IN DEFENSE OF THE PHONETIC ADEQUACY OF THE TRADITIONAL TERM "VOICED ASPIRATED"

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ABSTRACT

This paper defends phonetic adequacy of the traditional term "voiced aspirated" as a descriptor and classifier of a fourth category of homorganic stops such as /bh/, which has been questioned in recent phonetic literature.

INTRODUCTION

In those languages that possess four manner categories of homorganic stops such as /p/, /ph/, /b/ and /bh/, the fourth category has been, traditionally, described and classified as "voiced aspirated". This description and classification of the fourth category of stops has long been considered adequate phonologically as well as phonetically. Recently, however, the phonetic adequacy of the term "voiced aspirated" as a description and classifier of the fourth category of stops has been questioned. According to Ladefoged [7] "when one uses a term such as voiced aspirated, one is using neither the term voiced nor the term aspirated in the same way as in the description of the other stops." That is, unlike the voiced unaspirated stops which are produced with normal closure voicing, the closure voicing during the voiced aspirated stops is not normal [3,9]. Moreover, the voiced aspirated stops are also not aspirated either, since during their production the release of the oral closure is not followed by a period of voicelessness. They are thus unlike the voiceless aspirated stops where the release of the oral closure is immediately followed by a period of voicelessness [1,3,7,9].

There has been some confusion in the phonetic literature as to what aspiration really is. Part of this confusion can be, perhaps, attributed to Lisker and Abramson's [11] work on voice onset time associated with stop consonant production, although to no fault of theirs, as they did not consider voiced aspirates. Their findings on voice onset time led them to regard the "noise feature of aspiration"..."simply as an automatic concomitant of a large delay in voice onset". Unfortunately, "the noise feature of aspiraton," which provided the phonetic basis for the description and classification of the voiced aspirated stops as aspirated, was forgotten and the "large delay in voice onset" or "voicing lag" became the equivalent of aspiration. From then on most phoneticians and linguists used these terms in the sense of aspiration. Thus, the voiced aspirated stops were considered phonetically neither voiced nor aspirated and a few new terms such as "whispery voiced", "breathy voiced", "murmured", "murmured aspirated" and "voiced phonoaspirated" were suggested as phonetically more adequate replacements of the term "voiced aspirated".

The purpose of this paper is to examine and discuss the phonetic adequacy or inadequacy of the various terms mentioned above in the light of glottographic, aerodynamic and spectrographic data from Hindi (a four-category Indo-Aryan language) and to show that the term "voiced aspirated" is a better phonetic descriptor and classifier of the fourth category of stops than its suggested replacements.

EXPERIMENTAL RESULTS

The results presented here are based on the analysis of a large body of data. Although only a few illustrations are given here, they may be taken as typical of the data as a whole. Glottographic, aerodynamic and spectrographic data from one speaker of Hindi are presented in Figures 1, 2 and 3, respectively. These figures display records obtained during the nonsense words /pipi/, /phiphi/, /bibi/ and /bhibhi/ which were produced in a frame sentence /didi -- bolije/ 'elder sister -- (please) say'. We will not consider the data on the voiceless unaspirated stop /p/ in detail in the present study; we will simply note that Photo-Electric Glottograms (PEG) in Figure 1 show that the glottis is slightly apart during the initial /p/. The figure also shows that /b/ is produced with an approximated glottis and vibrating vocal folds; while /bh/ and /ph/ are produced with a moderately and a widely open glottis, respectively. The glottal opening during /bh/ begins appreciably before the oral release, peaks around the middle of the noise interval and terminates during the initial part of the

following vowel. However, during /ph/ the glottal opening starts at or slightly prior to the articulatory closure, peaks at or near the articulatory release and terminates during the early portion of the following vowel. Notice that the glottal opening during /ph/ is approximately double that during /bh/.

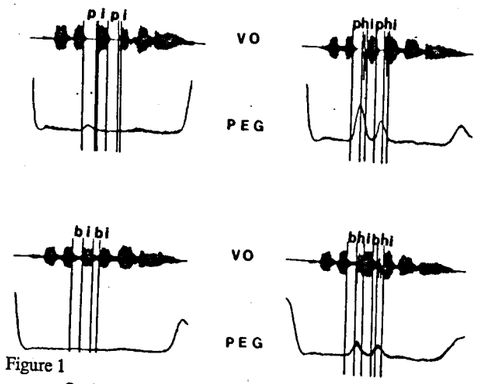

Figure 1

Oral air pressure (Po) and oral air flow (Uo) curves in Figure 2 show that the pressure profiles and the magnitudes of pressure during the articulatory closure for /b/ and /bh/ are about the same, but the magnitude of flow after the articulatory release is much greater for /bh/ than for /b/. However, the pressure profile as well as the magnitude of pressure and flow for /ph/ are different than those for /b/ and /bh/. For /ph/ the pressure rise is rapid, the pressure build up is higher and the flow rate is greater than each of these for either /b/ or /bh/.

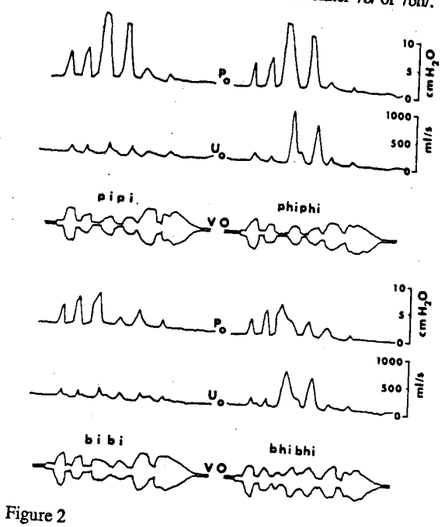

Figure 2

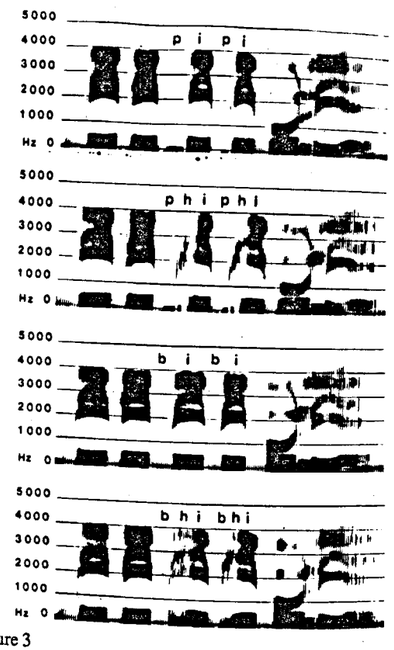

Figure 3

The spectrograms in Figure 3 show that the closure interval of /ph/ is mostly voiceless, except for a few vertical striations indicating vocal fold vibration continuing from the preceding voiced environment. The closure intervals of /b/ and /bh/, on the other hand, are fully voiced. The acoustic patterns of closure voicing for /b/ and /bh/ appear to be virtually identical. Notice that a period of voicelessness occurs between the articulatory release of /ph/ and the onset of the following vowel. However, such a period during /bh/ is not voiceless; it is occupied by a fuzzy acoustic pattern of vertical striations, which appear to be quite different from the one observed during closure interval of /bh/ or /b/. On the other hand, during this period acoustic noise can be observed for /bh/ and /ph/ alike, in about the same frequency regions as the resonances of the vowel following these stops.

DISCUSSION

The spectrographic data presented above clearly demonstrate that the voiced aspirated stops of Hindi are both voiced and aspirated. They are voiced because they are produced with regular closure voicing like the voiced unaspirated stops and they are aspirated because, like the voiceless aspirated stops, they are produced with glottal noise - in other words aspiration - following the release of oral closure. However, the period following the release of oral closure, during which aspiration occurs, is voiceless in the voiceless aspirated stops but not in the voiced aspirated stops; in the latter category of stops the vocal folds continue to vibrate through this period. In the voiced aspirated stops the mode of vocal fold vibration during the period of aspiration is apparently different from that during the closure interval. This is reflected in the fuzzy pattern of vertical striation during the aspiration vis-a-vis the clear pattern of vertical striations during the closure interval (Figure 3). The difference in the mode of vocal fold vibration within the voiced aspirated stops is further reflected in an approximated glottis and an extremely low flow rate during the closure interval versus a moderately open glottis and a high flow rate during the noise or period of aspiration (Figures 1 and 2).

During the aspiratory interval of these plosives the glottis is only moderately open and the vocal folds are relatively slack; consequently they can vibrate in the absence of an articulatory obstruction to the airflow. But they do not touch one another while vibrating. On the other hand, during the aspiratory interval of the voiceless aspirated stops the glottis is widely open and the vocal folds are relatively tense; they simply cannot vibrate even in the presence of high flow rate. Thus, the aspiratory interval of the voiceless stops is voiceless but that of the voiced stops is not. Further, the spectrograms in Figure 3 show that the acoustic noise during the voiceless aspirated as well as voiced aspirated stops is found in about the same frequency regions as resonances of the following vowel, which indicated that the noise source is located at the glottis. If the source were located elsewhere a different noise pattern would have resulted. Glottal noise is commonly called aspiration. Thus, the phonetic description of the voiced aspirated stops as aspirated cannot be reasonably rejected [4]. Likewise, their phonetic description as voiced is also unquestionable. In anticipation of the forthcoming aspiratory phase the glottis begins to open appreciably before the release of the oral closure; but the vocal folds continue to vibrate and remain fairly close together almost until the articulatory release, as attested by fiberoptic observations [2,6]. Those sounds in which the vocal folds "form a closure or near closure duing successive periods of the oscillation' are said to be regularly voiced [12]. Thus, the traditional term "voiced aspirated" is an adequate phonetic descriptor and classifier of the fourth category of homorganic stops. Further "voiced aspirated" is a better term since it produces a symmetrical matrix of classificatory terms, and is capable of capturing phonological generalization, while its suggested replacements produce an asymmetrical and counterintutive matrix and create problems in the description of such sound changes as Grassman's Law, as shown by Halle [5].

On the basis of the definitions of phonetic terms given in Petrerson and Shoup [12], Benguerel and Bhatia [2] have proposed the term "voiced phonaspirated" as a phonetically more adequate descriptor than the term "voiced aspirated" for the fourth category of homorganic stops. There is no problem with the term "voiced" which adequately describes what happens during oral closure. However, the term "phonoaspirated" which describes what happens after the release of oral closure is problematic. It appears that "phono" in "phonoaspirated" was prefixed to "aspirated" to indicate the particular mode of vocal fold vibration which occurs during the aspiratory period and which is different from the one that occurs during the oral closure. However, "phono" is also prefixed to "constricted" in the term "phonoconstricted" where it indicate a very different mode of vocal fold vibration from the one that occurs during the aspiratory interval. As "phono" describes two entirely different modes of vocal fold vibration, it renders the term "phonoaspirated" phonetically inadequate, and thus unacceptable.

The discussion of phonation types in Catford [3] suggests the term "whispery voiced" for the voiced aspirated stops. He says that "the fact is that in such sounds as [bh] there is whispery voice rather than voice during the stop and for a certain period after its release." The glottal stricture used in the production of whispery voice is described by Catford as "narrowed vibrating." The degree of opening according to him is less than 25% of maximal glottal opening, while during voiceless stops it is from 60 to 95% of maximal glottal opening. Let us assume that the opening for the voiceless aspirated is 95% of maximal glottal opening. Now recall that the degree of glottal opening for the voiced aspirated stops in the data presented here was about half of that for the voiceless aspirated stops. Thus, the voiced aspirated stops were produced with more than 45% rather than less than 25% of maximal glottal opening. Obviously, they were not produced with whispery voice, since the glottal stricture was inappropriate for the generation of whispery voice ,being twice as wide as required for such a phonation. Moreover, Catford's assumption that the glottis is in the phonatory posture for whispery voice during the stop phase is also not borne out by the data. But even if such a posture were present during the stop phase it could not generate whispery voice in the presence of a supraglottal obstrucion. Thus, the term "whispery voiced" instead of "voiced aspirated" is phonetically inapproopriate.

Ladefoged has suggested the terms "murmured" [7,8,9] and "murmured aspirated" [10] in place of the term "voiced

aspirated" for the phonetic description of the fourth category of homorganic stops. According to him [9] "murmured sounds are sometimes made...with the glottis fairly open at one end. They can also be made with a narrower opening extending over nearly the whole length of the vocal cords." Ladefoged has called both these physiological possibilities the "murmur" state of the glottis and has assumed that such a state occurs during the oral closure as well as after the release of the closure in the so-called murmured or murmured aspirated stops [8,10]. Thus the vocal fold vibrations that occur during the oral closure are assumed to be of "the kind that would be expected from a small volume of air flowing through the glottis while it is in the position for a murmured sound" [8], that is the vocal fold vibrations during articulatory closure are said to be different from those in normal voice vibrations. However, these assumptions do not find support in the glottographic and acoustic data presented here. The phonation that is generated after the release of a closure was earlier [7,8,9] described as murmur or breathy voice. Later [10] in relation to the somewhat different voiced aspirated stops of Owerri Igbo it was surprisingly though unjustifiably described as aspiration, (surprisingly since "aspiration" for Ladefoged is " a period of voicelessness during and immediately after the release of an articulatory stricture" [7]). This was the result of redefining aspiration in an attempt to accomodate the voiced aspirated and the unvoiced aspirated stops under the same phonetic category of "aspiration". The attempt, however, did not succeed since the closure voicing in the voiced aspirated stops of Owerri Igbo was still considered to be murmur, which is almost certainly contrafactual.

Lately, Ladefoged has changed his position. In the second edition of his book *A Course in Phonetics* he states that "voicing during the vowel and the closure are, as usual, the result of air flowing between the vocal cords while they are held loosely, fairly close together". In other words the closure voicing in the voiced aspirated stops is normal regular voicing. This is strongly supported by the glottographic and acoustic data presented here. Further, the vibrations that occur after the articulatory release of these stops are described as "murmured (breathy) vibrations". That is, after the articulatory release of the voiced aspirated stops "murmur" or breathy voice" occurs. Breathy voice may as well be called "voicy aspiration".

As we have seen, in the voiced aspirated stops of Hindi aspiration is accompanied by glottal vibration which noticeably changes its quality. It sounds more like breathy voice. However, it would be inappropriate to call the voiced aspirated stops "breathy voiced," because this term describes only the state of the glottis after the release of the closure in these stops. On the other hand, the term "voiced breathy voiced" sounds strange. If the term "murmur" could be strictly limited to the meaning of "breathy voice," then perhaps a term like "voiced murmured" could be suggested to describe the fourth category of homorganic stops. The seeds of this term were already present in Lisker and Abramson's [1] and Benguerel and Bhatia's [2] work, but for some reason they did not suggest it. If this term is accepted then a diaeresis [..] should not be used under the stop part of the consonant, since it will give the wrong impression that the closure voicing is murmur rather than regular voicing.

To conclude, the term "voiced murmured," although phonetically adequate, will produce an asymmetrical matrix of classification that will fail to capture phonological generalizations. However, it may turn out to be a useful term in speech synthesis. On the other hand, the term "voiced aspirated" is not only phonetically adequate but also produces a symmetrical matrix of classificatory values and is capable of capturing phonological generalizations. It will thus be more attractive to the linguist. The other terms which really are both phonetically and phonologically inadequate should be discarded.

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