THE PROFILE AS A VISUAL DEVICE FOR INDICATING CENTRAL TENDENCIES IN SPEECH DATA

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The purpose of this article is to describe a graphic method for simultaneous presentation of central tendencies in data containing a large number of categories such as are characteristic of speech sounds. It is not a new device. Rather it represents an application to transcriptions of vowel and consonant sounds of a device successfully used with other kinds of data. The method is especially useful for comparing individual and group differences in the production of the speech elements and for following trends of development. It consists of a profile of the relative frequency of speech elements or categories of elements and involves an x and a y axis. However, it is a visual aid rather than a system of co-ordinates. Its construction consists of a simple modification of the principle of the bar graph. A series of equidistant points is laid off on the x axis from which perpendiculars may be erected to accommodate bars which signify the frequencies of the various elements. The y axis is taken to represent per cents of frequency. The units of both axes are arbitrarily chosen, but for comparative purposes they should be kept equal from profile to profile. No assumptions concerning discreteness or continuity need be made about the units plotted on the x axis.

The essential condition for the usefulness of this device is the establishment of equal total areas under each of the compared profiles. The total area is taken as 100 per cent and represents the total frequencies of all sounds in each of the compared sets of elements. Thus the frequency of each speech element under the profile is in turn an area which represents its proportionate part of 100 per cent. Under these conditions the profile pattern will reveal quite readily the overall similarities and differences existing among groups of data.

This article will be devoted to various simple illustrative uses of the method. The profiles presented here are based on data which have been transcribed from the vocalization of newborn infants, of infants at several ages up to two years, of a group of low-grade feeble-minded children under five years, and from a study (2) on the distribution of elements in adult speech. A few of these samples are small, but since the aim is to illustrate a method and not to validate conclusions, the smallness of the sample does not prejudice the purpose of the article. The research findings as such may be found in reports appearing elsewhere. Moreover, it should be kept in mind that the profile illustrates only central tendencies and none of the other statistical characteristics of the data.

An analysis (1)[2] was made of the vowel elements occurring in the crying vocalization of forty infants under ten days of age. Figure 1 gives the data and illustrates the manner in which a profile is constructed. Thirteen vowel sounds are equally spaced on the x axis. The

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[2]*A new method of collecting speech data involves a variation of the short sample technique consisting in a behavior unit rather than a time unit.*

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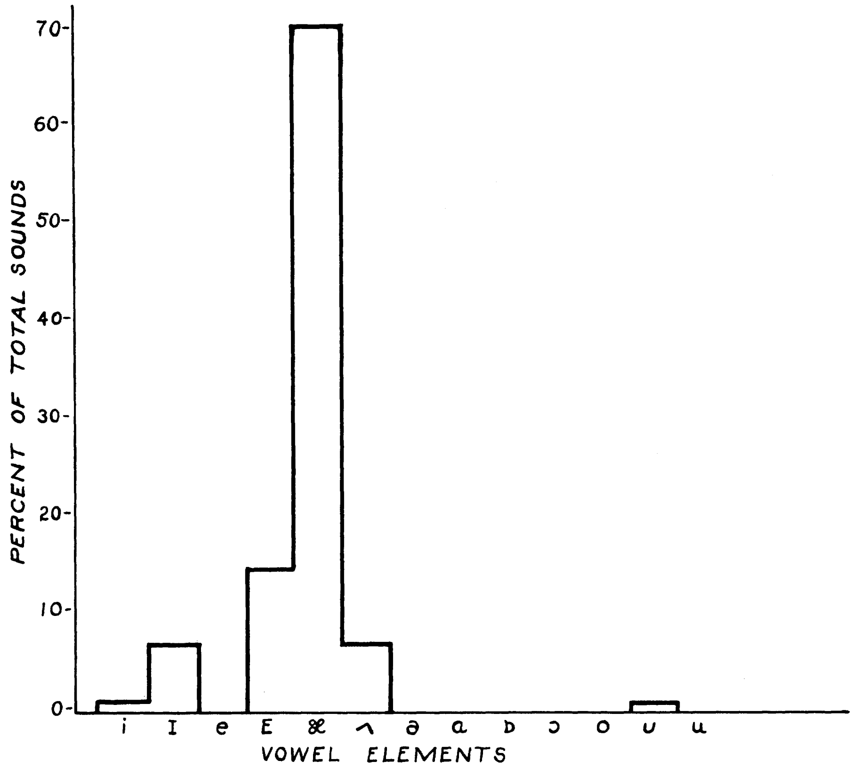


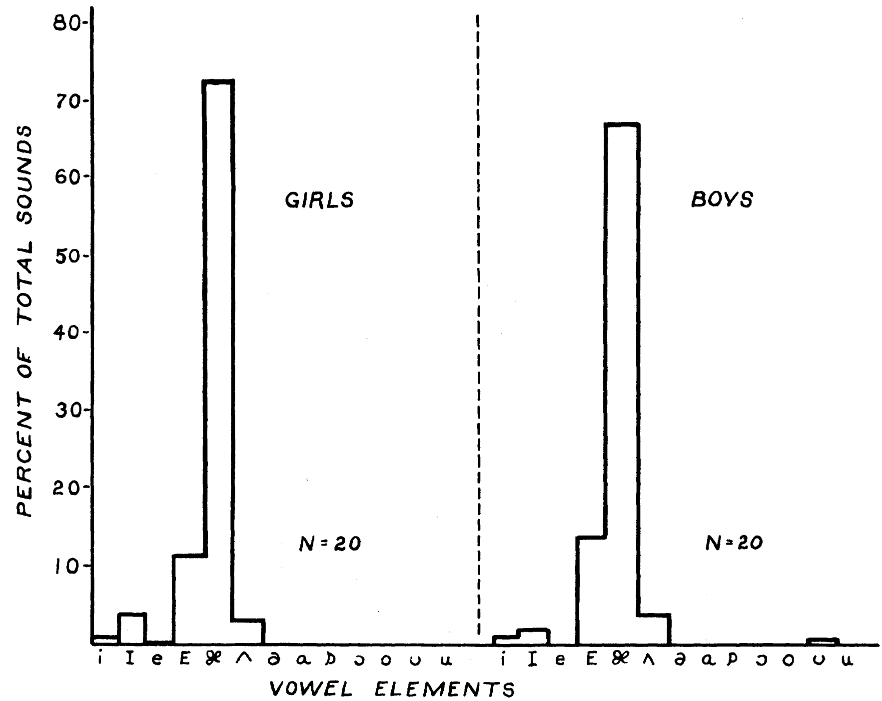
PROFILE OF VOWEL ELEMENTS DURING CRYING FOR FORTY NEWBORN INFANTS

FIGURE 1

y axis indicates the per cent of total vowel sounds. The area under the profile is taken as unity or 100 per cent. It will be noticed that in this profile 70 per cent of its area is occupied by the vowel æ. Fifteen per cent of the area represents the frequency of production of the vowel ɛ, and areas equal to 6 per cent each account for the vowels ɪ and ʌ.

This profile illustrates several interesting facts about the frequency of occurrence of vowel sounds in the crying of newborns: (1) that only four vowels occur with any appreciable frequency -- ɪ, ɛ, æ, and ʌ; (2) that the sound æ overwhelmingly dominates all other vowel sounds; and (3) that back vowels are practically absent from the sound repertoire of these forty babies.

The profile may be used to compare similarities and differences in certain aspects of two or more sets of data. Figure 2 presents two profiles, one the vowel equipment of girls under ten days and the other of boys. The patterns of distribution under these profiles are quite similar. They indicate that the outstanding predominance of one of the



PROFILES OF VOWEL ELEMENTS FOR GIRLS AND BOYS DURING THE FIRST TEN DAYS OF LIFE

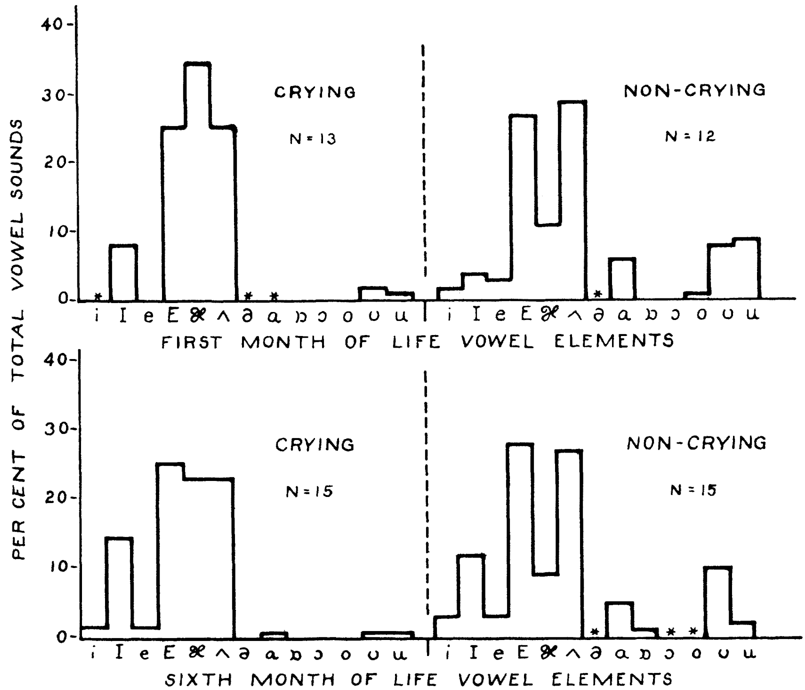
FIGURE 2

front vowels, as well as the absence of back vowels are characteristic of the crying vocalization of both newborn boys and girls.

The profile lends itself as a device for revealing age differences. Figure 3 shows four profiles illustrating differences between crying and non-crying vowel production of infants at one and six months of age.

Before considering this group of profiles, perhaps a preliminary comparison of the profile in Figure 1 should be made with the upper left profile in Figure 3. The former, as was pointed out above, is the dispersion of vowels of crying newborns, the latter represents the distribution of crying sounds of infants during the last half of the first month. Inspection of the two profiles reveals that whereas in the first the largest area, that representing æ, includes 70 per cent of the total area, this value in the second profile has been reduced to 35 per cent, or to one half, and that the ɛ and ʌ sounds are replacing it. Moreover, among the crying sounds of month-old babies there still are few back vowels produced.

Comparison of the profiles of first and sixth month crying infants



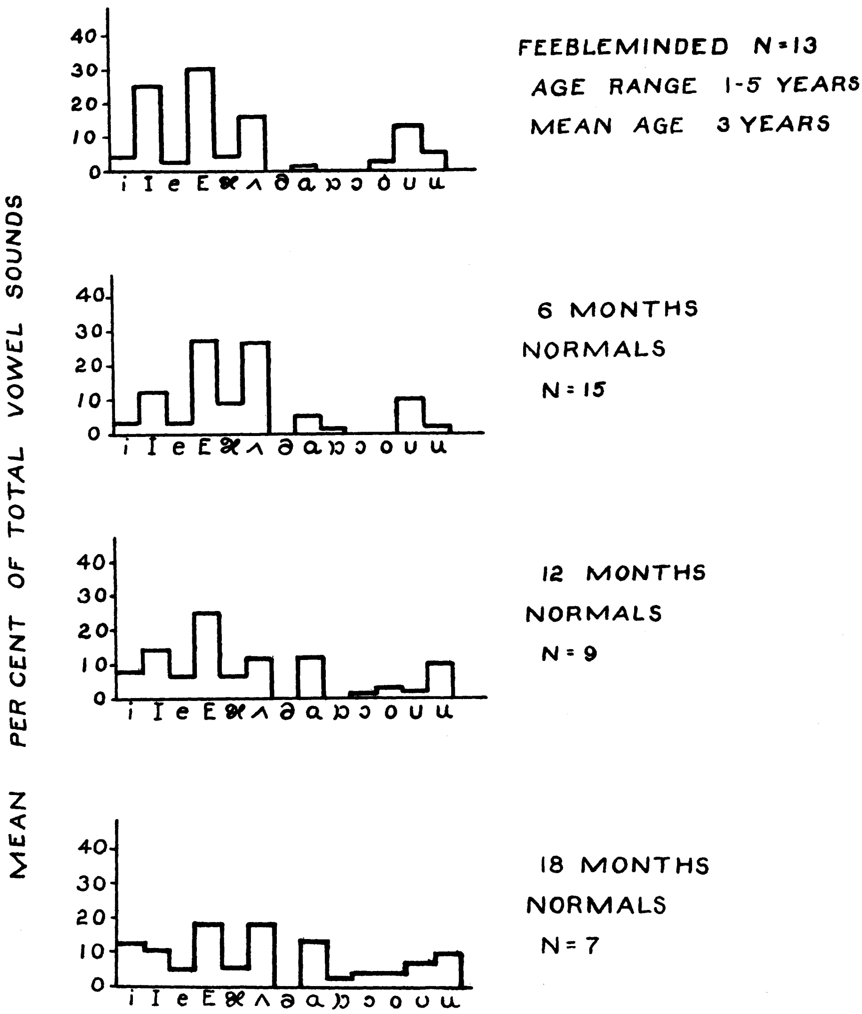
PROFILES OF VOWEL ELEMENTS UTTERED DURING CRYING AND NON-CRYING PERIODS FOR THE FIRST AND SIXTH MONTH OF LIFE

* *Per cent too negligible to indicate*

FIGURE 3

in Figure 3 shows a further reduction in the use of the vowel æ. Otherwise the two patterns are similar. In the non-crying infants on the right in the figure the profiles for the first and sixth months are almost alike. While there is an increment in the use of back vowels as compared with the two profiles at the left, the production of these sounds still remains a meager part of the total area. Horizontal comparisons of the profiles show that the vowel æ is more frequently used in the first month by crying than by non-crying children. Comparison of the two profiles for the sixth month shows a similar situation.

Figure 4 gives another age distribution of vowels. The three lower profiles present data of vowel sounds of normal babies at six, twelve, and eighteen months. An examination of the profiles for these age groups indicates a tendency toward an increase with age of the production of back vowels. It is manifested by a tendency toward equalization of the unit areas on the x axis. Thus the lowest profile in the figure is flatter than those above it. Some indication of the fattening process is beginning to appear in the profile of the twelve month group. It is quite appreciable in the eighteen month group.



PROFILE COMPARISONS OF VOWEL PRODUCTION OF FEEBLEMINDED AND NORMAL CHILDREN

FIGURE 4

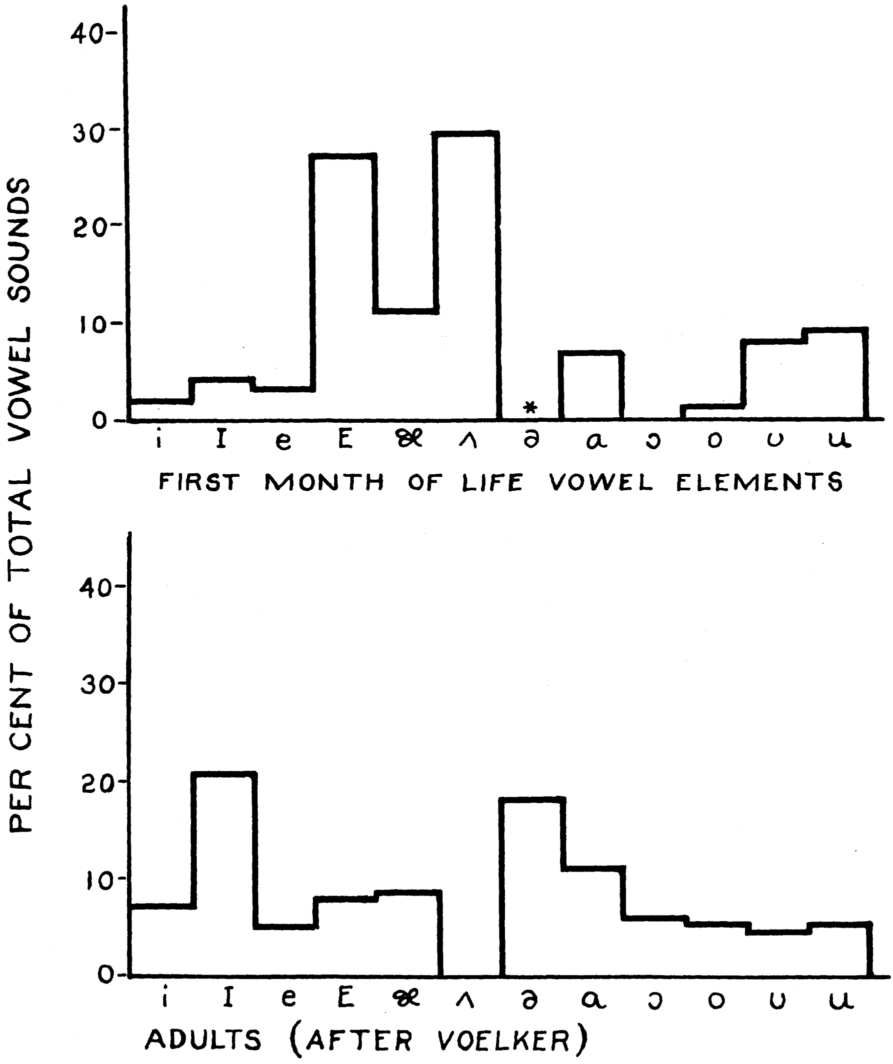
An exceedingly interesting comparison is afforded by the first profile in the figure with each of the other three. Consider first the contrast between the upper and lower profiles. The upper one represents the vowel usage of a group of low-grade feeble-minded children varying in age from one to five years with an average age of three years. The lower profile is that of the one and one-half year old group of normal babies. The greater part of the area of the profile for the feeble-minded group is located in the left half of the profile. The area in the profile for the normals tends to be more evenly distributed over the entire vowel range.

The upper profile resembles the second and third more closely than it does the fourth. It approaches the pattern of the second somewhat better than it does the third. The areas of the first and second profiles both show preponderance in their left halves. By calculating the percentages from the y axes it will be seen that the left halves of both include about 80 per cent of the total areas. Thus it is indicated that the central tendencies in the production of vowel sounds of these low-grade feeble-minded children is about the same as that of a group of normal babies in the second half of the first year of life. The comparative use of the profile renders this quite apparent from a visual standpoint.

Figure 5 presents two dissimilar profiles, one the picture of non-crying vowel production of infants under one month, the other the pattern of adult speech. The latter is an adaptation from vowel data collected by Voelker (2). The following are the outstanding differences between the two patterns: (1) the upper profile shows that the sounds are concentrated in the left half whereas in the second they are more evenly distributed over the vowel range; (2) the most prominent vowels in the first are ɛ and ʌ, in the second I is the most frequent; (3) more back vowels are present in adult speech; (4) the middle vowel ʌ is present in infant vocalization but ə is absent, while in adult speech this dispersion of middle vowels is reversed; (5) there is a bimodal distribution among the front vowels of infants whereas in the adult profile there is revealed a tendency among front vowels to be unimodal.

A further comparison of non-crying sounds of infants with adult vowel production may be made from Figures 4 and 5. The second profile in Figure 4 shows the vowel usage of six month infants. It is characterized by a concentration of vowels in the left half in contrast to the flatter distribution of adult vowels in the profile in Figure 5. In general, of all the profiles in Figure 4, the one for the eighteen month distribution presents the closest approximation in flatness to that for the adult. The comparison of these two profiles is at least suggestive of the possibility that adult status of vowel frequency may be achieved soon after the eighteenth month. A decision in regard to the matter must await the collection of further data.

Irwin and Curry (1) observed that consonant production in newborn infants is quite infrequent. Consequently a profile of these speech elements is not yet available for this age. However there are some data available for the frequency of consonant usage by a small group of six month infants who were not crying. Figure 6 presents a profile constructed from these data. Below it is a profile of adult consonant production adapted from the Voelker data. The two patterns are hardly alike. Of the twenty-three consonant sounds only twelve, or about half, are produced by six month infants, whereas all are used by adults. An interesting contrast exists in the frequency of the consonant h. In infants this sound occupies 64 per cent or about two-thirds of the



PER CENT FREQUENCY OF VOWEL SOUNDS

* Per cent too negligible to indicate

FIGURE 5

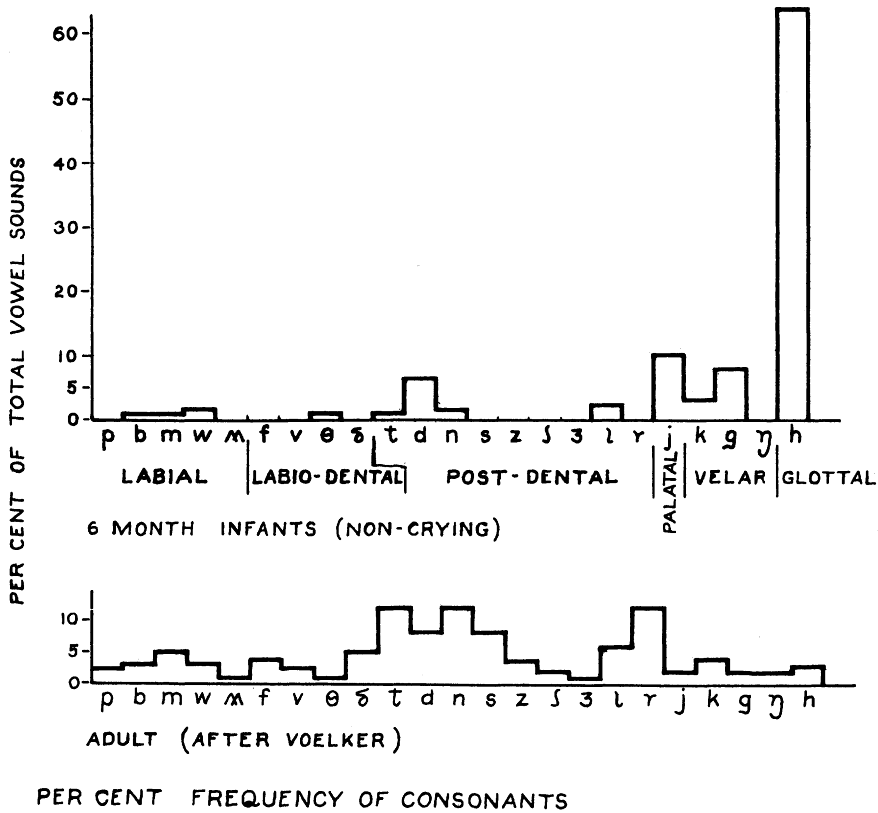


FIGURE 6

area under the profile. In adults the corresponding area is 3 per cent. The sound h, of course, requires little mouth formation, but the difference between its frequency in infants and adults is exhibited in the profile in a striking manner. If this sound were eliminated from the profile on the ground that there is little in the way of special mouth formation, the consonant profile still would not be similar to that of the adult.

In Figure 7 the consonant elements are grouped into classes according to the place of articulation. The upper profile indicates that infants produce consonants somewhat more frequently with the rear parts of the mouth than do adults. The lower profile shows the greater extent to which dental consonants are produced by adults than by infants, and that palatal, velar, and glottal structures are less frequently employed in adult consonant output.

This is not the place to elaborate a possible interpretation of these particular profiles, but if they are at all representative it is not unlikely that any interpretation of them concerning the course of development must recognize the infrequent production by infants of both back vowels and of labial and dental consonants. A comparison of the infant status of these elements with their adult status may indicate a

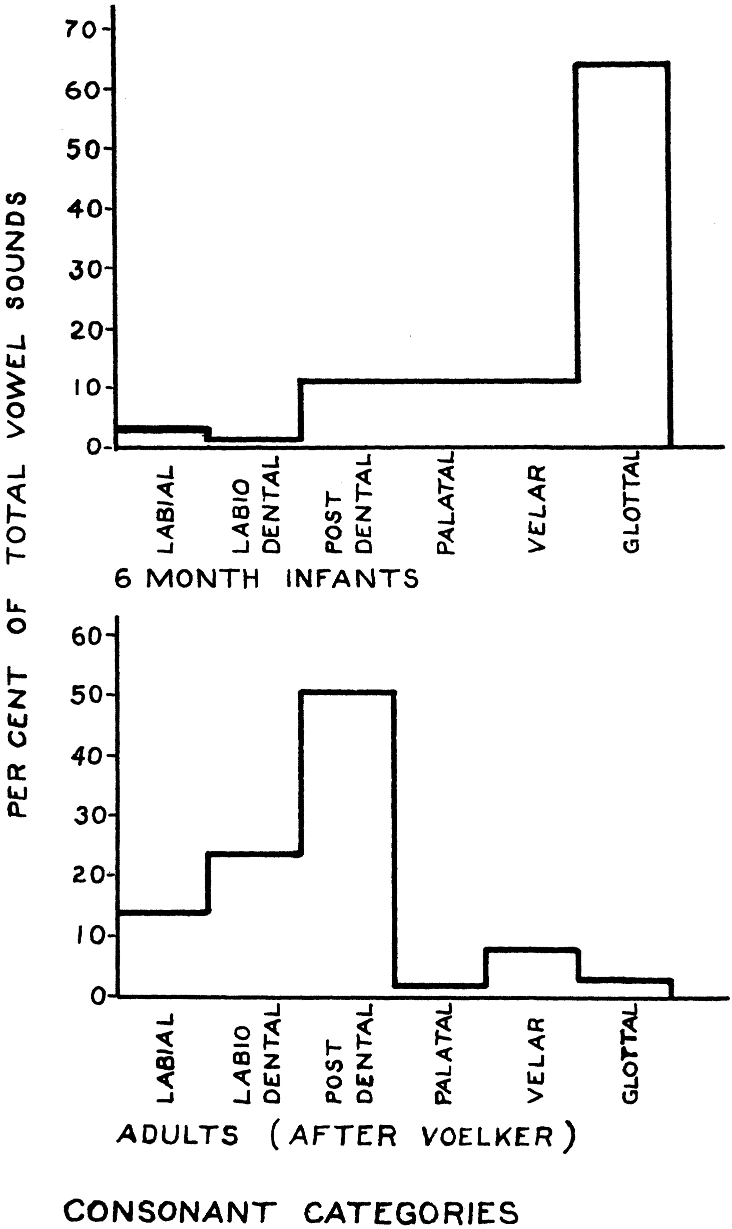

PER CENT OF TOTAL VOWEL SOUNDS
70
60
50
40
30
20
10
0
LABIAL
LABIO DENTAL
POST DENTAL
PALATAL
VELAR
GLOTTAL
6 MONTH INFANTS
60
50
40
30
20
10
0
LABIAL
LABIO DENTAL
POST DENTAL
PALATAL
VELAR
GLOTTAL
ADULTS (AFTER VOELKER)
CONSONANT CATEGORIES

FIGURE 7

possible future course of development of the newborn's speech sounds.

The object of this paper rather has been to illustrate the use of the profile with a type of data which is subdivided into a number of categories. Its advantage lies especially in its ability to present the overall effect of such data so that this effect is not lost in a detailed analysis of the component categories. The analysis of the development of speech sounds requires a device for preserving the general overview. The profile therefore has much to commend it as a graphic presentation of the central tendencies of these data, but it is not without its limitations, the greatest of which is the fact that it does not indicate variability within the individual category.

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(2) Voelker, Charles H.: A comparative study of investigations of phonetic dispersion in connected American speech. Extract des Archives Neerlandaises de Phonétiques Expérimentale, 1937, 13, 138-152.