

XVI. LINGUISTICS

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A. PLAYING WITH DISTINCTIVE FEATURES IN THE BABBLING OF INFANTS

In this report I shall describe the data obtained all on one day, consisting of the utterances of an infant, aged 403 days.¹ We shall discuss the utterances in an attempt to discover what if any patterns exist among them. It will be seen that significant patterns do exist when distinctive features are referred to,² and further theoretical implications of these patterns will be touched upon.

The following sequences of more than one syllable were found in the babbling of Mackie at the age of 403 days. This corresponds to an advanced stage of babbling. Approximately six weeks later the babbling has greatly decreased, and the child makes much simpler and much less frequent sequences of sound. It appears that the child at this later stage is speaking language, as opposed to babbling which is intentional, but not meant to be intelligible, sequences of sound. Utterances at this later stage, if and when produced, for the most part correspond to morphemes of English.

The largest number of sequences of more than one syllable consisted of any number of syllables beginning with a nonGrave segment, followed by any number of syllables beginning with a Grave segment. Here, a syllable is defined rather loosely, because

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of possible great complexity in the initial nonVocalic segment, and because of the difficulty in ascertaining the presence of a vowel between nonVocalic segments at times. In general, however, a syllable is a sequence consisting of a nonVocalic segment followed by a Vocalic segment, possibly augmented by one or more glides. When a particular segment is colored, either at the onset or the offset, by the features of some other type of segment, the symbol indicating the coloring segment is raised from the line.

Such sequences of nonGrave syllables followed by Grave ones are exhaustively listed below:

1.		nonGrave	Grave					
	ye	dew	tæ	gə	w ^v ə			
		dey	dæ	gə	w ^v ə			
			dæ	gi	v ^w əy			
			yi	p				
			ye	mp				
			ye	ge	v ^w i			
	yeh	yo	wey					
		də	we	gi	we	gi	we	gi
		yə	gə	m:				
	ye	ye	gi	v ^w ih				
		də	we	gi	gi	wi	wi	ge
	de	yə	wa					
		nə	m ^v					
	də ^r	tə	m	v ^v gə ^r				

Next we see that there were sequences consisting only of nonGrave syllables, which are listed below:

2.		nonGrave	
	yə ^l	do	dəh
		do:	yo:
	ə ^r	dey	day ti
	də	do	

In addition there are sequences of syllables beginning with only Grave segments:

3.		Grave	
	ge	v ^w iy	
	ge	v ^w i	
	ge	v	
m	ngi	v ^w eh	
m	ngo		
	bə	w ^v ə	
m	ba	wə	
way	be	b	
way	w:		
mə	mə	wə	

No sequences of syllables beginning with a Grave segment followed by a sequence of syllables beginning with a nonGrave segment occur. (There are two exceptional cases: e wi na and go we dæ. These two cases are exceptional in that they have the segments /n/ and /d/, the voiced fricative, both of which occur very seldom in sequence. After our analysis we shall be able to handle these two cases.)

Consequently we see that we have the generality up to this point that every babbling sequence consists in any number of nonGrave syllables followed by any number of Grave syllables, including zero as a possible number of syllables. We also get sequences of all sorts consisting of only one syllable, which will also follow from the generalization above.

We have also on this day, sequences consisting of syllables beginning with /h/, followed by any number of syllables beginning with a nonGrave segment, as below:

4.	/h/	nonGrave	
	hə	yə	
	hə	yə	
	he ^w	hə	yo
	he	dyo	dyəy
	he	y ^ə a ^w	

There is a couple of sequences consisting of an /h/ followed by a nonGrave syllable, followed by a Grave syllable:

5.	/h/	nonGrave	Grave
	ha	ye	gə
	hə	y:	w:

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Although there were no sequences consisting of /h/ followed by a Grave syllable, we shall have evidence to include that as a possibility later. Consequently we can elaborate our generalization to say that a babbling sequence consists of any number of /h/-initial syllables, followed by any number of nonGrave-initial syllables, followed by any number of Grave-initial syllables. In other words, we have a set of sequences corresponding to a finite-state language, expressed by the formula:

$$f-1. \quad [h]^* [\text{nonGrave}]^* [\text{Grave}]^*$$

There were only four sequences in the data which appeared to be real exceptions to f-1. These are

6. Exceptions

wə	heh
næ	hæ
da:	ho:
ga	he f ^l w _o

Apparent exceptions only, however, are the very long sequences:

7. Apparent Exceptions

hey	də	b ^v ə	də	b ^v ə			
hə		b ^w i	de	wi		de	wə
h	wi	b ^w e	də	bi		de	bi we
ha	yə	go	ha	yə	wə		
	yə	v ^w ə	yə	v ^w ə		yə	
	de	wa	də	gɔ	ge		

It seems that these sequences may be treated as repetitions of the formula f-1. In favor of this is the length of these sequences and some very apparent iterative characteristics about them.

If we allow f-1., to be repeated, however, and since single syllables do occur, we in fact allow anything at all to occur. What will save this from being vacuous would be some evidence, such as intonation or pause, which would necessitate the postulation of a sequence boundary. This will be investigated. Even without this, however, we could predict that the utterances that follow the rule given above are far more numerous than those that do not.

Note in the repetitions of 7., we have two instances of an /h/ followed by a Grave sequence, so that we are corroborated in including this possibility in the generalization above.

If rule f-1. represents a reality of the infants babbling, it is reasonable to ask what in fact the infant is doing on a more explanatory level. What we can say is that the initial segments of syllables increase in markedness from beginning to end in the sequence. A segment unmarked (u) for some feature is said to take the simplest or least effort value for that feature; a segment marked (m) for some feature takes the more complex value for that feature. Which is the marked and which is the unmarked value of a given feature is a question of universal grammar.

It has been postulated that /h/ represents a segment marked only for the feature Vocalic, being unmarked in all others. /y/ is marked for Sonorant and /d/ is marked for Consonantal, both being marked for Vocalic. Hence /y/ and /d/ have two marks, Vocalic and Consonantal or Sonorant. In a parallel fashion, /w/, /g/, and /b/ have three marks, differing from the others in being marked for the feature Grave. Thus /h/ is less marked than /y/ or /d/; and /y/ or /d/ is less marked than any of /w/, /g/, or /b/.³

The universal rules for interpreting markedness (m's and u's) in terms of feature values (+s and -s) for the features indicated here are:

r-1	[m Vocalic]→[- Vocalic]
	[u Vocalic]→[+ Vocalic]
	[m Sonorant]→[+ Sonorant]
	[u Sonorant]→[- Sonorant]
	[m Consonantal]→[+ Consonantal]
	[u Consonantal]→[- Consonantal]
	[m Grave]→[+ Grave]
	[u Grave]→[- Grave]

In particular, we have the following:

r-2	<u>1 Mark</u>		
	$\begin{bmatrix} \text{m Vocalic} \\ \text{u Sonorant} \\ \text{u Consonantal} \end{bmatrix}$	→	$\begin{bmatrix} \text{-Vocalic} \\ \text{-Sonorant} \\ \text{-Consonantal} \end{bmatrix} = /h/$
	<u>2 Marks</u>		
	$\begin{bmatrix} \text{m Vocalic} \\ \text{m Sonorant} \\ \text{u Consonantal} \\ \text{u Grave} \end{bmatrix}$	→	$\begin{bmatrix} \text{-Vocalic} \\ \text{+Sonorant} \\ \text{-Consonantal} \\ \text{-Grave} \end{bmatrix} = /y/$
	$\begin{bmatrix} \text{m Vocalic} \\ \text{u Sonorant} \\ \text{m Consonantal} \\ \text{u Grave} \end{bmatrix}$	→	$\begin{bmatrix} \text{-Vocalic} \\ \text{-Sonorant} \\ \text{+Consonantal} \\ \text{-Grave} \end{bmatrix} = /d/$

3 Marks

$$\begin{array}{l}
 \left[\begin{array}{l}
 m \text{ Vocalic} \\
 m \text{ Sonorant} \\
 u \text{ Consonantal} \\
 m \text{ Grave}
 \end{array} \right] \rightarrow \left[\begin{array}{l}
 -\text{Vocalic} \\
 +\text{Sonorant} \\
 -\text{Consonantal} \\
 +\text{Grave}
 \end{array} \right] = /w/ \\
 \\
 \left[\begin{array}{l}
 m \text{ Vocalic} \\
 u \text{ Sonorant} \\
 m \text{ Consonantal} \\
 m \text{ Grave}
 \end{array} \right] \rightarrow \left[\begin{array}{l}
 -\text{Vocalic} \\
 -\text{Sonorant} \\
 +\text{Consonantal} \\
 -\text{Grave}
 \end{array} \right] = /g, b/
 \end{array}$$

Intuitively, then, what this seems to mean is that the child begins an utterance with a certain degree of markedness, which he may increase in subsequent syllables of the sequence. The child may be thought of as playing a game, which consists of adding more commands to the syllable, producing more complex initial segments, for syllables toward the end of the sequence.

Several of the exceptions, such as e wi na and go we dæ, can now be seen not to be exceptions at all, since nasality, when it appears, must be marked, as must continuity. Thus markedness still increases from left to right.

J. S. Gruber

References

1. Material for this study comes from the longitudinal investigations headed by Margaret Bullowa, M.D., entitled "Development from Vocal to Verbal Behavior in Children," NIH Grant MH 04300-01-04.
2. These are the distinctive features postulated in R. Jakobson, M. Halle, and C. G. M. Fant, "Preliminaries to Speech Analysis," Technical Report No. 13, Acoustics Laboratory, M. I. T., 1952.
3. I am indebted to Richard Carter for having pointed this out to me. The revitalization and reinterpretation of the Prague School notion of markedness is due to Morris Halle.

B. SYLLABLE FINALS IN CHINESE PHONOLOGY¹

The crucial fact to be captured concerning the Chinese monosyllable is the unity of its structure and function. The Chinese tradition will be followed here in assuming the underlying form of the monosyllable to consist of two 'segments', an initial and a final. For the purposes of this discussion, the feature analysis of initials given by Hashimoto¹ will be adopted, unless otherwise stated. We shall return briefly to the initials after a consideration in detail of the content of the finals.

The final will contain features specifying the tone of the monosyllable. Gruber³ has suggested a set of features to handle such phenomena, and his formulation will be assumed here. The final will also contain the feature + or - compact, which will result in two classes of finals, with e (a mid central vowel) and with a (a low central vowel).

The final will contain the features + or - flat and + or - sharp, and the grammar will contain a phonological rule of the following sort:

$$a. \begin{bmatrix} \alpha \text{ compact} \\ \beta \text{ flat} \\ \gamma \text{ sharp} \end{bmatrix}_1 \rightarrow \begin{bmatrix} \beta \text{ flat} \\ \gamma \text{ sharp} \end{bmatrix}_1 \left[\begin{array}{c} \\ \\ \\ \end{array} \right]_1 / \text{---} +^4$$

Rule a. then creates a new 'segment' between the initial and the final which agrees in flatness and sharpness with the final. An additional rule will be needed, since only three such medials actually appear:

$$b. \begin{bmatrix} -\text{flat} \\ -\text{sharp} \end{bmatrix} \rightarrow \phi$$

The final may also contain the features + or - grave and + or - nasal, and analogously the phonology will contain:

$$c. \begin{bmatrix} \alpha \text{ compact} \\ \beta \text{ grave} \\ \gamma \text{ nasal} \end{bmatrix}_1 \rightarrow \begin{bmatrix} \\ \\ \\ \end{bmatrix}_1 \left[\begin{array}{c} \beta \text{ grave} \\ \gamma \text{ nasal} \end{array} \right]_1 / \text{---} +$$

Rule c., like Rule a., results in the creation of a new 'segment', this time following the final, agreeing in gravity and nasality. Rules a. b. and c. will produce a set of finals as in Table XVI-1.

Table XVI-1 contains 40 distinct finals; since there exist but 33 in fact,⁵ some further rules will be required. They fall into the morpheme structure category, and must apply before Rules a. b. and c.

Table XVI-1. Set of finals produced by rules a, b, and c.

e	a	ei	ai	eu	au	en	an	eng	ang
ie	ia	iei	iai ₂	ieu	iau	ien	ian	ieng	iang
ue	ua	uei	uai	ueu	uau ₂	uen	uan	ueng	uang
üe	üa	üei ₁	üai	üeu	üau ₁	üen	üan	üeng	üang ₃

where

i-	is	$\begin{bmatrix} -\text{flat} \\ +\text{sharp} \end{bmatrix}$	-i	is	$\begin{bmatrix} -\text{grave} \\ -\text{nasal} \end{bmatrix}$
u-	is	$\begin{bmatrix} +\text{flat} \\ -\text{sharp} \end{bmatrix}$	-u	is	$\begin{bmatrix} +\text{grave} \\ -\text{nasal} \end{bmatrix}$
ü-	is	$\begin{bmatrix} +\text{flat} \\ +\text{sharp} \end{bmatrix}$	-n	is	$\begin{bmatrix} -\text{grave} \\ +\text{nasal} \end{bmatrix}$
			-y	is	$\begin{bmatrix} +\text{grave} \\ +\text{nasal} \end{bmatrix}$

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- d. $\begin{bmatrix} -\text{nasal} \\ +\text{flat} \end{bmatrix} \rightarrow [-\text{sharp}]$
- e. $\begin{bmatrix} -\text{nasal} \\ a \text{ flat} \\ -a \text{ sharp} \\ \beta \text{ compact} \end{bmatrix} \rightarrow [\beta \text{ grave}]$
- f. $\begin{bmatrix} +\text{grave} \\ +\text{nasal} \\ +\text{sharp} \\ +\text{compact} \end{bmatrix} \rightarrow [-\text{flat}]$

Rule d. will exclude box 1 in Table XVI-1; Rule e., boxes 2; and Rule f., box 3.

Additional rules will be needed to approximate more closely the phonetic reality of various finals. The following are suggested.

- g. $\begin{bmatrix} a \text{ flat} \\ \beta \text{ sharp} \end{bmatrix} \rightarrow [+vocalic] / \text{---} [-\text{compact}] \left\{ \begin{array}{l} [+nasal] \\ [a \text{ grave}] \end{array} \right.$
- g'. $\begin{bmatrix} +\text{flat} \\ +\text{sharp} \end{bmatrix} \rightarrow [+vocalic] / \text{---} [\text{compact}]$
- h. $[\text{+compact}] \rightarrow [-\text{compact}] / \left\{ \begin{array}{l} [+sharp] \\ [+flat] \\ [+sharp] \end{array} \right. \begin{array}{l} [+nasal] \\ [-grave] \end{array}$
- i. $\begin{bmatrix} -\text{compact} \\ -\text{vocalic} \end{bmatrix} \rightarrow \phi$

Rules g. and g'. affect the assignment of the feature vocalic, which operates through a simple marking convention: 1) the segment specified for compactness is + vocalic if there are no other segments so marked in the syllable; 2) all segments not + vocalic are - vocalic. This could of course be stated in the form of rules (which would come between g'. and h.) but the conventional interpretation seems quite natural here. Table XVI-2 shows the results of Rules g. through i.

Table XVI-2. Finals produced by rules g, h, and i.

e	a	ei	ai	eu	au	en	an	eng	ang
ie	ia	i		ieu	iau	in	ien	ing	iang
ue	ua	uei	uai	u		un	uan	ung	uang
$\boxed{\ddot{u}}$	üe					ün	üen	üng	

Though more rules will be required to fill in and adjust the exact qualities of the various segments, in particular the non-compact vowels,⁶ familiar ground has been achieved. The rules will, among other things, replace the features on the main vowels 'left over' from rules a. and c. These features do not embarrass any of the later rules written above, but care will clearly be needed in their adjustment.

The general implications of the proposed analysis will now be evident. The part most in need of justification is the 'segment-creating' Rules a. and c. Of course there is nothing unprecedented in the elements that compose these rules: segment creation is an unavoidable aspect of any epenthetic phenomenon, and assimilation of epenthetic elements is familiar enough. So it would perhaps be difficult to exclude Rules a. and c. on any principled basis from present assumptions on the nature of phonology.

On the other hand, it is clear that unusual effects are obtained by the application of Rules a. and c. which ought to require a real evaluational gain to justify. Rule d., for example, plainly owes its simplicity to a. and c. Rule e. is a less clear case: if one accepts Table XVI-1 as an underlying stage, it too shows a simpler statement than could be arranged over three segments; but the value of Table XVI-1 as a real stage might be undermined in the absence of a. or c. Rule f. would presumably be equally costly in any case, and one might choose to consider the nonoccurrence of box 2 in Table XVI-1 merely an accidental gap in the Chinese lexicon.

Rules d. e. and f. provide only minimal justification, however. A more significant test will be a good solution to the complex restrictions which apply between initials and finals, a question not gone into in detail here. In particular, it has been promisingly suggested by T. R. Hoffman that the medial feature sharp is predictable under a proper analysis of the initials, and can therefore be eliminated from the final.

Under the assumption that Rules a. and c. are legitimate, there remain some difficulties in the analysis which must be pointed out. The primary one is the handling of those finals in which Rule c. does not apply (the two leftmost columns of Tables XVI-1 and XVI-2). The solution adopted has the effect of making the nonspecification of certain features distinctive. This has been judged preferable to the introduction of an ad hoc feature. The fact remains that the treatment of 5 distinct elements with binary features is troublesome. This may affect the analysis further in the apparent inability in incorporate Rule g'. into Rule g., where by all rights it should be. Rule g'. applies significantly to a single final, that boxed in Table XVI-2, which is one of the cases in question. It is not, however, clear that any ad hoc feature to allow a better statement of Rule c.

G. D. Bedell IV

Footnotes and References

1. This paper is a preliminary and abbreviated version of one chapter of a longer paper, tentatively entitled "An Essay on Chinese Phonology." The other chapters discuss the Chinese phonological tradition, 'phonemic' analyses, and some typological implications of the problem.
 These remarks have profited from the criticisms of G. H. Matthews, T. R. Hoffman, B. K. T'sou, and other participants in the Chinese seminar at Massachusetts Institute of Technology in 1964-1965 and 1965-1966.
2. M. J. Hashimoto, Phonological Rules in Mandarin – Synopsis, 1964, p. 5.
3. J. S. Gruber, The Distinctive Features of Tone (Cambridge, 1964).
4. The symbol + in rules is used to denote a syllable boundary. It is quite likely redundant, and will not need to appear in the underlying representation.
5. Left out of account is the final r as clearly outside the system discussed.
6. The final -y is considered an instance of -i.

C. TRANSITIVE SOFTENING IN RUSSIAN

The fundamental role in Russian morphology of a truncation rule (Rule C' below) which elides vowels before vowels was discovered by Jakobson.¹ Halle then showed² that the occurrence of so-called transitive softening in the conjugation in cases such as (1-4) below is determined by a simple rule (Rule A below) on the basis of the sequence of vowels in the underlying representation of verb forms. He proposed that (A) and (C'), in that order, applied in a transformational cycle to verb forms, for which he assumed the following constituent structure:

((ROOT + VERB SUFFIX + TENSE) + DESINENCE)

A further result was obtained by Lightner.³ He demonstrated that forms such as (5-8) are also regular because a rule of glide formation (B), which replaces prevocalic short u, i with their corresponding glides w, j, intervenes between (A) and (C'). In Lightner's formulation, the three cyclical rules are essentially as follows:

(A) $V \rightarrow j \ / \ _____ + V$

(B) $i, u \rightarrow [-\text{vocalic}] \ / \ _____ V$

(C) $V \rightarrow \phi \ / \ _____ + V$

Derivations:

	(1) <u>pišet</u> ((pis+o+e)+t)	(2) <u>pisu</u> ((pis+o+e)+U)	(3) <u>sidit</u> ((sid+e+i)+t)	(4) <u>sizu</u> ((sid+e+i)+U)
I A	(pis+j+e)	(pis+j+e)	(")	(")
B	(")	(")	(")	(")
C'	(")	(")	(sid +i)	(sid +i)
II A	(pis +j+e+t)	(pis+j+e +U)	(sid +i +t)	(sid +j +U)
B	(")	(")	(")	(")
C'	(")	(pis+j +U)	(")	(")
	(5) <u>kujot</u> ((kou+o+e)+t)	(6) <u>kuju</u> ((kou+o+e)+U)	(7) <u>lovit</u> ((lou+i+i)+t)	(8) <u>lovlju</u> ((lou+i+i)+U)
I A	(kou+j+e)	(kou+j+e)	(")	(")
B	(")	(")	(low+i+i)	(low+i+i)
C'	(")	(")	(low +i)	(low +i)
II A	(kou+j+e +t)	(kou+j+e +U)	(low +i +t)	(low +j +U)
B	(")	(")	(")	(")
C'	(")	(kou+j +U)	(")	(")

Now note first that rule (C') can be generalized by allowing vowels to elide before all nonconsonantal segments, that is, before glides as well as vowels, provided that the elided vowel is flanked by morpheme boundaries:

$$(C) \quad V \longrightarrow \phi \quad / \quad + \text{_____} + [-\text{consonantal}]$$

It will be seen that all verb forms dealt with by Halle and Lightner can still be derived as above if (C) is substituted for (C').

More important, however, is the fact that this simpler version (C) of the truncation rule, unlike (C'), does not require the constituent structure for the verb forms which has been described here. Indeed, with this change rules (A-C) no longer critically depend on the correctness of any particular syntactic analysis at all. This is because the correct phonetic forms are obtained if rules (A-C) apply postcyclically to a string whose internal constituent structure has been erased. Thus, consider examples (1-8) anew. Derivative nouns like *lovlja* are derived in the same way: e.g., *lou+i+o* \longrightarrow (B) *low+j+o*.

The proposed generalization of the truncation rule, if correct, strengthens the case for Halle's rule for transitive softening by making its validity immune to the outcome of still unsolved problems concerning the correct assignment

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	(1) <u>piset</u> pis+o+e+t	(2) <u>pisu</u> pis+o+e+U	(3) <u>sidit</u> sid+e+i+t	(4) <u>sizu</u> sid+e+i+U
A	pis+j+e+t	pis+j+e+U	"	sid+e+j+U
B	"	"	"	"
C	"	pis+j +U	sid +i+t	sid +j+U
	(5) <u>kujot</u> kou+o+e+t	(6) <u>kuju</u> kou+o+e+U	(7) <u>lovit</u> lou+i+i+t	(8) <u>lovlju</u> lou+i+i+U
A	kou+j+e+t	kou+j+e+U	"	lou+i+j+U
B	"	"	low+i+i+t	low+i+j+U
C	"	kou+j +U	low +i+t	low +j+U

of derived constituent structure in morphology.

R. P. V. Kiparsky

References

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3. T. M. Lightner, "O tsiklicheskih pravilakh v russkom sprjazhenii," *Voprosy Jazykoznanija* 2, 45-54 (1965); "Segmental Phonology of Modern Standard Russian," Ph. D. Thesis, Department of Modern Languages and Linguistics, M. I. T., 1965.