Areal Features and Natural Phonology: The Case of Front Rounded Vowels
Author(s): John Crothers
Proceedings of the 2nd Annual Meeting of the Berkeley Linguistics Society (1976), pp. 124-138

AREAL FEATURES AND NATURAL PHONOLOGY: THE CASE OF FRONT ROUNDED VOWELS

John Crothers UCB

1. Front rounded vowels (FRV's) are known to be a relatively rare type of sound.[1] Like some other marked phonological segment types they are areally restricted. They occur with considerable frequency in a large area including most of Europe and northern Asia, but are extremely rare in the rest of the world. I suggest the hypothesis that FRV's arose independently only once in this area, and that all the other languages or language groups in the area acquired them by contact. The alternative, that the FRV's arose independently, would imply an amazing set of coincidences not only in areal distribution, but also in the time periods when the FRV's arose.

2. Phonetic properties of FRV's and their phonological role. The traditional articulatory definition of FRV's appears clear enough: the lips are rounded, the tongue is advanced toward the hard palate. But descriptive data on the world's languages is almost exclusively perceptual. Perceptually an FRV falls somewhere between a front unrounded vowel and the back rounded vowel of the same height. Back unrounded vowels also fall into the same intermediate area. The possibilities for confusion were dramatically illustrated by an experiment by Ladefoged, in which a number of highly trained phoneticians perceived a recorded back unrounded vowel as front rounded. Given this, a descriptive statement that a language has FRV's must be viewed as provisional, pending more careful investigation. In the case of a mid FRV ö, it hardly seems possible to distinguish it from a weakly rounded mid central vowel. This means that Trubetzkoy's claim that languages with FRV's must have ü cannot be tested, at least from ordinary descriptive data, because we do not know whether ö is really front. For several languages ö without ü is reported: Akha, Archi, Bashkir, Icelandic, Korean, Lak, Provencal, Saisiyat, Ulithian, Yukaghir (see Ruhlen).

In determining whether a language has FRV's I will use the criterion of (surface) distinctiveness, i.e. relative independence of FRV's from neighboring segments. The FRV's of French and German are clearly distinctive, those of Turkish perhaps less distinctive, because subject to vowel harmony constraints, and those of Asmat (an Indo-Pacific language) strictly non-distinctive, because they occur only as allophones of i, e before w.

3. Areal distribution of FRV's. The evidence for a Eurasian area of languages with FRV's comes from a sample of 203 languages, compiled as part of the Stanford University Phonology Archiving Project[2], supplemented by other sources. The map shows the distribution of the 203 languages, distinguishing those that do not have FRV's either allophonically or distinctively, those that have them allophonically, and those that have them distinct-

ively. The dotted line on the map outlines the FRV area, and is drawn to maximize the concentration of FRV languages in the area.[3] The overall ratio of FRV languages to non-FRV languages inside and outside the FRV area is overwhelmingly different (see table). It is notable that it does not make much difference whether or not one counts as FRV languages those with allophonic FRV's.

Of the three FRV languages outside the FRV area, one, Akha (Tibeto-Burman) has only ŏ, which, as mentioned earlier, is somewhat problematic as an FRV. Likewise, in Hopi (Uto-Aztecan) ü and ö (which are short and long counterparts to each other) are described in unclear terms. Iai (Austronesian) apparently has ü, ö, and ö; however, although transcriptions indicate a distinction between u and ü in roughly the same environments, the material was transcribed from taped texts, and it is not clear that repetition tests were made with speakers, so the absence of minimal pairs leaves some doubt about the distinction.

As for other sources, Hockett reports a number of languages with FRV's, all but one within the FRV area. (Some languages of course are the same as ones in the 203 language sample.) The one exception, Taki-Taki, a creolized English spoken in Surinam, has ü, but apparently only in Dutch loanwords (Hall). Trubetzkoy reports no FRV's outside the FRV area. Ruhlen gives segment inventories (not necessarily phonemic) for 692 languages, including nearly all of the 203 languages in the Stanford archive. Eighty of these have FRV's, and only nine are located outside the FRV area. Of these nine, five are in the smaller sample, the three languages with distinctive FRV's (Akha, Hopi, Iai), and two with non-distinctive FRV's (Wolof, Asmat). Of the other four, Malinka (a Mande language of Mali) has ü, but only as an occasional variant of u, apparently adjacent to dentals. (See Delafosse p.20. Tokarskaja does not mention ü.) Ngwe (a Benue-Congo language of West Cameroon) is said to have several FRV's, but the orthography is plainly not phonemicized, and the source is not concerned with phonetics or phonology (Dunstan). The remaining two languages, Ulithian and Saisiyat (Austronesian) both have the problematic ö. Clearly then distinctive FRV's are extremely rare outside the FRV area.

4. The spread of FRV's by language contact. The most appealing hypothesis to explain the distribution of FRV's is that they arose independently only once in the FRV area, and that the concentration is due otherwise entirely to contact. The data I now have on the historical development indicates that FRV's arise for the most part by regular sound changes that could conceivably have occurred spontaneously, and are generally interpreted that way in the literature on specific languages. FRV's do not arise simply by lexical borrowing of words with FRV's, though of course this may occur, as in Albanian, in which the majority of words with ü are Turkish loans. What I mean by contact is that the sound changes producing FRV's do not occur spontaneously, but are cultivated or encouraged by bilingual speakers who regard the FRV's as a prestige feature, and seek to transfer them from one language


+ distinctive FRV's
| non-distinctive FRV's
• no FRV's

The Spread of FRV's.

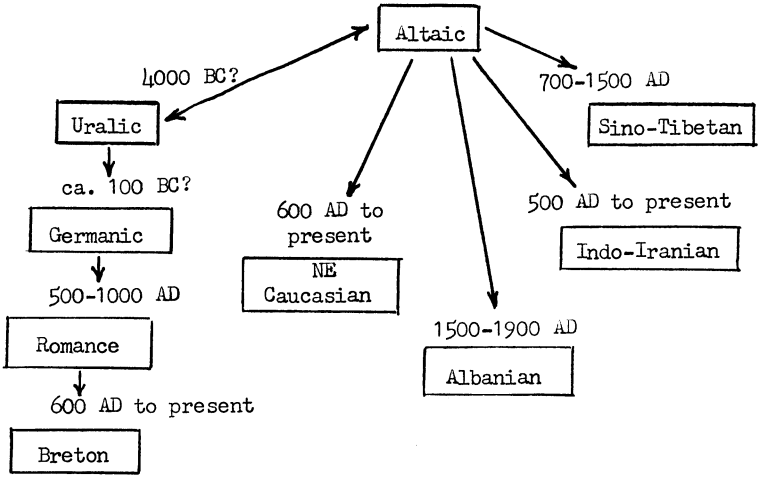

Table.

Sample area	World	FRV area	non-FRV area
no. of languages	203	34	169
no. with FRV's (distinctive)	19	16	3
% with FRV's	9%	47%	2%
no. with FRV's (including non-distinctive)	28	17	11
% with FRV's	14%	50%	7%

to the other.

The general picture of language contacts relevant to the FRV area is as follows. Three main language families, Uralic, Altaic, and Germanic have FRV's. Palatal vowel harmony and FRV's can be reconstructed for Uralic and Altaic proto-languages. The north and west branches of Germanic have palatal umlaut, a curtailed form of palatal harmony. Palatal harmony is not known to occur elsewhere in the world (Ultan[4]). A number of adjacent languages of different families seem to have acquired FRV's, including northern Sino-Tibetan, Iranian, Northeast Caucasian, Albanian, Romance, and Breton.

4.1 Altaic and Uralic. A period of substantial contact and linguistic influence between early Uralic and early Altaic is regarded as well established by scholars in both fields. Collinder (1965 p.30) cites extensive resemblances in the morphology, including several common suffixes, as well as some lexical resemblances. Menges considers the two groups related genetically, and argues that 'the numerous isoglosses...even if they were due to borrowing...could only be explained on the assumption of enduring, extensive and rather ancient mutual contacts.' (p.57) He places the area of contact 'on the steppes between Tien-Shan and Ural or Volga', Altaic peoples being subsequently pushed to the east during the period of Indo-European expansion in the second millennium BC. Estimates of the date of contact range from 2000 BC to 4000 and beyond.

4.2 Altaic and Chinese. The Chinese have had extensive contacts with Altaic groups throughout their history. One can hardly say that there was any single period to which possible Altaic influence could be restricted. Karlgren proposed that Ancient Chinese, the language of the T'ang dynasty (618-907 AD) had a vowel system with no FRV's, but did have extensive palatalization and labialization of initial consonants, from which ü and ɥ eventually developed, e.g. ACh. -n^{i}wo > Peking yú 'fish' (y = ü), ACh. -xiwet > Peking /cyě 'blood' (y = ɥ) (Forrest). This change could have taken place in the centuries after the fall of the T'ang. The T'ang themselves had extensive contacts with Turkic peoples (Menges p.22,ff.) and after their fall northern China was overrun by Mongolian and other Altaic peoples. Mongol rule did not finally end until 1368. Although the period 900-1400 seems most probable for the emergence of FRV's in Chinese, it is possible that it occurred a good deal earlier, and that the complex palatalized and labialized consonants posited by Karlgren for Ancient Chinese already represent FRV's, or the front rounded glide. This would not be inconsistent with Altaic influence at a much earlier date.

4.3 Altaic and Tibetan. Modern central Tibetan has FRV's ü, ö which developed from u, o before dental consonants. The consonants were then lost, except n, which either remains or is lost with nasalization of the preceding vowel (Chang & Sheits, Roerich). Since the orthography was imported from India about the sixth century AD, loss of the final dentals and the emergence of distinctive FRV's must have occurred later, but one cannot be sure

that the fronting of u, o had not already occurred. Altaic influence in this development is plausible through a long period of history. During the period of the Tibetan empire in the seventh to ninth centuries the Turkic Uighurs were conquered, and there were certainly contacts with other Turkic peoples. Later Tibet was subject to Mongol rule. Santa and Monguor, Mongolian languages of west China (Kansu and Tsinghai provences) have a number of Tibetan loans, and Tibetan religious terms occur in other Mongolian languages. Poppe dates the latter to the foundation of Tibetan speaking monastaries in the 16th and 17th centuries. To judge from one word, fronting of u had occurred by this time: Khalkha güŋgerwa < Tibetan kun-dgāh-ra-ba (orthographic) 'shrine'.

4.4 FRV's are reported for another northern Sino-Tibetan language, Dungan, spoken in Kirghiz SSR (see Ruhlen).

4.5 Indo-Iranian, Northeast Caucasian, and Altaic. By the sixth century AD Turkic peoples, in their westward expansion, had reached the area just east of the Caspian, initiating contacts with Indo-Iranian that continue today. In the eleventh century the Seljuk Turks (a tribal confederacy) moved from there through Persia into Anatolia. Other Turkic groups (the Oghuz) followed into present day Soviet Azerbaijan, Iran, Afghanistan, and India, forming the basis of present Turkic populations in those areas.

In Ruhlen's segment inventories I have found two Iranian languages with FRV's. Tat, in Daghestan SSR probably borders on Azerbaijani, while Yaghnobi (a Pamir language) is a southern neighbor of Özbek (Turkic) in Tadshik SSR (Menges p.55).

There is a cluster of Northeast Caucasian languages spreading through Azerbaijan SSR and Daghestan SSR which are reported to have FRV's (Ruhlen). In addition to Azerbaijani influence, there is also the question of contact with the more northerly Turkic groups, which first appeared around the lower Volga in the seventh century.

4.6 Albanian and Turkish. The Albanians, under Turkish rule from 1501 to 1912, were partly converted to Islam, and acquired a considerable number of Turkish loanwards. The majority of Albanian words with ü (the only FRV in Albanian) are Turkish loans (based on Meyer), e.g. A. bütün 'entirely' < T. (same). In addition, ü developed adjacent to a labial consonant, in both Turkish and older words, from earlier i, e.g. mbül, mbil < mbil 'to close' (native word). Latin ū (but not ŭ) became Albanian ü, e.g. gük < L. judicem 'judge'. There are also other, apparently somewhat sporadic processes by which ü arose. While the rule Latin ū > Albanian ü looks like a regular sound change, it must be remembered that it accounts for only a tiny fraction of the ü's in the lexicon. It is most plausible to assume that Latin ū became a diphthong in Albanian (or better, had become a diphthong in neighboring late Latin dialects), and that the regular rule was just part of a much more general process by which Albanian first acquired Turkish words with ü, and then, as it were, seized upon likely pretexts to introduce the same sound into the older

lexicon.

4.7 Uralic and Germanic. The north and west Germanic languages acquired FRV's by the process of palatal umlaut, the fronting of back vowels when i or j occurred in the following syllable. The FRV's became distinctive when the conditioning syllable was reduced or lost. While the orthographic indication of FRV's is sporadic or altogether lacking until relatively late (in High German, for example, FRV's were not indicated until after 1000 AD), this has been viewed in the more recent scholarship as resulting from the non-distinctive character of the FRV's when i and j were still present in the following syllable (Twaddell, Penzl). Given that palatal umlaut occurs in fundamentally the same form throughout the north and west Germanic area, it must have developed at an early time, when the Germanic tribes formed a compact geographical unit. This would have been before 100 AD, by which time substantial migrations into southern Germany had occurred. Before this time, when the Germanic tribes formed a more unified group in southern Sweden, Jutland, and the north of Germany, FRV's and palatal umlaut could have arisen under Uralic influence, either from Lapp or from Finnish. The linguistic contact between early Germanic and Uralic is well documented, there being Germanic loans of ancient form in both Lapp and Finnish.

A recently expressed theory is that what was established in this early period was a kind of basic tendency to umlaut (including palatal umlaut) which then unfolded by independent parallel development in the separate Germanic areas (Höfler, Sonderegger). A clear case of this kind of parallel development cited by Höfler is the gradual loss of unstressed syllables by similar courses of change in the different Germanic languages. This also was the common cause of the emergence of fully distinctive FRV's in all the north and west Germanic languages. However, while the loss of unstressed syllables can be readily understood as the consequence of an inherited accentual system in which the root syllable was strongly stressed, palatal umlaut is quite another matter. Given the rarity of FRV's and the greater rarity of palatal harmony in the languages of the world, it is hardly credible that palatal umlaut could have developed independently in several Germanic dialects from some unspecified inherited tendency. It is far more plausible to attribute to early Germanic, ca. 100 BC, a fully developed system of palatal umlaut.

The fact that fully distinctive FRV's developed later, at various times in different Germanic languages, would then result simply from the different periods at which unstressed i was reduced or lost. In addition to FRV's, palatal umlaut also produced a fronted a, presumably at first æ. This fell together with e in different languages at different times, as is readily understandable from the closeness of the two sounds. There is no need to ascribe this merger to an inherited tendency, as Höfler does.

While Finnish must have had FRV's and palatal harmony at the time of early contact with Germanic, it is only a plausible assumption that Lapp did. (Modern Lapp has neither.) Both

must have had the Uralic system of initial accent. It is striking that Germanic acquired a substantially similar accent system (stress on the first syllable of the root) as well as FRV's and a system of palatal harmony. Furthermore both palatal umlaut and velar umlaut (the 'breaking' found in Old Norse and Old English) had the effect of harmonizing words and transferring the vocalic distinctions to the stressed first syllable (see Höfler), which resembles the Uralic system of concentrating vocalic differentiation in the first syllable. Collinder reconstructs five back and four front vowels in the first syllable of proto-Uralic words, while the second syllable contained only two front and two back (Collinder 1965 p.94 ff). The development of palatal umlaut can be seen, not as a specific imitation of Uralic vowel harmony, but as part of a general process of imposing a Uralic style word prosody on Germanic, including the occurrence of FRV's in the first syllable.

4.8 Romance, Celtic, and Germanic. The development of Latin ū to ü is found in France (including Provence), Swiss dialects, some Tirolean dialects, and Italian dialects in Lombardy and Emilia (Lausberg). This change is generally dated before the year 1000. Also, one or more mid FRV's emerged in a number of these same dialects, e.g. French ŏ from Latin ō in open syllable, presumably via a diphthong eu (Regula p. 46 ff). It is clear that the FRV's arose in areas of west Germanic conquest and settlement, or areas with close and lasting contact with west Germanic. The Frankish takeover of Gaul was already under way in the fourth century; by the beginning of the 6th Franks were rulers of all of the modern French area. Elcock assumes that Frankish influence on Latin speech was especially heavy in the north. 'Though the Gallo-Roman speech of northern Gaul eventually prevailed, when first it appears as a literary language it is permeated with words of Germanic stock and even shows unmistakable Germanic influences in its pronunciation and word formation.' He notes the spread of the Germanic suffix -isk in France and Italy and acquisition of German h and w in France. The Lombard invasion of northern Italy in the latter half of the sixth century likewise put a west Germanic people in control of a large stretch of Roman territory. The linguistic influence may not have been as pervasive as that of the Franks, but Elcock mentions numerous Lombard loans that are still to be found in rural dialects, if not the literary language.

The emergence of ŭ in these areas coincided very closely in time with the absorption of the new German speaking aristocracy into the Roman speech community. The development can be imagined in this way. In late Latin ū and ŭ had diverged substantially in quality, the latter remaining close to its original quality, but the former being possibly diphthongized to wi, or something of the sort. German speakers rendered this diphthong with ü, reserving their u for Roman ŭ, and possibly also for ou. This became the standard aristocratic pronunciation which, due to the prestige and mobility of the ruling class, spread throughout the conquered area.

My theory that Germanic influence caused the emergence of

ü and ö seems more likely than either of the two explanations generally offered in accounts of Romance historical phonology, the theory of the Celtic substratum (Wartburg p.36ff), and the theory of spontaneous development due to structural crowding of the back vowel space (Lausberg). According to the Celtic theory the original Gallic dialects of France etc. had an ü which was very gradually absorbed into Roman speech. The fundamental weakness of this theory is that there is absolutely no basis for assuming a Gallic ü. Appeal has to be made to the British Celtic shift of IE u to i, which may never have gone through a stage ü (see below). As for the spontaneous theory, it of course does not account for the restriction of ü to areas of Germanic contact, and also does not reckon with the rarity of spontaneous development of FRV's.

The Bretons, who left Britain in the course of the Anglo-Saxon invasions, seem to have acquired FRV's by a process very similar to that in French. Modern Breton ü has been taken as the reflex of a British Celtic ü, but this reconstructed sound could equally well have been a diphthong iw. Similarly, Breton ö, which corresponds to Welsh aw (and o) and Cornish e, all of which go back to British Celtic o, has been derived from ö, an intermediate state between British and later Breton and Cornish. (At the intermediate stage Breton spelling is eu, Cornish e, eu, ue, u, o (Lewis & Pedersen p.6).) But it would be better to assume a diphthong in British, e.g. əw or aw, which would account for the development in Welsh as well. Breton ö would then have a history very similar to French ö, possibly emerging at the same time.

4.9 Summary. The idea that FRV's emerged by contact is plausible in all cases examined. Ancient influence between Altaic and Uralic is well established. Influence of Altaic on northern Sino-Tibetan is quite likely, though not precisely dateable. Turkic influence on some Iranian and Northeast Caucasian languages is suggested by known contacts going back a thousand years or more. Turkic influence on Albanian during the past 500 years is amply documented in the Albanian lexicon. Substantial contact is known to have occurred between Uralic and Germanic, from the ancient Germanic loan words in Finnish and Lapp. Germanic word prosody, originally very different from the Uralic pattern, developed some striking resemblances. Finally, the distribution of FRV's in the Romance dialects and Breton fits so exactly with west Germanic expansion into Roman areas, and coincides so closely in time with that expansion, that is is difficult to accept any other theory as to the origin of FRV's there.

5. Counterexamples. Two apparent counterexamples to the contact theory are the reconstructed ü of ancient and early medieval Greek, and the reconstructed ü of British Celtic. While These languages occur within the FRV area, the supposed FRV's arose at a time when influence from Germanic or Altaic was impossible, and they would have to be considered independent internal developments. In both cases it is known that an earlier u eventually became i, through an intermediate stage which has been reconstructed as ü. There is no reason to question the beginning or

end points of the chain, but the middle is a problem.

According to Allen in Attic Greek u had become a sound intermediate between u and i by the time of Herodotus (5th century BC), and this intermediate form may have lasted as long as the tenth century AD (Browning) before becoming i. The major evidence for an intermediate sound in Ancient Attic is as follows. (1) Herodotus transcribed Old Persian vi (= wi) with Greek Y (i.e. the original letter for u, which was retained in Greek for the intermediate sound.) (2) The Boeotians, in adopting Attic spelling, used the letters OY for their own inherited u (presumably Attic ou (OY) had become u by this time); also they used the letter Y to represent a sound corresponding to Attic OI (oi). Both peices of evidence show that Attic Y represented neither the earlier u nor the later i at this time, but they hardly prove the existence of ü; the sound could just as well have been wi or wə. Further evidence shows that the intermediate sound was retained for some time, but does not help to identify the phonetic quality more closely. (3) In Indo-Greek coins of the 2nd century BC Greek Y is transliterated by i. (4) Latin originally borrowed Y as u. In the first century BC Dionysius of Halicarnassus mentions a 'marked contraction around the lips' in the pronunciation of Y. (5) In the 2nd century AD OY (i.e. u) sometimes replaces Y, especially after r. (6) In the 4th century AD Wulfila, in adapting the Greek alphabet for Gothic, used Y for Gothic w, as well as for Greek Y. It should be noted also that classical Attic had lost w and abandoned the letter for it, so that if Y was a diphthong, there would not have been an obvious alternative spelling for it.

Clearly the hypothesized rule u > ü of Ancient Attic is based on the assumed naturalness of vowel systems with ü and the naturalness of the fronting process. But we have seen that FRV's are relatively rare. Unambiguous cases of the change of u to ü are known only under conditions of contact with an FRV language, and even then probably went through a diphthongal stage. This greatly diminishes the probability of ü in Ancient and Medieval Greek.

In British Celtic u became i (Lewis & Pedersen p.7). ü is assumed as an intermediate stage, but there is no evidence for this. A diphthong or back unrounded vowel would be equally plausible. Also in British Celtic ü (written u) is considered to be the pronunciation of the sound which developed from the IE diphthongs au, ou, eu and from ō in Latin loans. This became ɯ in modern Welsh, i in Cornish, and ü in Breton. The reconstruction is to some extent an extrapolation from the modern Breton. One could equally well reconstruct ɯ or a diphthong.

6. Phonetic processes leading to FRV's. Not surprisingly FRV's generally arise by (1) fronting of a back rounded vowel next to an anterior segment, (2) rounding of a front vowel next to a labial segment, and (3) contraction of a diphthong with labial and palatal components (i.e. (1) and (2) combined). Examples: (1) Albanian krük < Latin crucem (k is palatal); Peking /nü < Anc. Chinese *nwo; Wolof u → ü after a palatal stop;

Akan u → ü/ t,d,s __ V; Nyangumata u → ü next to a laminoalveolar consonant; Greenlandic u tends to be fronted between dentals and before i, j; Old Norse u → ü/ __R; Tibetan u, o → ü, ö before dentals; Cantonese u → ü after č or before n (u occurs after labials; see Chao). (2) Akan i, e → ü, ö/ __mu; Asmat i, e → ü, ö/ __w; Washkuk i → ü/ __w; German finf > fünf; Old Norse i, e → ü, ö/ __Cw; Turkic (Osman, Qyrghyz, Jakut) i,ɯ → ü, u following ü, ö in the preceding syllable (labial harmony); various Altaic languages a, ä → o, ö following o, ö in the preceding syllable (labial attraction); Albanian i → ü next to a labial consonant. (3) French eu → ö; ue → ë ; Old Norse iw → ü; wi → ü/C__ .

As to the unconditioned fronting of a back rounded vowel, as was stated earlier we cannot be sure that this actually happened, rather than some kind of diphthongization, in Ancient Greek, Celtic, and early Romance. In Uralic Collinder reconstructs a development from öö (= ʌ) to ö. In Sentani Cowan suggests that ö, which has a variant ə, derives from earlier ə .

Palatal harmony (including palatal umlaut) cannot be regarded as a direct cause of the origin of FRV's, but has to be considered a complex phenomenon resulting from a series of developments. Hypothetically FRV's and palatal harmony could arise in a language with palatalized consonants before palatal vowels (CʲVi) and labialized or plain consonants before back vowels (CʷVu, CVa). Palatalization of back vowels before the palatalized consonants could lead to the beginning of FRV's and palatal harmony. Then the original palatal or velar vowel of the 2nd syllable could have been absorbed by a following suffix vowel, to begin the development of suffix harmony. Once established, the pattern could be extended by analogy to all suffixes and stem internal vowel sequences, e.g. uCʲi+a > üCʲi+a > üCʲ+ä , and uCa+a > uC+a .

Generally speaking the types of processes listed above produce non-distinctive FRV's, or produce more FRV's in languages that already have them, or introduce FRV's into a language in imitation of the FRV's of a neighbor language. It seems as though there is a natural beginning point for FRV's in assimilation, but that phonological systems are, as it were, unwilling to accept them without outside pressure. I interpret this as being due to the optimal character of small vowel quality systems. Certainly the system of five vowel qualities is the commonest in the world's languages. It is also the one which conforms most neatly, of known vowel systems, to a perceptual model in which the vowels are equidistant from each other (Liljencrants and Lindblom). Perhaps the most natural development of vowel systems would be for languages to resist expansion beyond a system of five qualities. In a large vowel system some of the phonemes will be rare, and correspondingly it may be unimportant whether they maintain an optimal perceptual distance from other vowels in the system. It may then be a matter of fashion or style for a language to have more than the strictly functional number of vowels, and also a

matter of style just what the quality of those vowels is. By inheritance and contact these stylistic preferences may spread over large areas, given sufficient time, and favorable cultural circumstances.

FOOTNOTES

1. This paper is presented here in a shortened preliminary form. Some data and discussion have been omitted. I am grateful to a number of participants in the BLS conference for useful comments and additional data which I hope to incorporate into the future version of the paper. Lynn Friedman gave much needed help and encouragement during the preparation. In the bibliography only a few references are given for particular languages. Others are found in Vihman or Ruhlen.
2. The 203 languages represent a nearly completed sample of segment inventories of the world's languages, being compiled as part of the Stanford University Phonology Archiving Project. The general character of the results reported here will undoubtedly not change much in the finished sample. The sample languages were selected to give a broad survey of the geographical areas and language families of thw world, without regard to particular types of phonological system. The areal distribution of FRV's is thus the result of impartial methods.
3. The term 'FRV area' is offered for convenience. I do not mean to suggest either that there is a precisely delimitable area within which FRV's are to be found, or that the general area represents some kind of coherent linguistic community. The proliferation of FRV's took place piecemeal, in widely separated contact situations.
4. Nez Perce has a mixed type of vowel harmony which might be reconstructed as a palatal type (very different from Ural-Altaic), though other reconstructions are possible. Somali has basically a 'vertical' harmony system, like a number of African languages, but the heightened correspondents of u, o are described as being fronted, while remaining phonetically central or back vowels. (Ultan, Armstrong).

BIBLIOGRAPHY

Allen, W.S. 1968. Vox Graeca. Cambridge Univ. Press.
Armstrong, Lilias E. 1934. The phonetic structure of Somali. Mitteilungen des Seminars fur Orientalische Sprachen. Berlin. 37/38. 116-161.
Browning, Robert. 1969. Medieval and modern Greek. Hutchinson University Library: London.
Chang, Kun and Betty Shefts. 1964. A manual of spoken Tibetan. Univ. of Washington Press: Seattle.
Chao, Yuen Ren. 1947. Cantonese Primer. Harvard Univ. Press: Cambridge.

Collinder, Bjorn. 1942. Das Alter der Vokalharmonie in den Uralischen Sprachen. Språkvetenskapliga Sällskapets in Uppsala Förhandingar. 85-114.

_____ 1960. Comparative Grammar of the Uralic Languages. Almquist & Wiksell: Stockholm.

_____ 1965. An Introduction to the Uralic Languages. Univ. of California Press.

Cowan, H.K.J. 1965. Grammar of the Sentani Language. Martinus Nijhoff: The Hague.

Delafosse, Maurice. 1929. La Langue Mandingue et ses Dialectes. Bibliotheque Nationale des Langues Orientale Vivantes.

Dunstan, E. 1963. Conjugation in Ngwe. Journal of African Languages 2. 235-243.

Elcock, W.D. 1960. The Romance Languages. Faber & Faber: London.

Fant, Gunnar. 1968. Analysis and synthesis of speech processes. in Malmberg, ed. Manual of Phonetics. North Holland Publishing Co.: Amsterdam.

Forrest, R.A.D. 1965. The Chinese Language. Faber & Faber: London.

Fromm, H. 1958. Die ältesten germanischen Lehnwörter im Finnischen. Zeitschrift für deutsches Altertum und deutsche Literatur. 88. 299-324.

Gordon, E.V. 1957. An Introduction to Old Norse. 2nd. ed. Oxford.

Hall, R.A. Jr. 1948. The linguistic structure of Taki-Taki. Language 24. 92-116.

Hockett, C.F. 1955. A Manual of Phonology. (IJAL Memoir 11.) Baltimore.

Höfler, Otto. 1955. Stammbaumtheorie, Wellentheorie, Entfaltungstheorie. Beiträge zur Geschichte der deutschen Sprache und Literatur. (Tübingen). 77. 30-66.

_____ 1956. Nachahmung und Spontanentfaltung von Sprachneuerungen. Mnemes Xarin: Gedenkschrift Paul Kretschmer. 158-174.

Jokl, N. 1917. Albanisch. in Geschichte der Indogermanischen Sprachwissenschaft. II.3. Trübner: Strassburg. 109-151.

Krahe, H. & W. Meid. 1969. Germanische Sprachwissenschaft. (7th ed.) Sammlung Göschen No.238. Walter de Gruyter: Berlin.

Ladefoged, Peter. 1967. Three Areas of Experimental Phonetics. Oxford: London.

Lausberg, Heinrich. 1956. Romanische Sprachwissenschaft. Walter de Gruyter: Berlin.

Lewis, Henry & Holger Pedersen. 1961. A Concise Comparative Celtic Grammar. Vandenhoeck & Ruprecht: Göttingen.

Liljencrants, J. & B. Lindblom. 1972. Numerical simulation of vowel quality systems: the role of perceptual contrast. Language 48. 839-862.

Menges, Karl H 1968. The Turkic Languages and Peoples. Otto Harrassowitz: Wiesbaden.

Meyer, Gustav. 1891. Etymologisches Wörterbuch der Albanesischen Sprache. Trübner: Strassburg.

Pedersen, Holger. 1909. Vergleichende Grammatik der Keltischen Sprachen. Vandenhoeck & Ruprecht: Göttingen.

Penzl, H. 1949. Umlaut and secondary umlaut in Old High German. Language 25. 223-240.
Peterson, G.E. & H .J. Barney. 1951. Control methods used in a study of the vowels. reprinted in Lehiste, ed. 1967. Readings in Acoustic Phonetics. MIT.
Poppe, Nicholas. 1965. Introduction to Altaic Linguistics. Otto Harrassowitz: Wiesbaden.
Regula, Moritz. 1955. Historische Grammatik des Französischen. Winter: Heidelberg.
Richardson, H.E. 1962. Tibet and its History. Oxford: London.
Roerich, G.N. & Tse-Trung Lopsang Dhuntshok. 1957. Textbook of Colloquial Tibetan (Dialect of Central Tibet). Government of West Bengal, Education Department, Education Bureau.
Ruhlen, Merritt. 1975. A Guide to the Languages of the World. xeroxed. Stanford.
Sonderegger, Stefan. 1959. Die Umlautfrage in den germanischen Sprachen. Kratylos 4. 1-12.
Tokarskaja, V.P. 1964. Jazyka Malinke. Moscow.
Trubetzkoy, N .S. 1969. Principles of Phonology. trans. Baltaxe. Univ. of California Press.
Twaddell, W.F. 1938. A note on OHG umlaut. reprinted in Joos, ed. 1957. Readings in Linguistics I. U. of Chicago Press.
Ultan, Russell. 1973. Some reflections on vowel harmony. Working Papers in Language Universals 12. 37-68.
Vihman, Marilyn. 1974. **Phonology Archive Coding Manual.** (Preliminary edition) xeroxed. Stanford
Wartburg, Walther von. 1950. Die Ausgliederung der Romanischen Sprachräume. A. Franke: Bern.

List of Languages in Sample

(+) = distinctive FRV's; (') = non-distinctive FRV's

INDO-EUROPEAN
Bengali
English
French (+)
German (+)
Portuguese
Russian
Spanish
Breton (+)
Icelandic (+)
Norwegian (+)
Polish
Rumanian
Italian
Albanian (+)
Lithuanian
Persian
Pashto
Punjabi
Sinhalese

AFRO-ASIATIC
Arabic (Egypt)
Shilha
Amharic
Somali
Awiya
Iraqw
Walamo
Hausa
Angas
Margi
Arabic (Malta)

NIGER-KORDOFANIAN
Wolof (')
Fulani
Kpelle
Grebo
Gbari
Dagbani
Mianka (')
Ewe
Akan (')
Mbembe
Ga
Swahili
Ewondo
Luvale
Zulu
Gbeya
Katla
Koalib
Tegali
Katcha

NILO-SAHARAN
Luo
Nubian
Songhai
Kanuri
Logbarra

KHOISAN
Nama

CAUCASIAN
Georgian
Zan
Kabardian
Lak
Dido

DRAVIDIAN
Telugu
Malayalam
Kota
Kurux

AUSTRO-ASIATIC
Mundari
Kharia
Sedang
Pacoh
Koho
Khasi
Vietnamese

SINO-TIBETAN
Dafla
Mandarin (+)
Tibetan (+)
Burmese
Akha (+)
Naga
Garo
Rawang
Bodo
Yao
Cantonese (')
Hakka
Wu

KAM-TAI
Nung
Yay
Lao
Lakkia

ALTAIC
Turkish (+)
Azerbaijani (+)
Chuvash (+)
Kirghiz (+)
Mongolian (')
Evenki
Ryukyuan

URALIC
Cheremis (+)
Komi
Ostyak (+)
Yurak

AUSTRONESIAN
Wolio
Malay
Batak
Cham
Sa'ban
Malagasy
Sundanese
Javanese
Atayal
Tagalog
Chamorro
Maori
Hawaiian
Arosi
Nengone
Iai (+)
Adzera
Kaliai

INDO-PACIFIC
Asmat (')
Selepet
Gadsup
Auyana
Sentani (')
Washkuk (')
Telefol
Kunimaipa
Nasioi

AUSTRALIAN
West. Desert
Maung
Nungubuyu
Nyangumata
Wik Munkan
Maranungku
Mantjiltjara
Kunjen

ESKIMO-ALEUT
Greenlandic
Alaskan
Aleut

NA-DENE
Haida
Chipewyan
Tolowa
Hupa

MACRO-ALGONKIAN
Ojibwa
Delaware
Tunica
Alabaman

MACRO-SIOUAN
Seneca
Oneida
Wichita
Dakota
Yuchi

HOKAN
Karok
Pomo
Diegueno

PENUTIAN
Maidu
Nez Perce
Zuni
Chontal
Zoque
Totonac
Tzeltal
Araucanian

SALISHAN
Squamish
Puget Sound

WAKASHAN
Nootka
Kwakiutl

AZTEC-TANOAN
Papago
Picuris
Tewa
Luiseno
Hopi (+)

OTO-MANGUEAN
Mazahua
Mazatec
Mixtec

MACRO-CHIBCHAN
Cayapa
Itonama
Paez

GE-PANO-CARIB
Amahuaca
Chacobo
Carib
Ocaina
Apinaye

ANDEAN-EQUATORIAL
Wapishana
Island Carib
Quechua
Jaqaru
Amuesha
Campa
Goajiro
Guarani
Moxo
Siriono
Ticuna
Barasano
Jivaro

UNCLASSIFIED
Basque
Burushaski
Ket
Chuckchi
Yukaghir
Gilyak
Ainu
Tarascan