪ʈɖkgqtʃdʒ/
Iai	/pbtdʈɖg͡bkgtʃdʒ/
Puget Sound	/pbtdkgqtsdztʃdʒ/
Telegu	/pbt̪d̪ʈɖkgtstztʃ/

12A /pbtdkgtsdʒtçdʃ/

Albanian Hungarian

12B.

Pashto /pbtdʈɖkgtsdztʃdʒ/

13.

Komi /pbtdcɟkgtstʃdʒtcdʃ/

14 miscel.

Awiya	/pbtɖkgqɢtsdztʃdʒk͡pg͡b/
Burushaski	/pbtʈɖtdkgqɢtstʂdʐtʃdʒ/
Tlingit	/pbtdkgqɢtsdztʃdʒtɬdɬ/

Appendix D.

All plosives and affricates - all languages

3A /ptk/

Arabela
Fasu
Iwam
Maori
Pawaian
Taoripe

3B /pk?/

Hawaiian

4A /ptck/

Burera
Gugu-Yalanji
Malakmalak
Sebei

4B /ptkt∫/

Ainu
Asmat
Spanish

4 miscel.

Sentani /ptkd/
Rotokas /ptkg/
Banjalang /ptgt∫/
Aleut /tkqts/

5A /ptkt∫?/

Amahuaca
Karok

5B /ptck?/

Ao
Wik-Munkan

5C /btdkg/

Chuave
Koiari

5D /pbtk?/

Nasioi
Roro

5E /p̪t̪t̪k/

Tiwi
W. Desert

5 miscel.

Abipon /p̪kqt∫/
Bardi /pt̪ck/
Efik /btdkk͡p/
Greenlandic /p̪kqts/
Maung /pt̪kt͡ç/
Seneca /btk?dz/

Alabama /pbt̪kt∫/
Dan /ptk?kʷ/
Gadsup /ptdk?/
Kewa /tcgmbnd/
Ostyak /ptchts/
Vietnamese /t̪ck?tʰ/

6A /pbtdkg/

Auca
Barasano
Bisa
Boro
Dafla
Dera
French
Garo
Mabuiag
Nimboram

6B /p̪t̪t̪ck/

Arabena-Wangamura
Nungu-Buyu

6C /ptkq?ts/

Atayal
Chukchi

6D /ptk?t∫kʷ/

Guarani
Mixtec

6 miscel.

Achumawi	/ptkq?dʒ/	Alawa	/bdḍgjɲɟ/
Araucanian	/pt̪tkt̪ʃt̪ʃ/	Campa	/ptcktstʃ/
Chacobo	/ptk?tṡtʃ/	Daribi	/ptt$p^h t^h k^h$/
Hopi	/ptkq?k^w/	Kaliai	/ptkmbndŋg/
Kariera-Ngarluma	/pt̪tṭcg/	Mura	/pbtkg?/
Nera	/ptdkgdʒ/	Nyangumata	/ptṭkgtʲj/
Selepet	/bdgpht^{h}k^h/	Siriono	/pbtktʃkʲj/
Tonkawa	/pt̪k?t̪sk^w/	Totontepec-Mixe	/ptdkg?/
Tsou	/pbtk?ts/	Yareba	/btdkgdz/

7A /pbtdkg?/

Carib	Chatino
Tucano	Yagaria

7B /pbtdkgdʒ/

Batak
Fur

7 miscel.

Cashinahua	/pbtdktstʃ/	Cheremis	/ptktstʃ$p^ʲ t^ʲ$/
Guahibo	/pbtdktst^h/	Island Carib	/pbtdkgtʃ/
Kunama	/bt̪d̪cɟkg/	Kunimaipa	/pbtḏkgɢ/
Maranungku	/ptckp:ṭ:k:/	Nubian	/btdkgtʃdʒ/
Songhai	/btdkgt^{ʲ}d^ʲ/	Suena	/pbtdkgdz/
Telefol	/pbtdkgk^w/	Totonac	/ptkɋtstʃ?^{h}'/

8A /pbtdkgtʃdʒ/

Andamanese	Bambara
Khalaj	Evenki
Goldi	Manchu

8B /pbtdkgtstʃ/

Bribri
Lappish
Tuva

8C /pbtdkgk͡pg͡b/

Bariba
Zande

8D /pbtdcɟkg/

Diola
Malay

8E /pbtdkg?ts/

Tagalog
Zoque

8 miscel.

Breton	/bdɟgp^{h}t^{h}c^{h}k^h/	Delaware	/ptktʃp:t:k:tʃ:/
Dieguena	/pt̪tkɋt̪ʃk^w/	Dieri	/pt̪tḏḍck/
Fuchow	/ptktsp^{h}t^{h}k^{h}ts^h/	German	/bdgpftsp^{h}t^{h}k^h/
Greek	/pbtdkgtsdz/	Kanakuru	/pbtdkgɓɗ/
Ket	/btdkɋtʲdʲ/	Kirghiz	/ptɋtstʃp^{h}t^{h}ɋ^h/
Luiseno	/ptkɋt̪ʃk^{w}ɋ^w/	Luvale	/ptktʃmbndŋdndʒ/
Maasai	/ptktʃbdfg/	Moro	/pbt̪ṭkgtʃdʒ/
Moxo	/pbtdk?tstʃ/	Norwegian	/bd̪ḍgp^{h}t^{h}ṭ^{h}k^h/
Nyangi	/ptckɓɗfgɣ/	Sa'ban	/pbtdg?tʃdʒ/
Socotri	/btdkg?t'k'/	Tacana	/pbtdk?t̪stʃ/
Tama	/bt̪d̪ɟkgɓd̪/	Tunica	/bdg?p^{h}ṭ^{h}k^{h}tʃ^h/
Wantoat	/pbtdkgk^{w}g^w/	Yaqui	/pbtdkg?tʃ/

9A /ptkʔtʃʰpʰtʰkʰtʃ/

Guajiro
Ojibwa

9B /ptkʔtʃp̪ʰtʰkʰtʃʰ/

Khmer
Po-ai

9 miscel.

Adzera	/bdgʔtsdʒpʰtʰkʰ/
Amuesha	/ptkʔtʃpʲtsʰtsʰtʃʲʰ/
Apinaye	/ptkʔtʃmbndn̪ɟŋg/
Bashkir	/pbtdkgʔtstʃ/
Beembe	/ptpftspʰtʰkʰpfʰtsʰ/
Chamoro	/pbtdkgʔtsdz/
Chuvash	/pbtdkgtstʃtʲ/
Finnish	/pbt̪d̪kgpːt̪ːkː/
Jivaro	/ptkʔt̪tstʃʔspˀ/
Kanuri	/pbtdkgʔtʃdʒ/
Karen	/ptckʔpʰtʰcʰkʰ/
Maba	/btdt̪d̪ɟkgʔ/
Romanian	/pbtdkgtstʃdʒ/
Saek	/pbtdkʔpʰtʰkʰ/
Shasta	/pt̪kʔtʃpʰt̪'k'tʃ'/
Sudanese	/pbt̪dkgʔɟtʃ/
Tabi	/pbt̪d̪cjkgʔ/
Temein	/pbt̪d̪tdɟkg/
Temne	/pbt̪tdkgʔg͡b/
Tuareg	/bt̪ɟkgq̟tʰt̪t̪ʰ/
Wapishana	/b̪dgʔtʃpʰtʰd̪kʰ/
Yukaghir	/pbtdɟkgq̟tʃ/

10A /pbtdcjkgk͡pg͡b/

Birom
Senadi
Tampulma

10B /pbtdkgqʔtʃcʒ/

Kurdish
Neo-Aramaic

10C /pbtdkgk͡pg͡bɓd/

Dan
Doayo

10 miscel.

Akan	/bdgtçdʃp̪ʰtʰkʰtçʷdːʃʷ/
Azerbaijani	/ptcktʃdʒpʰtʰcʰkʰ/
Dagbani	/pbtdkgk͡pg͡btʃdʒ/
Dizi	/btdt̪kgtʃdʒk'tʃ'/
Ewe	/bd̪kgk͡pg͡btsdzpʰt̪ʰ/
Gilyak	/ptckq̟pʰtʰkʰq̟ʰtʃʰ/
Hakka	/ptktspʰtʰkʰt̪ʰtsʰndŋg/
Hebrew	/pbtdkgʔtstʃdʒ/
Kadugli	/pbt̪d̪dckgɓʃ/
Kan	/ptktstʃpʰtʰkʰtsʰtʃʰ/
Khasi	/pbtdkʔdʒpʰtʰkʰ/
Kunjen	/pt̪tckpʰtʰt̪ʰcʰkʰ/
Lelemi	/bt̪d̪kgkpgbt̪sdzp'/
Maidu	/pʰbtʰʃkʰcʰp't'c'k'/
Malagasy	/pbt̪d̪kgt̪sdzt̪sd̪z/
Malayalam	/pbt̪d̪t̪d̪kgtʃdʒ/
Mongolian	/bdgdzdʒpʰtʰkʰtsʰtʃʰ/
Mursi	/pbtdcɟkgɓɗʸ/
Ocaina	/pbtkgʔtsdztʲdʲ/
Papago	/pbt̪d̪d̪kgʔtʃdʒ/
Persian	/bd̪gɢʔtʃdʒpʰt̪ʰkʰ/
Rukai	/pbt̪d̪t̪dkgʔts/
Siona	/ptkʔtʃkʷptkkʷ/
Taishan	/ptktʃpʰtʰkʰtʃʰkʷkʷʰ/
Tamang	/pt̪ktstʂpʰt̪ʰkʰtʂʰtsʰ/
Tavgy	/pbtdcɟkgkxʔ/
Teke	/pbtdkgpfbvtʃdʒ/
Ticuna	/pbtdkgʔtʃdʒkʷ/
Turkish	/bd̪gʔdʒpʰt̪ʰçʰkʰtʃʰ/
Yurak	/pbtkʔtspʲbʲtʲtsʲ/

11 miscel.

Amo	/pbtdkgk͡pg͡btstʃdʒ/
Basque	/pbtdcɟkgtststʃ/
Beja	/bt̪d̪kg?dʒf̪ʰkʷgʷ/
Berta	/bdg?dʒp'mbndɗŋgk'/
Brahui	/pbt̪dt̪d̪kg?tʃdʒ/
Cayapa	/pbtdcɟkg?tstʃ/
Iai	/pbtdt̪d̪kgk͡pg͡btʃdʒ/
Itoma	/pbtdk?tʃtʲt'ktʃ'/
Javanese	/pttk?tspʱt̪ʱt̪ʱkʱt̪sʱ/
Katcha	/bt̪d̪tdcɟkgɓɗ/
Kpelle	/pbtdkgk͡pg͡bɓkʷgʷ/
Kurukh	/pbtdt̪dcɟkg?/
Lungchow	/ptk?tʃpʰtʰkʰb̪dt̪ʃʰ/
Luo	/bdg?tsdztʃdʒp̃ʱtʰkʰ/
Muinane	/pbtdcɟkg?tʃdʒ/
Nez Perce	/pt̪tk?qχp'ṯ'k'q̟'/
Paez	/ptk?tstʃmbtʲndndʲŋg/
Swahili	/pktʃpʰɓtʰɗʃtʃʰkʰgɣ/
Thai	/pbt̪d̪k?tspʰt̪ʰkʰtsʰ/
Tiddin	/pbtdkg?tspʱtʰʔw/
Washkuk	/tk?tʃmbmbʷndkʷŋgŋgʷɲdʒ/
Wolof	/pbtdcɟk?qχb:ʃ:/
Yay	/pbtdck?pʱtʰcʰkʰ/
Zuni	/pt?tʃtskʰk'ts'tʃ'kʷʰkʷ'/

12 miscel.

Albanian	/pb̪t̪d̪kgtsdztʃdʒtçdʃɟ/
Aranda	/ptttckmbndndndɲɟŋg/
Ashluslay	ptk?tstʃkɬp̃t̪k̃ts't̪ʃ'/
Chontal	/pbtdk?tstʃp̃'t̪'k'tʃ'/
Dakota	/ptktʃpʰp'tʰt'kʡk'tʃʰtʃ'/
Gã	/bt̪dgk͡pg͡bt̪ʃdʒpʰkʰt̪ʃʷdʒʷ/
Irish	/t̪d̪dtʃdʒp̪ʷʰpʲʰbʷbʲtʰkʲʰgʲ/
Koma	/pbtdkg?p̪'ɓt'ɗk'/
Kota	/bt̪d̪dgdʒpʰtʰt̪ʰkʰtʃʰ/
Korean	/ptktʃpʰpt̪ʰt̪̃kʰk̃tʃʰtʃ/
Kullo	/bkg?tstʃdʒt̪ʰt'ɗts'ɣ̃/
Mandarin	/ptktststʃpʰtʰkʰtsʰtʂʰtʃʰ/
Pashito	/pbtdt̪d̪kgtsdztjdʒ/
Tarok	/pbtdkgk͡pg͡btʃdʒɓɗ/
Wichita	/tk?tskʷts:tʰkʰk'kʷʰtsʷtʂ'/

13 miscel.

Angas	/bdcɟgtʃdʒtʰɗǯkʰpʰɓ/
Burmese	/pbtdkg?tʃdʒpʰtʰkʰtʃʰ/
Cham	/pbtdt̪ck?pʰtʰt̪ʰcʰkʰ/
Changchow	/ptk?tspʰpʱtʰt̪ʱkʰkʱtsʰtsʱ/
Hamer	/pbtdcɟkgtsɓɗk'ɠ/
Hungarian	/pb̪t̪d̪kgt̪s̪dz̪tʃdʒtçdʃt̪'/
Japanese	/pbtdkgtʃdʒp:t:k:ts:tʃ:/
Kefa	/pbtdcɟkg?p't'c'k'/
K'ekchi	/ptkq̟?tstʃb̪t'k'q̟'ts'tʃ'/
Komi	/pbtdcjkgtstʃdʒt̪çtj/
Lakkia	/pbtk?tspʰtʰkʰkʲʰkʷkʷʰtsʰ/
Logbara	/pb̪t̪d̪kg?k͡pg͡btʃdʒb̪d̪/
Margi	/pbtdcɟ?tsdztʃdʒɓ̃ɗ̃/
Mazatec	/pbtk?tʃtstʃndŋgndzndzndʒ/
Russian	/pb̪t̪d̪kgtspʲbʲt̪ʲd̪ʲkʲtʃʲ/
Sara	/pbtdkgdʒmbndɲɟŋgɓɗ/
Shilha	/btdkgb:t:t̪d̪d:k̟:kg:/
Wiyot	/ptk?tstʃpʰt̪ʰkʰkʷkʷʰtsʰtʃʰ/
Yakut	/pbtdkgtʃdʒp̪:t:k:tʃ:dʒ:/
Yana	/b̪d̪kg?tʃdʒpʰt̪ʰp'ṯ'k't̪ʃ'/

14 miscel.

Amoy	/pbtdkg?tstʃdʒpʰtʰkʰtsʰ/
Sedang	/pbtdkg?tʃdʒpʰb̪tʰd̪kʰ/
Somali	/bdd̪gq̟?tʃb:tʰd̪:d̪:k̃ʰg:q̟:/
Tolowa	/ptk?tstʃtʰt'k'kʷkʷ'ts'tʃ'tʃʰ/
Tzeltal	/pbtdg?tstʃp'tʼkʰk'ts'tʃ'/

15 miscel.

Cofan	/pbtdcɟkgtʃdʒpʰtʰcʰkʰtʃʰ/
E. Armenian	/ptktstʃpʰpʼtʰtʼkʰkʼtsʰtsʼtʃʰtʃʼ/
Gbeya	/pbt̪d̪kgʔk͡pg͡bɓmbdn̪d̪ŋgŋ̊m͡gb̥/
Iraqw	/pbtdkgqʔk͡pg͡btsɓɗqʷtɬʼ/
Lahu	/pbtdkqʔtʃdʒpʰtʰkʰqʰtʃʰ/
Pomo	/pbtdtkqʔtspʼt̪ʼtʼkʼqʼtsʼ/
Quechua	/ptkqtʃpʰpʼtʰtʼkʰkʼqʰqʼtʃʰtʃʼ/
S. Nambiquara	/ptkʔpʰpʼtʰtʼkʰkʼkʷkʷʰkwʼɓɗ/
Tiwa	/pbtdkgʔtʃpʰpʼtʰtʼkʷkʼkwʼ/

16 miscel.

Awiya	/pbtɖkgqɢtsdztʃdʒk͡pg͡bɢʷɢw/
Bulgarian	/bdgtstʃdʒpʰtʰkʰpʲʰbʲtʲʲʰdʲkʲʰgʲtsʲ/
Georgian	/pt̪ktstʃpʰpʼt̪ʰt̪ʒkʰkʼqʼtsʰtsʼtʃʰtʃʼ/
Gununa-Kena	/pbt̪d̪kqʔtstʃtɕpʼt̪ʼkʼtsʼtʃʼkxʼ/
Hupa	/tcqʔtstʃtʰtʼcʰcʼqʼtɬʼtʃʼtʃʷʰtsʰtsʼ/
Jingpho	/ptkʔtsp̂tk̂tpʰtʰkʰpʲpʲʰpʰtʰkʲkʲʰk̂tʰ/
Klamath	/bd̪ɟgʔpʰt̪ʰkʰcʰqʰɢʼqʼkʼcʼt̪ʼpʼ/
Tarascan	/pbtdkgʔtstʃpʰtʰkʰtsʰtʃʰkʷkʷʰ/
Wappo	/pbt̪d̪tkgʔtstʃpˠt̪ˠʼtʼkʼtsʼtʃʼ/
Yao	/pbt̪d̪cjkgʔtsdzpʱt̪ʰcʰkʰtsʰ/
Zulu	/pʱkdʒ ɬʧsʃpʰpʼɓtʰtʼkʰkʼtʃʼkɬʼ/

17 miscel.

Hausa	/btdkgʔtʃdʒɓɗkʲkʷgʲjʷkʷʼkʲʼkʼ/
Ik	/pbt̪d̪kgtsdztʃdʒbd̪ts̪ʼt̪sʼʃgkʼ/
Lithuanian	/pbt̪dkgtsdzpʲbʲtʲdʲkʲgʲtsʲtʃʲdʒʲ/
Ngizim	/pbtdcɟkgkʷgʷb̪d̪ɟmbndŋgŋgʷ/
Sui	/pbtdkqʔtstʃpʰtʰkʰqʰbd̪tsʰtʃʰ/
Yulu	/pbt̪d̪ckgk͡pg͡bdzɓɗʤfmɓn̪ɲŋg/

18 miscel.

Egyptian Arabic	/ptdkgqʔdʒbːt̪t̪ːɖkːgːqːɖːdːʔː/
Kashmiri	/pbtdt̪d̪kgtsdzp̂tʰkʰtsʰt̪ʃʲtʃʲʰdʒʲ/
Nambakaengo	/ptkpʱtʰkʰpʷtʷkʷpʲtʲkʲmbndŋgmbʷndʷŋgʷ/
Navajo	/ptkʔtstɬtʃtʰtʼkʰkʼtsʰtsʼtɬʰtɬʼtʃʰtʃʼkwʰ/
Wintu	/pbtdkqʔtɬtʃdʒpʰtʰpʼtʼkʼqʼtɬʼtʃʼ

19 miscel.

Kharia	/pbt̪d̪t̪d̪kgtʃdʒpʰbt̪ʰt̪d̪kʰgtʃdʒ/
Squamish	/pt̪kqʔtstɬtʃpʼt̪ʼ̃kʼk̃ʷ̃kʷʼqʷ̃qɬʷ̃ʼqʼtsʼtʃʼtɬʼ/

20 miscel.

Bengali	/pbtdṭḍkgtʃdʒpʰtʰṭʰkʰtʃʰbʱdʱḍʱgʱdʒʱ/
Nootka	/ptkq̣ʔtstɬtʃp't'k'q̣'kʷkʷ'ʔ̣tʃ'ts'tɬ'q̣ʷ/
Otomi	/pbtdkgʔtstʃpʰp'btʰt'kʰkʷk'kʷ'gʷtʃ'/
Sinhalese	/pbṯḏṭḍkgtçdʃp:b:ṯ:ḏ:ṭ:ḍ:tç:dʃk:g:/

21 miscel.

Kabardian	/bḏgqʔtsdzq̣χpʰp'ṯʰṯ'kʰk'kʷʰgwkʷ'q̣ʷts'q̣χʷʔʷ/
Mandarin	/pbṯdṭḍkgʔtʃdʒpʰḇtʰdṭḍkʰgtʃdʒ/
Yuchi	/pbt̆dkgʔtsdztʃdʒp̃ʰpˀt̃ʰt'k̃ʰk̃'t̃sʰtsʰtʃʰtʃ'/

22 miscel.

Acoma	/bdɟkgʔdẕdzdʒpʰṯʰcʰp't'tsʰtʃʰtʃ'ṯs'tsʰ/
Burushaski	/pbtdṭḍkgqtstṣdẓtʃdʒpʰtʰṭʰkʰqʰtsʰtṣʰtʃʰ/
Hindi-Urdu	/pbṯḏṭḍkgq̣ʔtʃdʒpʰṯʰṭʰkʰtʃʰbʱḏʱḍʱgʱdʒʱ/
Mazahua	/ptkgʔtstʃpʰḇtʰt'dkʰkʷʰkʷkʷ'k'gʷtʃʰtsʰts'tʃ'/
Quileute	/pbtdkgq̣ʔtstɬtʃp't̃'k'q̣'kʷq̣ʷ'tɬ'ts'tʃ'/

23 miscel.

Chipewyan	/ptkʔṯṣtstɬtʃtʰt'kxʰkʷk'kʷ'ṯṣ'ṯṣʰts'tsʰtɬ'tɬʰtʃ'tʃʰkxʷʰ/
Pujet Sound	/pbtdkgq̣ʔtsdztʃdʒq̣ʷ'kʷgʷq̣'tɬts'tʃ'p't'l'q̣ʷ/
Tigre	/bdgʔdʒtstʃb:tʰt:t'ʼt':d:kʰk:k'k':g:ts:tʃʰ:tʃʰ:tʃ:dz:/

24 miscel.

Amharic	/pbtdkgk͡pg͡btʃdʒp':b:t:t'ʼt':d:k:k'k':kʷ'g:tʃ:tʃʷ:dʒ:/
Jaquaru	/ptckq̣tstʃtʃpʰp'tʰt'cʰc'kʰk'q̣ʰq̣'tsʰts'tʃʰtʃ'tʃʰtʃ'

25 miscel.

Igbo	/pbtdkgtʃdʒpʰp̃pʲpʲʰbʱɓbʲtʰtʃdʱ kʰkʷkʷʰgʱgʷgʷʱdʒʱ/
Kwakiutl	/ptcq̣ʔtʃtɬpʰp'tʰt'cʰkʷkʷʰq̣ʷq̣ʷʰq̣ʰkʷ'q̣'c'q̣ʷ'tʃʰtʃ'tʃ'tɬʰtɬ'/

26 miscel.

Haida	/ptkq̣cʔtɬdɮtʃpʰtʰkʰcʰkʷkʷʰq̣ʰq̣ʷʰ q̣ʷc'k'kʷ'q̣'q̣ʷ'tʃʰtɬ'/
Nama	/pṯkʔṯṣkx|ʔ|ʰk|ŋ|k|kǂʔǂʰkǂŋǂkǂʰ!ʔ!ʰk!ŋ!k!ʰ‖ʔ‖ʰk‖ŋ‖k‖ʰ

28 miscel.

Telegu	/pbtdṭḍkgtsdztʃdʒp:b:ṯ:ṭ:ḏ:d:k:g:ts:dz:pʰtʰkʰbʱḍʱgʱ/
Tlingit	/pbt̄d̄kgq̣ɢʔtsdztʃdʒtɬdɮkʷgʷq̣ʷɢʷq̣'q̣ʷ'kʷ'k'p't't'tɬ'ts'tʃ'/

30 miscel.

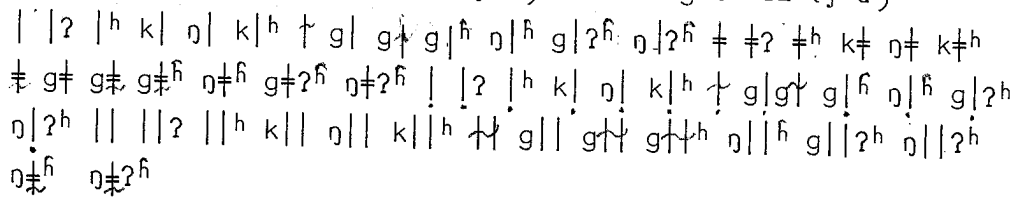
Punjabi /pbṭḍtdkgtʃdʒpʰtʰṭʰkʰtʃʰp:pʰ:b:t:tʰ:d:ṭ:ḍ:k:kʰ:g:tʃ:tʃʰ:dʒ/

35 miscel.

Lak /pʰbdgɢp'tʰt'k'kʰkʷʰkʷ'qʰq'qʷʰqʷ'ɢʷtsʰts'tsʷʰtsʷ'tʃʰtʃ'tʃʷʰtʃʷ' p:t:k:kʷ:q:qʷ:ts:tsʷ:tʃ:tʃʷ:/

86 miscel.

!xũ /pbtdkgtsdztʃdʒpʰtʰkʰgʱtsʰdzʱtʃʱdʒʱb't'd'k'g'ts'dz'tʃ'dʒ'



Appendix E. Primary nasal consonants-with dental and alveolar places of articulation.

1A /n/

Brahui
S. Nambiquara
Wichita
Chipewyan
Tlingit
Yuchi

1 miscel.

Taoripi /m/
Mixtec /n/

2A /mn/

Ainu
Akan
Alabama
Amahuaca
Arabela
Ashluslay
Asmat
Azerbaijani
Bariba
Beembe
Beja
Bulgarian
Cashinahua
Chacobo
Chatino
Chontal
Chuave
Chuvash
Dakota
Dan
Dani
Daribi
Delaware
Dizi
E. Armenian
Egyptian Arabic
Fasu
Gadsup
Georgian
Greek
Guahibo
Guajiro
Gununa-Kena
Hausa
Hawaiian
Hindu-Urdu
Island Carib
Itoma
Kabardian
Karok
Kashmiri
Kefa
K'ekchi
Khalaj
Klamath
Koiari
Kullo
Kurukh
Kwakiutl
Lak
Logbara
Maidu
Malagasy
Mongolian
Nama
Nasioi
Navajo
Neo-Aramaic
Nez-Perce
Nootka
Ojibwa
Otomi
Pawaian
Persian

Pomo	Siona	Tiwa	Wappo
Romanian	Socotri	Tolowa	Wintu
Roro	Somali	Tonkawa	Wiyot
Russian	Squamish	Totontepec Mixe	Yagaria
Seneca	Suena	Totnak	Yana
Sentani	Tacana	Tunica	Yaqui
Shasta	Temne	Turkish	Yareba
Shilha	Tigre	Tzeltal	Zulu
			Zuni

2B /mɲ/

Wapishana

3A /mnŋ/

Adzera	Aleut	Amoy	Ao
Atayal	Bashkir	Batak	Bengali
Berta	Birom	Boro	Burushaski
Carib	Changchow	Chuchi	Daila
Dera	Doayo	Finnish	Fuchow
Garo	German	Greenlandic	Haida
Hebrew	Hupa	Iwam	Javanese
Jingpho	Kaliai	Ket	Kirghiz
Koma	Korean	Kunimaipa	Kurdish
Lahu	Lakkia	Luiseno	Lunchow
Mabuiag	Manchu	Mandarin	Maori
Nambakaengo	Nera	Nimboran	Po-ai
Rukai	Selepet	Senadi	Tagalog
Tamang	Tarok	Tashan	Telefol
Thai	Tiddin	Tsou	Tuva
Wantoat	Yurak	Zoque	!xũ

3B /mnŋ/

Abipon	Acoma	Albanian	Amharic
Amueha	B`sque	Bribri	Campa
Cofan	Hungarian	Jivaro	Kewa
Komi	Lithuanian	Mazahua	Mazatec
Muinane	Ngizim	Nubian	Ocaina
Paez	Papago	Quechua	Sara
Spanish	Tuareg	Washkuk	Zande

3C /mnn̩/

Nyangumata
Pashto

3 miscel.

Irish /n̪ɲŋ/
Telegu /mn̪n̩/

4A /mnɲŋ/

Adamanese	Amo	Angas	Auca
Bambara	Banjalang	Bisa	Breton
Burera	Burmese	Cayapa	Cham
Chamoro	Cheremis	Diola	Efik
Evenki	Ewe	French	Fur
Gilyak	Goldi	Guarani	Gugu-Yalanji
Hamer	Hopi	Ik	Jaquaru
Javanese	Kadugli	Kan	Kanuri
Karen	Katcha	Kharia	Khasi
Khmer	Kpelle	Kunama	Lappish
Lelemi	Luo	Luvale	Maasai
Maba	Malakmalak	Malay	Maranungku
Margi	Moro	Moxo	Mursi
Nyangi	Sa'ban	Saek	Sebei
Sedang	Sinhalese	Sui	Sudanese
Swahili	Tabi	Tama	Tarascan
Tavgy	Temein	Ticuna	Tucano
Vietnamese	Wik-Munkan	Wolof	Yakut
Yao	Yay	Yukaghir	Yulu

4B /mnn̥ŋ/

Kota
Mandarin
Norwegian
Siriono

4C /mnŋm̂/

Awiya
Iraqw

4 miscel.

Dieguena /mn̪nɲ/

5A /mnɲŋm̂

Dagbani
Gã
Igbo
Tampulma

5B /mnn̥ɲŋ/

Alawa
Bardi
Ostyak
Punjabi

5C /mn̥nɲŋ/

Araucanian
Kunjen

5D /mn̪nn̥ŋ/

Tiwi
W. Desert

5 miscel.

Gbeya /mn̪nŋm̂/
Maung /mnn̥ŋn̪r̂/
Teke /mɯ̃nɲŋ/

6A /mn̪nn̥ɲŋ/

Arabana-Wanganura
Aranda
Dieri
Kariera-Ngarluma
Malayalam
Nungubuyu

6B

Iai /mnn̥ɲŋm̂/

Ø Nasals

Achumawi
Apinaye
Barasano
Hakka
Mura
Puget Sound
Quileute
Rotokas

Appendix F. All nasal consonants - all languages

1A /n/

Brahui
Chipewyan
S. Nambiquara
Tlingit

1B /ŋ/

Mixtec

1C /m/

Taoripi

2A /mn/

Ainu
Akan
Alabama
Amahuaka
Arabela
Ashluslay
Asmat
Azerbaijani
Bariba
Beembe
Beja
Cashinahua
Chacobo
Chatino
Chontal
Chuave
Dakota
Dan
Dani
Daribi
Dizi
E. Armenian
Fasu
Gadsup
Georgian
Greek
Guahibo
Guajiro
Hausa
Hawaiian
Island Carib
Itoma
Karok
Kashmiri
Kefa
K'ekchi
Koiari
Kullo
Kurukh
Lak
Logbara
Maidu
Malagasy
Mongolian
Nasioi
Navajo
Neo-Aramaic
Ojibwa
Pawaian
Pomo
Romanian
Seneca
Sentani
Siona
Socotri
Suena
Tacana
Temne
Tiwa
Totontepec Mixe
Totonak
Tunica
Turkish
Tzeltal
Wintu
Wiyot
Yagaria
Yaqui
Yareba
Zuni

2B /mn̪/

Gununa-Kena
Kabardian
Khalaj
Persian
Roro
Shasta
Squamish
Tonkawa
Yana

2 miscel.

Wapishana /mɲ/
Wichita /nn:/
Yuchi /nn̪/

3A /mnŋ/

Adzera
Amoy
Ao
Atayal
Bashkir
Batak
Bengali
Berta
Birom
Boro
Burushaski
Carib
Changchow
Chukchi
Fadla
Dera
Doayo
Fuchow
Garo
German
Hebrew
Hupa
Iwam
Japanese
Kirghiz
Koma
Korean
Kunimaipa
Lahu
Lungchow
Mabuiag
Mandarin
Maori
Nera
Nimboram
Po-ai
Rukai
Senadi
Tagalog
Tamang
Tarok
Tashan
Telefol
Tiddin
Tsou
Zoque

3B /mnŋ/

Albanian	Campa	Komi	Quechua
Basque	Cofan	Muinane	Tuareg
Bribri	Jivaro	Nubian	Zande

3C /mn̪ŋ/

Greenlandic
Kurdish
Luiseno
Manchu
Thai
Tuva

3D /mn̪n/

Abipon
Hungarian
Papago
Spanish

3 miscel.

Pashto	/mnɳ/
Somali	/mnn̥ /
Zulu	/mnǰ/
Hakka	/nd:ŋg mbɦ/

4A /m n ɲ ŋ/

Adamanese	Ewe	Khmer	Saek
Amo	French	Kunama	Sebei
Angas	Fur	Lappish	Sudanese
Auca	Gilyak	Lelemi	Swahili
Bambara	Goldi	Luo	Tabi
Banjalang	Gugu-Yalanji	Maasai	Tama
Bisa	Hamer	Maba	Tarascan
Burera	Jaquaru	Malakmalak	Tavgy
Cayapa	Javanese	Malay	Ticuna
Cham	Kadugli	Margi	Tucano
Chamoro	Kan	Moro	Vietnamese
Cheremis	Karen	Moxo	Wik-Munkan
Diola	Kharia	Mursi	Yay
Efik	Khasi	Nyangi	Yukaghir
Evenki	Katcha	Sa'ban	Yulu

4B /mnmn/

Kwakiutl
Nez Perce
Nootka
Tolowa
Wappo

4C /mnm:n:/

Delaware
Egyptian Arabic
Shilha
Tigre

4D /mnɳŋ/

Kota
Siriono

4E /mmʲnɲ/

Amuehia
Lithuenian

4F /mnŋm̃/

Awiya
Iraqw

4G /mn̪ɲŋ/

Ik
Temein

4 miscel.

Apinaye	/mb ɳd ɲʄ ŋg/	Ket	/m n nʲ ŋ/
Bulgarian	/m mʲ nnʲ/	Norwegian	/m ɳ ɲ ŋ/
Dieguena	/m ɲ n ɲ/	Nyangumata	/mnɳnʲ/
Russian	/mɲmʲɲʲ/		

5A /mnɲŋm̃/ 5B mɲnɲŋ/ 5C /mnɳɲŋ/ 5D /mɲnɳŋ/

5A	5B	5C
Dagbani	Araucanian	Bardi
Gã	Kunjen	Ostyak
Igbo		
Tampulma		

5 miscel.

Breton	/mnɲŋw̃/	Kewa	/mnɲmbnd/
Chuvash	/mm:nn:nʲ/	Kpelle	/mnɲŋŋʷ/
Finnish	/mm:ɲɲ:ŋ:/	Maung	/mnɳŋn̂ɲ/
Guarani	/mɲɲŋɲʷ/	Teke	/mmnɲŋ/
Hindi-Urdu	/mɲr̃mn/	Telegu	/mm:ɲɲ:ɳ/
Jingpho	/mmʲn̰ŋŋʲ/	Yurak	/mmʲnnʲŋ/

6A /mɲnɳɲŋ/ 6B /mm:nn:ɲɲ:/ 6C /mm:nn:ɲŋ/

6A	6B	6C
Arabana-Wanganura	Amharic	Maranungku
Dieri	Ocaina	Wolof
Kariera-Ngarluma		
Malayalam		
Nungubuyu		

6 miscel.

Acoma	/mm̰nnɲɲ/	Klamath	/mmm̰nñɲ/
Aleut	/mm̰nn̰ŋŋ/	Nama	/mɲ̃ɲdnˀʖnʔndʔ
Haida	/mmnnŋŋ/	Otomi	/mm̰m̰nnɲ̰/
Kaliai	/mñŋmbndŋg/	Selepet	/mɲŋmbɳdŋg/

7 miscel.

Mazatec	/mnɲndndznznd̰z/	Sara	/mnɲmbndɲdʒŋg/
Ngizim	/mnɲmbndŋgŋgʷ/	Sinhalese	/mm:nn:ɲɲ:ŋ/
Punjabi	/mm:ɲɲ:nɲŋ/		

8 miscel.

Burmese	/mm̥nn̥ɲn̥ŋ̊/
Hopi	/mm̥nn̥ɲn̥ŋ̊ʷ/
Lakka	/mm̥nn̥ɲn̥ŋ̊ʷŋg/
Luvale	/mnɲnmɓndŋgɲdʒ/
Mazahua	/mm̥mn̥ɲn̥ŋ̊/
Yakut	/mm̰ n̪n̪ː ɲ j ŋŋː/
Yao	/mm̥n̪n̪ɲn̥ŋ̊/

9 miscel.

Kanuri	/mnɲŋmbndɲʒŋgɠ͡mg͡b/
Paez	/mnɲmbndndJŋgnzɲʒ/
Wantoat	/mnŋmbndŋgŋʷnzŋgʷ/

10 miscel.

Alawa	/mnn̥ɲŋmbn̥ndndɲdʒŋg/
Gbeya	/mn̪nn̥ŋmn̥mbn̥dŋgɠ͡mg͡b/
Irish	/nɲŋmʷmʲn̥ɲɲnʲn̥ʒŋʲ/
Washkuk	/mnɲmbndɲdʒŋgmʷmbʷŋgʷ/

11.

Iai	/mnn̥ɲŋɠ͡mm̥n̥n̥ŋ̊ɠ͡m̥/

12.

Aranda	/mn̪nn̥ɲŋbmdndndn̥dʒŋgŋ/
Sui	/mm̥m̰n̥n̰n̥ɲn̥ŋ̊ŋ̊/

13.

Nanbakaengo /mnŋmʷnʷŋʷnʲmbndŋdmbʷndʷŋgʷ/

16.

Senadi /mnɲŋm̥m̰n̥n̰n̥ɲn̥mbndɲdʒŋgŋ̊ŋ̊/

18.

!xu /mmm̥nŋŋː/
~?

Appendix G. The database languages and their genetic as well as geographic relations.

Indo-European

Greek: Greek
Celtic: Irish, Breton
Germanic: German, Norwegian,
Baltic: Lithuanian
Slavic: Russian, Bulgarian,
Romance: French, Spanish, Romanian
Iranian: Persian, Pashto, Kurdish
Indic: Hindi-Urdu, Bengali, Kashmiri, Punjabi, Sinhalese
Albanian: Albanian
Armenian: E. Armenian

Ural-Altaic

Fino-Ugric: Ostyak, Cheremis, Komi, Finnish, Hungarian, Lappish
Samoyed: Yurak, Tavgy
Turkic: Turkish, Azerbaijani, Chuvash, Yakut, Kirghiz, Bashkir, Khalaj, Tuva
Mongolian: Mongolian
Tungus: Evenki, Goldi, Manchu
Korean: Korean
Japanese: Japanese

Austro-Asiatic

Munda: Mundari, Kharia
Khasi: Khasi
Vietmuong: Vietnamese
Bahnaric: Sedang
Khmer: Khmer

Niger-Kordofanian

Kordofanian: Katcha, Moro, Kadugli
Mande: Kpelle, Bisa, Bambara, Dan
W. Atlantic: Wolof, Diola, Temne
Voltaic: Dagbani, Senadi, Tampulma, Bariba
Kwa: Ewe, Akan, Igbo, Gã
Togo Remnant: Lelemi
Cross River: Efik
Plateau: Birom, Tarok, Amo
Bantoid: Beembe, Swahili, Luvale, Zulu, Teke
Adamawa: Doayo
Eastern: Gbeya, Zande

Nilo-Saharan

Songhai: Songhai
Saharan: Kanuri
Maban: Maba
Fur: Fur
E. Sudanic: Maasai, Luo, Nubian, Nyangi, Ik, Sebei, Tama, Temein, Nera, Tabi, Mursi
C. Sudanic: Logbara, Yulu, Sara
Berta: Berta
Kunama: Kunama
Koman: Koma

Afro-Asiatic

Semitic: Egyptian Arabic, Tigre, Amharic, Hebrew, Socotri, Neo-Aramaic
Berber: Shilha, Tuareg
Cushitic: Somali, Awiya, Iraqw, Beja
Omotic: Kullo, Dizi, Kefa, Hamer
Chadic: Hausa, Angas, Margi, Ngizim, Kanakuru

Australian

Iwaidjan: Maung
Tiwian: Tiwi
Bureran: Burera
Nunggubuyan: Nunggubuyu

Australian (continued)

Maran: Alawa
Daly: Maranungku, Malakmalak
Nyulnyan: Bardi
Pama-Nyungan: Wik-Munkan, Kunjen, W. Desert, Nyangumata, Aranda, Kariera-Ngarluma, Gugu-Yalanji, Mabuiag, Arabana-Wanganura, Dieri, Banjalang

Austro-Tai

Kam-Tai: Standard Thai, Lakkia, Yay, Sui, Saek, Po-ai, Lungchow
Atayalic: Atayal
W. Indonesian: Sundanese, Javanese, Malagasy, Cham, Malay, Batak
Philippine: Tagalog, Sa'ban, Chamoro, Rukai
Formosan: Tsou
N.E. New Guinea: Adzera, Roro
New Britan: Kaliai
Loyalty: Iai
Polynesian: Maori, Hawaiian

Sino-Tibetan

Sinitic: Mandarin, Taishan, Hakka, Changchow, Amoy, Fuchow, Kan
Himalayish-Kirantish: Tamang
Mirish, etc: Dafla
Lolo-Burmese: Burmese, Lahu
Kachin: Jingpho
Kuki-Chin: Ao, Tiddim
Baric: Garo, Boro
Karenic: Karen
Miao-Yao: Yao

Amerind (Northern)

Haida: Haida
Tlingit: Tlingit
Athapaskan: Navajo, Chipewyan, Tolowa, Hupa
N. Penutian: Nez Perce, Klamath
Cal. Penutian: Maidu, Wintu
Mex. Penutian: Chontal, Zoque, Tzeltal, Totonac, K'ekchi, Totontepec Mixe
Oto-Manguean: Otomi, Mazahua, Mazatec, Mixtec, Chatino
Wakashan: Nootka, Kwakiutl
Chemakuan: Quileute
Salishan: Squamish, Pujet Sound
Uto-Aztecan: Papago, Luiseno, Hopi, Yacqui
Kiowa-Tanoan: Tiwa
Hokan: Karok, Pomo, Dieguena, Achumawi, Yana, Shasta
Tarascan: Tarascan
Zuni: Zuni
Keres: Acoma
M-Algonkian: Ojibwa, Delaware, Tonkawa, Wiyot
M-Siouan: Seneca, Wichita, Dakota, Yuchi, Tunica, Alabama

Indo-Pacific

Andamanese: Andamanese
W. New Guinea: Asmat
N. New Guinea: Washkuk, Sentani, Nimboram, Iwam
S.W. New Guinea: Telefol
C. New Guinea: Selepet, Gadsup, Yagaria, Kewa, Daribi, Chuave, Pawaian, Dani, Wantoat, Fasu
S. New Guinea: Suena
N.E. New Guinea: Dera
E. New Guinea: Kunimaipa, Yareba, Koiari, Taoripi
Bougainville: Nasioi, Rotokas
C. Melanesian: Nambakaengo

Amerind (southern)

Chibchan: Itonama, Bribri, Mura
Paezan: Cayapa, Paez
Witotoan: Ocaina, Muinane
Carib: Carib
M-Ge: Apinaye
Pano-Tacanan: Amahuaca, Chacobo, Tacana, Cashinahua
Mataco: Ashluslay
Zaparoan: Arabela, Auca
Quechumaran: Quechua, Jaquaru
Chon: Gununa-Kena
Arawakan: Wapishana, Island Carib, Amuesha, Campa, Guajiro, Moxo
Tupi: Guarani, Siriono
Guahibo-Pamigua; Guahibo
Ticanoan: Ticuna, Barasano, Siona, Tucano
Jivaroan: Jivaro, Cofan,
?Penutian: Araucanian

Other

Eskimo-Aleut: Greenlandic, Aleut
Dravidian: Telegu, Kota, Kurukh, Malayalam, Brahui
Paleo-Siberian: Ket, Yukaghir, Chukchi, Gilyak
Khoisan: Nama, !xũ
Basque: Basque
Burushaski: Burushaski
Ainu: Ainu
Georgian: Georgian
Kabardian: Kabardian
Lak: Lak

Appendix H. Language sources - UCLA DATABASE (for the other sources, consult the Stanford Archives.)

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Acoma	Miller, W.R. (1966) *Acoma Grammar and Texts.* UCPL. v. 40.
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Arabana-Wanganura	Hercus, A. (1973) "The prestopped nasal and lateral consonants in Arabana-Wanganura." *Anthropological Linguistics.* 14.8: 293-305.
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