The literature on the mastery of speech sounds by infants has been summarized by the authors (3). The literature contains no clear-cut statements indicating the continual progress by the infant in the acquisition of the elemental sounds he will use when he becomes an adult. There are no systematic efforts to analyze the course of the development in early speech of the various classifications of speech sounds. The purposes of the present article are to determine the number of types of speech sounds appearing in infant vocalization during the first two and a half years of life, to indicate the nature of the development of speech sounds by means of a curve, and to derive its equation. Consideration is also given to sex differences. For these purposes, measures of central tendency are used. Problems of variability are being reserved for future publications.

In regard to the investigation itself, it was originally planned to visit a large number of babies in their homes twice each month during the first thirty months of life. Unfortunately the original plan was handicapped by the necessities of the war. Many infants moved with their families to other communities. Sickness, vacations, and other absences contributed the usual irregularities encountered in collecting the longitudinal type of materials. In spite of these handicaps, a very considerable amount of data has been collected and is available for analysis.

A total of 95 infants were included in the investigation. These infants were from middleclass homes, the parents being professional, business, clerical, and some laboring people. Although it has not been possible to follow all of them continuously throughout the entire two and a half year period, the speech sounds of a majority of them were recorded for extended periods. About 20 babies have been followed to the end of the period of infancy and about 35 of them yield quite continuous records. The analysis consequently is in two parts, one of which includes the data obtained from the 95 cases, and a second which is limited to the most continuous data obtained from 35 cases. The data consists of 1622 records transcribed in the International Phonetic Alphabet. The record secured at a given visit contains a sample of such vocalizations as were uttered on 30 respirations or breaths (4). Observer and data reliabilities have been reported elsewhere (3).

The simplest index of phonemic development is furnished by the number of types of speech sounds. In this study the International Phonetic Alphabet as modified by Fairbanks (1) has been used. The time unit employed is the two-month period, so that the curve of development for the first 30 months is based upon 15 points, each point being a mean value for the corresponding two-month period. It has been found that the differences between means of adjacent months are not statistically different and that trends can be adequately shown with 15 points on the curve.

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Table I gives the means and the number of infants upon which these values are based, the number of records available, and also values for the 35 cases which include most of the continuous records. The table is to be read as follows: for the first period the mean number of phonemes is 7.2, the number of infants for this period is 62, and 125 transcriptions of 30 breaths each is the number of records.

![Fig. 1. Phoneme types (all data).](image)
Fig. 1 presents the curve based on all the data made available by the investigation. Age \((A)\) is laid off on the X axis, and \((N)\), number of phonemic types, is plotted on the Y axis. Closed dots represent the observed values. The curve approximates a parabolic arc whose equation is \(N = 7.533 \, A^{0.471}\). By inspection it is obvious that the curve derived from the equation is a good fit to the empirical data. When the chi-square goodness of fit value is calculated it is found to be 0.191 (\(P = .99\)).

\[
N = 8.505 \, A^{0.428}
\]

In order to learn if those cases for whom there existed the most continuous records yield a reasonable approximation to the curve based on all data, Fig. 2 is presented. A total of 1004 records were available for this analysis. The equation for this curve is \(N = 8.505 \, A^{0.428}\) and likewise approximates a parabolic arc. This curve also is a good fit to the observed scores, the chi-square value being 0.422 (\(P = .99\)).

The two curves, it is seen, are quite similar and either may be taken as reasonably representative of the mastery of sound types
during the first two and one-half years of life. They show that the average number of types for the first two-month period is about eight and that for the last two-month period the infant is in possession of an average of 27 of the 35 sound elements used in adult English speech. It is interesting that the rate of the development of this type of infant behavior is a changing rather than a constant rate.

Table II gives the mean values for the fifteen units for boys and girls separately. These means are based upon the most continuous data.

When theoretical values are derived from the observed values in Table II and are plotted, the resulting curves are approximate parabolic arcs whose equations are:

\[ \text{Boys, } N = 8.614 A^{0.414} \]
\[ \text{Girls, } N = 8.356 A^{0.411} \]

The curves appear in Fig. 3.

The curves show that boys and girls start with the same endowment of speech sound types but that the girls end with a slightly higher achievement. They also show that the rate of development for the sexes changes. While the tendency for girls to be superior to boys is apparent, there are no statistically significant differences between the observed values. During the last year, where the tendency to differ is most apparent, of the six pairs of values only two are statistically significant. This is not enough evidence upon which to base an assertion of the definite presence of sex difference.

**Summary**

Ninety-five infants ranging in age from one to 30 months were visited in their homes and their spontaneously uttered speech sounds were recorded in the International Phonetic Alphabet. The sounds uttered on each of the 30 breaths constituted the sample obtained at each visit. The present article is concerned with the mean number...
of phonemic types used by the infants and indicates the nature of this aspect of infant speech development. An equation is derived from the observed data and a curve is presented.

The curve approaches a parabolic arc, the equation being \( N = 7.533 A^{0.471} \). It shows that the phonemic equipment of the child during the first two-month period of life includes 7.5 sounds and that at the last two-month period (29–30 months) it is in possession of 27 of the 35 sounds present in adult speech. The infant’s mastery of the types of phonemes used in the English language proceeds in a curvilinear manner, that is, at a changing rate. Greater progress is made during the first year of life than during the second and a half years.

A second curve fitted to data transcribed from the vocalizations of the 35 children who were the most continuously observed infants among the group of 95, shows similar results. The equation for this curve is \( N = 8.505 A^{0.428} \). When equations of the mean values for boys and for girls are derived, the equations are \( N = 8.614 A^{0.414} \) for
boys and $N = 8.365 A^{0.441}$ for girls. The curves derived from these equations show that while the two sexes begin with similar values and remain together during the first year, the girls tend to exceed the boys during and after the second year. The differences, however, are not statistically significant.

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