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Source: *Child Development*, Vol. 13, No. 1 (Mar., 1942), pp. 29-39

Published by: [Blackwell Publishing](#) on behalf of the [Society for Research in Child Development](#)

Stable URL: <http://www.jstor.org/stable/1125804>

Accessed: 17/01/2011 11:00

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THE DEVELOPMENTAL STATUS OF SPEECH SOUNDS
OF TEN FEEBLE-MINDED CHILDREN

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This report represents the first step in a systematic study of the use of vowel and consonant elements by feeble-minded children. The purpose is to determine developmental trends in the speech of mentally retarded children and to relate data acquired in this field to the processes of development in normal infants and children and to the status of adult speech. Ultimately, information concerning the comparative rates of speech development in normal and feeble-minded children may be established and remedial measures for speech retardation may be set up. A further aim is to try out several indices of speech status on this type of data.

Transcriptions of the speech of a group of twenty-five low-grade feeble-minded children in a state institution were attempted. Unfortunately a sufficient sample of sounds could be secured for only thirteen of these children. A considerable amount of time is necessary to make a transcription on each child and many of them produce sounds only after long intervals. Frequently no vocalization occurs. The work was done during the first week of the year 1941. A second transcription of the sounds of these children was obtained on December 22, 1941. Approximately, then, a year had elapsed between the taking of the two samples. During the year the number had been further reduced by death to ten cases. It is recognized that ten cases do not constitute an adequate sample for sound statistical treatment; nevertheless, there are tendencies in these data which possess at least preliminary meaning, and an elaborate statistical treatment will be postponed pending the accumulation of more cases.

The method of sampling the speech sounds of immature children has been described elsewhere (4). Briefly, it consists of such sounds as occur on a given number of breaths of each subject. In the present study 30 breaths constituted the sample from each child. The vowel sample on the first transcription consisted of 417 elements. On the second transcription it amounted to 560. The total thus is close to 1,000 vowel sounds. On the first transcription 174 consonant elements were included; on the second, 332. The total consonant sounds used by these children thus amounted to about 500. Altogether, about 1,500 separate speech elements are available for analysis.

Transcriptions were taken in the International Phonetic Alphabet as adapted by Fairbanks (1). The problem of the reliability of the observer and of the data in transcriptions of the speech of immature children has been discussed by Irwin and Curry (4), Irwin and Krehbiel (5), and Irwin and Chen (3).

At the beginning of the year these children ranged in age from about

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one to five years with a mean age of three years. All of the children are low-grade feeble-minded cases, idiots and imbeciles. Their IQ's ranged from 7 to 48. The average is 29. Among them are Mongols, hydrocephalics, and unidentified clinical types. Thus clinically they do not constitute a homogeneous group. General information concerning these ten children is tabulated below.

Subject	IQ	Clinical Type	Age		
			Second Years	Transcription Months	Days
1	22	?	3	- 3	- 10
2	48	Mongol	2	- 9	- 10
3	7	?	4	- 9	- 12
4	45	?	5	- 7	- 20
5	18	Hydrocephalic	4	- 10	- 10
6	39	Hydrocephalic	5	- 0	- 5
7	*	Mongol	3	- 6	- 17
8	32	?	5	- 10	- 23
9	23	?	3	- 10	- 0
10	25	?	4	- 1	- 7

* Passed only one item on Kuhlmann-Binet. The item is turning the head to source of sound.

The original data are presented in four tables. They will be analyzed in terms of the vowel-consonant ratio, the vowel ratio, and as vowel and consonant dispersions plotted graphically in the form of "profiles." Under each of these analyses comparisons will be made with the corresponding indices of the speech status of infants and adults. Table 1 gives the frequency of occurrence of each of eleven vowels for each of the ten subjects. The data for each vowel are arranged in two columns representing the first and the second transcriptions. Table 2 is similarly organized but presents the corresponding per cents of frequency in two columns for each subject. Tables 3 and 4 present frequencies and per cents of frequencies of consonant elements in a manner comparable to that of Tables 1 and 2 for vowels.

These tables furnish the basic data from which the tabulations and analyses of the speech sounds of the feeble-minded children are derived. The comparative data on speech sounds of infants are from studies done by the writer and his associates. The data on adult speech sounds status are from Voelker (6).

The first matter of interest is the question: Do any of these children use meaningful language? Of the ten cases only one (Number 4), a boy of five and one-half years, exhibited meaningful speech patterns, and these consisted only of mutilations and approximations. Of the 30 breath samples of his sounds transcribed at the beginning of the year, 10 were meaningful patterns and 20 were meaningless. At the end of the year 15 of the 30 samples were meaningful. Thus he increased his use of meaningful approximations during the course of the year from one-third to one-half. None of the other subjects of this group exhibited the slightest tendency toward meaningful expression. Thus the bulk of this report concerns sounds characteristic of the premeaning stages of speech devel-

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TABLE 1
FREQUENCY OF VOWELS

Subject	i		I		e		ε		ɛ		^		a		ɔ		o		u		u	
	1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	1	1	19	20			8	2	12	23	7		1				1	9	1	1		
2		1	5	4			17	26		1	22	12		7			5		12	9		
5	5	8	17	18	2	1	26	22	1		6	14						4	1			
4	4	11	9	21	2	4	2	7	1	2	6	15	1	7		2	11	7	11	16	4	2
5	1		16	27			4	11			2	17		5				7	5			1
6	1		9	28	4		18	8	1		1	1						6		5		
7	2	1	14	17			4	14	5		2	14										
8	1	5	11	14	2		29	15				4		5						2	5	
9	2		4	7			10	10				8	14		1		2	4	4	6		
10		5	4	24			6	22			6	8		1								
Total	15	28	108	180	10	5	124	157	20	26	60	99	2	23	0	5	11	13	45	45	22	5

*Indicates first transcript

**Indicates second transcript made one year later

TABLE 2
PER CENT OF FREQUENCY OF VOWELS

Subject	i		I		e		ε		ɛ		^		a		ɔ		o		u		u	
	1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	2	2	52	41			14	5	21	48	12		2				2	16	2	2		
2		2	10	5			40	34		2	50	16		9			4		7	16		12
5	5	12	29	28	5	2	44	34	2		10	22										
4	8	11	18	21	4	4	4	7	2	2	12	16	2	7		4	21	7	21	17	8	4
5	5		52	41			14	17			7	26		7					24	7		2
6	2		21	75	10		42	22	2		2	5						14			7	
7	7	2	52	58			15	30	19		7	30										
8	2	7	21	34	4		55	37				10		7					8	5	10	
9	8		14	18			55	25			29	35			2		5	14	15			
10		5	24	41			58	56			58	14		2								

* Indicates first transcript

**Indicates second transcript made one year later

opment and in this respect resembles the speech of infants under twelve months of age.

The data assembled in the tables furnish answers to the question: How many of the vowel and consonant elements appearing in adult English speech do these feeble-minded children use? The following tabulation gives the number of subjects using each vowel sound.

Vowels	i	I	e	ε	ɛ	^	a	ɔ	o	u	u
Number of Subjects	8	10	4	10	5	10	6	2	4	8	6
Using Vowel Sound											

It may be seen that all ten use the sounds I, ε, and ^. The range is from 2 to 10. It is apparent from the tabulation that fewer of these feeble-minded children use back vowels than front vowels.

There are in adult English speech approximately thirteen vowel sounds (broad transcription). These feeble-minded children have not mastered the use of all of them. The matter is explicated in the next tabulation.

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TABLE 3

FREQUENCY OF CONSONANTS

Subject	1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
1			3		13	2									3		13	17	5	24	
2				1				1							1		14			3	
3				1		3	5	6											2		
4	5	5	1	3		4		2				1		5			1		5	10	
5			2	13											5		2		2	14	
6						1															
7						3														4	
8						5	5												1	4	
9						6														1	
10																				3	
Total	5	5	6	18	13	29	8	9		1	3			1	3	8	13	30	44	12	40

Subject	1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2			
1																1				1	2		
2									5							5				2	3		
3																2	2			6	3		
4	2	5			2	1			1	4		2		2	2	11	5	3	4	4	9		
5		8		3									10							22	1		
6															2					12	14		
7					1															11	3		
8				1															1	5	20		
9																				2	7		
10											2									22	12		
Total	2	13		5	2	1			4	4		2	2	14	11	12	5	12	1	64	80	3	23

* Indicates first transcript

**Indicates second transcript made one year later

TABLE 4

PER CENT OF FREQUENCY OF CONSONANTS

Subject	1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2		
1					9	37	4								9		56	37	9	51		
2					2				19								35	39		8		
3					4		12	27	25											8		
4	9	6	5	4		6		3		1			4			1		15	14	6	11	
5			9	24											6					26		
6						6																
7						36															18	
8						14	45													10	11	
9						40														6	14	
10																					100	10

Subject	1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
1																2				2	4
2									8							14				66	8
3																8				55	12
4	6	6			6	1			3	6		3	18	8		25	10	9	6	13	12
5		14												18						91	2
6																				86	83
7					5															100	14
8					3															45	55
9																				40	48
10											5									55	30

* Indicates first transcript

**Indicates second transcript made one year later

Subject Number	1	2	3	4	5	6	7	8	9	10	Average
Number of Vowels	9	9	8	11	7	8	5	8	7	5	7.7

Subject 4 uses 11 of the full number of vowels. He is the child whose speech exhibits a degree of meaningful patterning. The fewest number of vowel sounds used by any of these cases is 5. The average for

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the group is 7.7 vowels.

In adult speech about 24 consonant sounds occur. In the following tabulation may be seen how many feeble-minded subjects use each of them.

Consonants	P	b	m	w	M	f	v	θ	ʒ	t	d	ŋ
Number of Subjects Using Consonant Sound	1	5	7	4	0	1	1	0	2	3	6	7
Consonants	s	z	ʒ	ʒ	l	ʁ	j	ʁ	g	ŋ	h	ʔ
Number of Subjects Using Consonant Sound	2	3	1	0	2	1	3	2	5	1	10	6

The range is from 0 to 10. Three of the consonants are not used by any of the children. These are M, θ, and ʒ. The sound h is used by all.

The number of consonants articulated by each of the ten subjects appears below.

Subject Number	1	2	3	4	5	6	7	8	9	10	Average
Number of Consonants	8	9	9	17	8	4	5	7	4	4	7.5

Again Subject 4 leads with 17 consonants in his repertoire. The range is from 4 to 17 consonants. The average for the group is 7.5.

The vowel-consonant ratio may be taken as a convenient index of developmental status of speech. Since there are about 13 vowels to 24 consonants in adult speech, the vowel-consonant ratio for mature speech is 1 to 2. The next tabulation includes vowel-consonant ratios for each of the ten children and for the group as a whole.

Subject Number	1	2	3	4	5	6	7	8	9	10	Group
$\frac{v}{c}$	$\frac{9}{8}$	$\frac{9}{9}$	$\frac{8}{9}$	$\frac{11}{17}$	$\frac{7}{8}$	$\frac{8}{4}$	$\frac{5}{5}$	$\frac{8}{7}$	$\frac{7}{4}$	$\frac{5}{4}$	$\frac{7.7}{7.5}$ or 1

Of the ten cases only three have vowel-consonant ratios less than 1, two have ratios of 1, and five are greater than 1. None of the ten shows the mature ratio of 1 to 2. For the group as a whole the vowel-consonant ratio is 1.

The following tabulation gives the vowel-consonant ratio for newborn infants, for the ten feeble-minded cases, and for mature speech.

	Vowels average	Consonants average	Ratio
Newborns	2.7	2.2	3 to 2
Feeble-minded (Mean age = 4 years)	7.7	7.5	1 to 1
Adults	13.0	24.0	1 to 2

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Another suggestive index of speech development is the vowel ratio. It is based on the relation of the per cent of frequency of front vowels to the sum of the per cents of frequencies of middle and back vowels. In month-old infants (2) front vowels constitute about 80 per cent of all vowels spoken, whereas middle and back vowels amount to 20 per cent of the total. In adult speech front vowels constitute 50 per cent, and middle and back vowels also 50 per cent (6). It is evident therefore that a fundamental process of development in early speech consists of the mastery of back vowels.

In order to indicate speech retardation, the vowel ratio may be applied to speech data of feeble-minded children. Table 5 presents the vowel ratios of each of the ten children for the first transcript as well as for the second one taken a year later. The values are in terms of per cents.

It will be noted that most of these ratios of front to middle and back vowels deviate greatly from that of normal adult speech. In only two cases is the ratio comparable to that of adult speech. Both transcripts for Subject 2 show the fifty-fifty relationship. The second transcript of Subject 4 also shows this proportion. The tabulation gives the per cents and the ratios for the group as a whole at the beginning and at the end of the year.

	Per Cents		Ratio	
	First	Second	First	Second
Front	$\frac{66}{34}$	$\frac{67}{33}$	$\frac{2}{1}$	$\frac{2}{1}$
Middle + Back				

There can be no doubt that in the ratio of front to middle and back vowels the group as a whole has made no progress whatever, although one case did show improvement.

It would be of value to compare this result on low-grade feeble-minded with the progress during the course of a year which might possibly be made in speech status of high-grade feeble-minded children such as morons and borderline cases. Such data are not available. However, our work on infant speech sounds has advanced far enough to make tentative comparisons which may be helpful in determining approximately the developmental position of this group of feeble-minded children.

The following tabulation gives the vowel ratios for one-month infants (2), for the ten feeble-minded cases, for six-month infants (5), and for adults (6).

Subjects	Per Cent		
	Front	Middle + Back	Ratio
One-month	80	20	4 to 1
Feeble-minded (Mean age = 4 years)	67	33	2 to 1
Six-months	55	45	1 to 1 (Approximately)
Adults	49	51	1 to 1

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TABLE 5

Vowel Group	Subject	Transcript	
		First	Second
Front Middle+Back	1	$\frac{69}{31}$	$\frac{96}{4}$
Front Middle+Back	2	$\frac{49}{51}$	$\frac{50}{50}$
Front Middle+Back	3	$\frac{83}{17}$	$\frac{77}{23}$
Front Middle+Back	4	$\frac{15}{85}$	$\frac{48}{52}$
Front Middle+Back	5	$\frac{66}{33}$	$\frac{57}{43}$
Front Middle+Back	6	$\frac{77}{23}$	$\frac{97}{3}$
Front Middle+Back	7	$\frac{92}{8}$	$\frac{70}{30}$
Front Middle+Back	8	$\frac{91}{9}$	$\frac{69}{31}$
Front Middle+Back	9	$\frac{57}{43}$	$\frac{42}{58}$
Front Middle+Back	10	$\frac{62}{38}$	$\frac{84}{16}$

Thus a series of ratios such as the above establishes the approximate position in development of these feeble-minded children.

A useful graphic method for the simultaneous presentation of central tendencies in the dispersion of speech sounds is the profile (2). The method may be applied to the vowel and consonant production of the ten feeble-minded children in order to give an account of the distribution of these elements. Vowel and consonant profiles are found in Figures 1 and 2 in juxtaposition with other developmental data.

Figure 1 comprises three profiles comparing the vowel status of feeble-minded children with that of six-month infants and with adults.

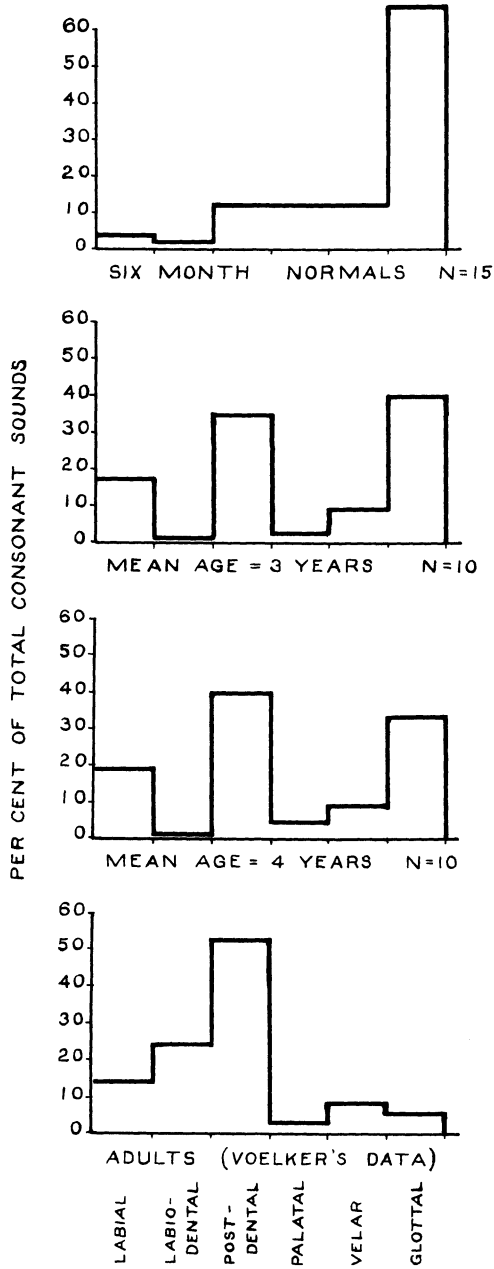
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VOWEL DISPERSION

FIGURE 1

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CONSONANT DISPERSION

FIGURE 2

It will be apparent that there is little difference between the patterns of distribution at three years and at four years of the group of feeble-minded cases. Moreover, it is noteworthy that the concentration within each of the first three profiles is toward the left, that is, toward the front vowel sections of the profiles. Thus a profile of the dispersion of vowel sounds in the speech of the feeble-minded resembles that of six-month children much more than it does that of adult speech in which the distribution is about equal on both halves of the profile.

Figure 2 compares the two consonant profiles of the feeble-minded subjects with that of six-month infants and with that of adults. Here, too, there is little difference between the patterns of consonant distribution at the beginning and end of the year. There is a heavy concentration of elements in the glottals in the consonant articulation of infants. In adult speech concentration is largely in the labials and dentals. However, in the speech of the feeble-minded subjects consonant articulation is mainly in the labials, the post-dentals, and the glottals. Whereas among infants the consonant dispersion shows a concentration to the right of the profile, in the adult the concentration is to the left. This suggests that the problem of speech development in regard to consonants during the early stages of life is concerned to a great extent with a mastery of the articulation of labials and dentals. In this connection the status of the feeble-minded is interesting. Their profiles show an increment among the labials and dentals part way along the course of development. Glottal sounds are less frequent than in the case of the infants, but more frequent than in adults. The dominance of the post-dentals, characteristic of adults, has not been achieved. In a word, the infant and adult profiles are each unimodal with the modes at opposite ends, while the profiles for the feeble-minded definitely exhibit a trimodal type of distribution.

Although these data comprise only a segment of a broader research in the immature stages of human speech development, there are some conclusions which may reasonably be inferred from them. These are:

1. Feeble-minded children use back vowels more infrequently than front vowels. In this respect their speech resembles that of young infants rather than that of adults.

2. In consonant articulation the dispersion is trimodal whereas in young infants and adults the distributions are unimodal. The feeble-minded show a concentration in the labial, post-dental, and glottal regions while infants show the greatest piling up among the glottals, and adults among the post-dentals.

3. The ratio of vowels to consonants in the speech sounds of this group of feeble-minded children is 1, whereas that of mature speech is 1 to 2. None of the ten subjects exhibits the mature ratio.

4. The developmental status of the speech sounds of the group of four-year-old feeble-minded children approximates that of normal children less than one year of age.

5. The vowel ratio, the vowel-consonant ratio, and the profile are suitable tools for analyzing the speech sound status of retarded children.

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