# 5. Voicing and Gaps in Plosive Systems

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## 1. Plosive systems

In this chapter we will look at some patterns found within the sets of stop consonant sounds in the world's languages. It will emerge that two well-known patterns, here labeled "missing /p/" and "missing /g/", which were previously considered to reflect universal phonetic factors in an equal way, are quite differently distributed. This difference suggests that these patterns are not in fact parallel.

| | | | | |
|---|---|---|---|---|
| @ | 1. | Other | | 243 |
| @ | 2. | /p t k b d g/ | | 256 |
| @ | 3. | Missing /p/ | | 32 |
| @ | 4. | Missing /g/ | | 32 |
| @ | 5. | Both missing | | 3 |
| | | | total | 566 |

**Stops** are sounds in which the flow of air which is active in creating the sound is completely blocked for a short interval of time. In the most common type of stop sound, known as a **plosive**, air in the lungs is briefly blocked from flowing out through the mouth and nose, and pressure builds up behind the blockage. The sounds that are generally associated with the letters *p, t, k, b, d, g* in English words such *pat, kid, bag* are examples of plosives. At least some sounds of this type are found in every known language spoken by humans. In phonetic terminology the sounds associated with *p, b* are called **bilabial plosives** because their pronunciation requires bringing the two lips together; the sounds associated with *t, d* are called **dental** or **alveolar plosives** because the tongue closes against the upper teeth or the skin covering the roots (alveoli) of the teeth; the

sounds associated with *k, g* are called **velar plosives** because the tongue closes against the soft part of the palate, technically known as the velum. Bilabial, dental, alveolar and velar are known as **places of articulation**.

The letters *p, t, k* represent **voiceless plosives**, that is, those in which the vocal folds in the larynx are apart and air is able to flow quite freely from the lungs into the mouth cavity. The letters *b, d, g* represent **voiced plosives**, that is, those in which the vocal folds are in a position close together so that, provided the air pressure in the lungs is sufficient, the vocal folds will be caused to vibrate against one another (as they do, for example during humming). Almost half of the languages surveyed for this chapter include these six plosives. In some languages, these are the only stops. In many others there are additional types of stops, such as plosives made by closing the tongue against the uvula as described in chapter 6, or stops made with other configurations of the larynx, such as the glottalized stops discussed in chapter 7, or the clicks mentioned in chapter 19, to mention only a few of the possibilities. None of these other stops will be taken into account in this chapter.

## 2. The values

*2.1. Other.* The first class of languages shown on Map 5 are those which neither include all six of the set /p, t, k, b, d, g/ (now using these letters as general phonetic symbols) in their consonant inventories, nor have one of the three specific variants on this set which will be described shortly. These languages have a system of stop sounds which is simply described as “other” than those of specific interest here. In all, 243 (or 43% of the sample) languages fall into the category. There are many different ways in which a language can qualify as a member of the “other” category. The most common case, accounting for about 17% of the total sample, is that the language lacks voiced stops of any kind, as in Mandarin,

Nahuatl, Dyirbal (Pama-Nyungan; Queensland, Australia), or Maori. But there are many other possibilities; for example, the language may have voiced stops but not of the simple plosive type, as is the case in Fijian or Vietnamese, or it may lack bilabial consonants of any type, as is the case with Tlingit (Na-Dene; Alaska), or it may have partial sets of voiced and voiceless plosives, as in Seneca (Iroquoian; New York State), which has only three of the six plosives under discussion, namely /t, k, b/. And these are far from the only patterns. As this class is very heterogeneous it is of somewhat limited interest to examine the geographical distribution it displays, but including all such cases makes it possible to provide an estimate of the overall frequency of the patterns that are coded by the remaining categories.

*2.2. All six stops /p t k b d g/.* Of the remaining languages, 256 (or 45% of the sample) have all six of the stops under discussion, with or without additional stops of one or more kinds. This class is designated "/ptkbdg/". Languages of this type predominate in the greater part of the Eurasian landmass and in sub-Saharan Africa, and are not uncommon in the Americas and in New Guinea. They are almost entirely absent from Australia, from the southern cone of South America, from the northern tier of North America, and from a part of East Asia. These are areas where the languages mostly lack any simple voiced plosives in their consonant inventories and hence do not have voiced counterparts to /p, t, k/.

*2.3. /p/, /g/ or both missing.* The residual languages have one or more gaps of specific interest in the set of plosives they contain. It was noted by linguists some time ago that if one of the common set of voiceless plosives is absent from a language it is more likely to be /p/ than either /t/ or /k/; and if one of the common set of voiced plosives is absent from a language it is more likely to be /g/ than either /b/ or /d/. These absences might be explained by how the flow of air from the lungs during

speaking interacts with the movements of the speech articulators as they are positioned to make different kinds of sounds. In a plosive the regular outflow of air is briefly held back by the closure in the mouth. After this closure is formed, the pressure of the air in the mouth cavity quickly reaches the level of the pressure which is driving air out from the lungs. If the vocal folds are in the position for voicing, this will happen more slowly, since the rate of air flow from the lungs is slowed down by the narrowed passage in the larynx. However, since the vocal fold vibration which we call voicing is driven by the flow of air between the vocal folds, voicing will not be able to continue when the air pressure above the larynx approaches that below the larynx, as the flow will become insufficient to drive the vibration, which consequently will stop. How rapidly this happens is related to how large the space in the mouth is between the larynx and the location of the plosive closure. It will take longest in /b/, since the closure is as far away as possible from the larynx and the enclosed space is the largest possible, and, importantly, the possibilities for expansion of this space by yielding of the soft tissues of the cheeks and other surfaces under pressure is greatest. By contrast, in /g/ the space is much smaller because the location of the closure is much closer to the larynx. Consequently, voicing is more likely to be extinguished before the plosive closure is released when the pronunciation target is /g/ than when it is /b/. This could possibly lead to confusion of /g/ with /k/, and over time to loss of the distinction between the two sounds. Alternatively, if the plosive is pronounced with less than a complete closure (as often occurs in more relaxed speech) and consequently voicing is able to continue through its duration, the pronunciation norm may shift away from the plosive realization. Either path may provide a route by which /g/ is eliminated from the consonant set. Finally, in a language which is undergoing a process creating a series of voiced plosives, the difficulty of combining voicing with velar articulation may prevent such a process from effecting a change

of /k/ into /g/ under the same conditions which change /p/ into /b/ and /t/ into /d/. Because of the aerodynamic facts, /g/ can be seen to be a less favored plosive than /b/ or /d/. (For a more detailed discussion of these issues, see Ohala 1983.)

It has sometimes been considered that bilabial plosives are least compatible with voicelessness for a reason also linked to speech aerodynamics, namely, the large volume of the cavity behind the closure at the lips allows the greatest volume of air to flow between the open vocal folds from the lungs into the mouth cavity before that cavity becomes fully pressurized and the flow stops. For this reason, the amount of pressure built up behind a closure at the lips might be less at the time the closure is released than is the case with a closure formed further back in the mouth, especially if the closure is only held for a short time. Consequently the force of the explosion of air at the release of a voiceless bilabial plosive may be weaker than for other plosives, making it more likely to be misidentified. In fact, detailed phonetic studies show that almost all of the pressure increase in the mouth during a plosive occurs in the first 20 milliseconds of the closure duration, and furthermore that the closure for /p/ tends to be held a little longer than that for /t/ or /k/. Hence differences in pressure in the mouth are unlikely to be relevant to explaining why /p/ seems less favored than /t/ or /k/.

The residual categories on the map show the distribution of languages whose plosive sets are lacking a /g/ sound or a /p/ sound when it might have been expected to occur. Stringent criteria were applied in order to make sure that the expectation is well-founded; there must be a distinction between voiced and voiceless plosives, and the relevant place of articulation must be present in an otherwise standard-looking plosive set. Thus in the pattern that is labeled “missing /p/” the language has /b/ in its series of voiced plosives and lacks /p/ in its series of voiceless plosives but otherwise has matching pairs of voiced and voiceless plosives, as in (1). In the pattern labeled “missing /g/” the language has /k/ in its series of voiceless plosives and

lacks /g/ in its series of voiced plosives but otherwise has matching pairs of voiced and voiceless plosives, as in (2). A few languages are labeled “both missing”; they include the sounds shown in (3) in their plosive set.

| (1) | | | | (2) | | | | (3) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | t | k | | p | t | k | | | t | k |
| | b | d | g | | b | d | | | b | d | |

There are equal numbers of cases of “missing /p/” and “missing /g/” in the sample of languages examined, namely 32 of each. In addition there are three languages which show the “both missing” pattern: Una (Trans-New Guinea), Ket (Yeniseian; Siberia), and Efik (Cross River, Niger-Congo; southeastern Nigeria). In terms of frequency of occurrence, then, these two patterns are very similar. However, the map shows that they are not geographically distributed in similar fashion.

## 3. Geographical distribution

Languages representing the “missing /g/” pattern are quite widely scattered in the Americas, and are also found in Africa, in New Guinea and island Asia, and on the Asian mainland. Although a local concentration occurs in Southeast Asia, the impression is essentially of a wide-spread global distribution — precisely what would be expected if this pattern is one which may arise in multiple independent localities in response to general physical laws governing speech production.

On the other hand, languages representing the “missing /p/” pattern occur with a much more clustered distribution, with a predominant cluster in Africa north of the equator, especially around the margins of the Sahara desert, in languages from all three of the major language families present in the area (Niger-Congo, Nilo-Saharan and Afro-Asiatic). Only a few cases occur outside this area, most notably a small group in New Guinea. The African concentration weakens the assumption that there

are similarly general principles working against the combination of bilabial place and voicelessness as is the case for the combination of velar place and voicing — note that the proposed aerodynamic explanation for “missing /p/” appears invalid. Instead, it suggests that one or more areal factors may have operated to favor the initiation and/or spread of this pattern within the circum-Saharan zone.

These areal factors may have been as subtle as the convergence on a regional norm for pronunciation of /p/-sounds. Imagine that voiceless plosives came to be typically pronounced with aspiration, that is, with the voiceless air flow continuing for some time after the closure has been released, as if pronouncing /h/ after /p, t, k/. Because when a stop closure is released the lips separate more quickly than happens with the other articulators, the noise generated by the release itself is shorter and less easy to distinguish from the noise of the following aspiration in /ph/ than is the case with /th/ or /kh/. Hence only the sound of /h/, or a sound reminiscent of a labial fricative such as /f/, might be identified by a listener (compare Ancient Greek /ph/ as the source of /f/ in modern words such as ‘phonetics’), and the pronunciation norm would again change.

It is also possible to speculate on roles for more straighforwardly social factors, such as the prestige of Arabic — a “missing /p/” language — over much of this area for centuries, or the potential impact of cosmetic modification of the lips, practiced in historic times among quite a number of the peoples of the Sahel, of the northern margins of the tropical rain forest, and into the Ethiopian highlands.

A more detailed description of plosive systems and the gaps in their structures would take into account matters such as where these sounds occur within the structure of words, the relative frequency of different plosives in the lexicon, or their relation to other sounds not considered here. However, the narrow perspective of the present analysis is sufficient to

suggest that a useful distinction can be drawn between the very general factors tending to exclude /g/ from consonant inventories, and the more locale- or language-specific ones tending to exclude /p/ from consonant inventories.