DOCUMENT RESUME

ED 030 098 AL 001 858

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Spons Agency-American Council of Learned Societies, New York, N.Y.; Social Science Research Council, Washington, D.C.

Pub Date 29 Dec 68

Note-24p.. Slightly expanded version of a paper presented at the 43rd Annual Meeting of the Linguistic Society of America, New York City, December 29, 1968.

EDRS Price MF-$0.25 HC-$1.30

Descriptors-*Child Language, Consonants, *Distinctive Features, Early Childhood, *English, *Language Development, Language Learning Levels, Language Patterns, Language Typology, Phonemes, Phonetic Analysis, *Phonology, Vowels

The phonologies of three English-speaking children at approximately two years of age are examined. Two of the analyses are based on published studies; the third is based on observations and recordings made by the author. Summary statements on phonemic inventories and on correspondences with the adult model are presented. For the third case, fairly detailed phonetic and distributional data are also utilized. The paper attempts to draw conclusions about typical difficulties of phonological development at this stage and possible strategies used by children in attaining the adult norms. (Author/JD)

THE TWO-YEAR-OLD STAGE IN THE ACQUISITION OF ENGLISH PHONOLOGY[1]

Arlene I. Moskowitz

0. Introduction. It is a widely held view among linguists and psycholinguists that the phonology of a child's speech at any stage during the acquisition process is structured.[2] Such structure, however, has not been well documented in the past. This paper is an attempt to find and present the phonological structure of three children at age two.

One approach is an analysis of substitutions, or sets of correspondences between the child's renditions and the utterances of the adult model. Such an approach is able to reveal much information about phonetic structure, distribution, and particular problems which the child is encountering and overcoming at the moment. Another is a phonological analysis, potentially more revealing of structure, but encompassing many more theoretical problems. To be most useful, the resultant phonology should fit into a series of phonologies, each of which describes an independent stage with segmental and rule structure, and the totality of which presents a unified picture of the development of segmental and rule structure from the post-babbling stage to the full mastery of English phonology.[3] (Note that such a developmental sequence may not be uni-dimensional in detail, in the sense that the child may attempt to work with incorrect hypotheses which are later rejected, or may regress at times.)

The first of these two approaches is parallel to the linguistic study of borrowing. The types of changes a child makes in "borrowing" words from the language of the environment are as revealing of the borrower's phonological structure as are the changes language X

imposes on the borrowed words of language Y. Likewise, a series of phonologies covering a period of several years in the life of a particular child can be treated as a special case of the study of internal diachronic history.

The writing of a phonology for a child's speech is especially problematic because there are no existent theories which can be directly applied. Certainly we do not want to attribute to the very young child the complicated rule structure which generative phonology[4] employs to describe mature speech; the vocabulary of a two-year-old, for example presents little if any of the morphological evidence which would justify such asolution. Likewise, bi-unique autonomous phonology[5] is not only inadequate for the description of data of this type (which is highly variant and is produced under a linguistically unusual set of articulatory constraints), but may obscure much of the structure we are trying to reveal. Consider the typical requirement of such a theory that no two phonemes may both have an identical phone as an allophone. Such a requirement apparently led Ruth Weir (1962) to the conclusion that her son had no /θ/ in his structure because every word in which [θ] occured had a variant pronunciation with either [f] or [t], and therefore the phonemicization of such words must include either /f/ or /t/. This solution is only a partial satisfaction of the requirement anyway, as the dental spirant is an allophone of two phonemes, and it obscures the fact that those (and only those) words in which the child has such alternations happen to have as their model from the adult language words with /θ/

and not with /f/ or /t/.[6]

Since the value of phonologies of children's speech lies in their display of the progression of structure, new methods of phonological analysis and new evaluation criteria will have to be developed. The procedures of the present study are somewhat ad hoc and atheoretical; work during the coming years should produce more information about the required methods and criteria.

1. Mackie. The data for the first child are taken from the corpus in Albright and Albright (1956). The corpus consists of 232 utterances transcribed in a notation which seems to be a hybrid of Smith-Trager phonemic notation for English and IPA. The child, whom we will call Mackie, was 26 months old at the time of recording; he was the older of two male children. Parents and child are native speakers of English.

Although the form of transcription chosen obscures much of the relevent information about Mackie's vowel system, it reveals a sufficient amount of information about the consonants to allow a substitution analysis (see Table 1).

In general, consonants are less stable in final position than either initially or medially. Omissions occur in final position comparativelyoften, while in initial and medial positions substitutions are made frequently and omissions are rare. For example, Table 2 shows the percentages of correct correspondances, incorrect substitutions, and omissions totaled over all stop consonants.

If we think of the English consonant system as consisting of 24 phonemes, then Mackie has substantially acquired 19 of them, is

in the process of acquiring three (/v/, /z/, and /ð/), and is missing two (/ž/ and /θ/). The absence of /θ/ from the inventory is real: there are three potential examples, and Mackie substitutes other consonants in two of those instances. On the other hand, the absence of /ž/ is an accidental gap in the corpus; it is not clear whether Mackie is able to pronounce [ž] correctly, or whether he would omit it or substitute other phones for it.

According to the data compiled by Wang and Crawford (1960), /θ/ and /ž/ are by far the least frequent consonant phonemes in English. This fact may account for the relative infrequency of opportunity for Mackie to display his competence in the pronunciation of either phoneme; but relative frequency of occurance in adult speech plays no more than a minor role, if any at all, in predicting the order in which a child will acquire phonemes. Such a conclusion is obvious if we examine the relative frequencies of adult spirantal phonemes. The average data for the ten studies discussed by Wang and Crawford are: /s/ 7.02, /š/ 4.76, /z/ 3.57, /v/ 2.88, /f/ 2.75, /š/ 2.03, /θ/ 0.88, and /ž/ 0.87. (It should be noted that affricates were counted as clusters in that study, and so the figures for the shibilants are somewhat higher than they might otherwise be.) When we compare Mackie's ability to pronounce spirants, which will be discussed subsequently, we have a totally different picture: he has learned /s/, /f/, and /š/; is in the process of acquiring /z/, /v/, and /ð/; and has not learned /θ/. (As mentioned above, the status of /ž/ is questionable.) The fact that Mackie has learned /f/ and /š/ but not the higher-frequency /ð/, /z/, and /v/ indicates that the

relative frequency in adult speech bears little relation to the order of acquisition of consonant phonemes.

Of the 19 consonants which have been acquired, only three are distributionally defective. /š/ and /ǰ/ occur initially only, and /z/ occurs only medially and finally. That is to say, there are no potential examples in the corpus to illustrate what would happen to these phonemes in the missing positions.

1.1. The child's stop consonants are fairly regular in their correspondance to those of the adult model. Almost all of the very few fluctuations which do occur involve the substitution of another stop consonant for the appropriate one. In initial position, however, there are several substitutions of either [t] or [ǰ] for adult /d/. These are primarily assimilations of voicelessness or manner of articulation to the initial consonant of the preceding syllable. Such assimilations of initial consonants occur across and including up to four syllables. The large number of omissions of /d/ intervocalically is accounted for primarily by instances of the word "daddy", the pronunciation of which is probably a residue of an earlier stage (see footnote * of Table 2). All of the stop consonants are established in final position except for /b/, which seems still to be in flux.

Nasals are quite stable in all positions: in the entire corpus, only four fluctuations involve loss of nasality, and only five involve incorrect place of articulation. Pre-vocalic /h/, /w/, and /y/, as well as the affricates - /č/ and /ǰ/ - are also stable.

/l/ and /r/ are fairly stable; both are omitted quite often in final position. Just as folklore would predict, [w] is the most frequent incorrect substitution for both of them.

1.2. Mackie is still, apparently, in the process of mastering the spirantal consonants, and they are therefore the most interesting aspect of this corpus. /s/ is the only spirant for which there is evidence of complete mastery; it occurs frequently in all positions and there are no substitutions for it in any of those positions. In comparison, /z/ is not yet stable: its articulation is the same as that of /s/, but only about one half of its total number of occurances are correctly voiced.

The consonant pair /θ/-/ð/ presents a considerably different picture. The voiceless dental spirant has not yet entered the inventory; out of three possible occurances, recorded are one [t], one [s], and one [θ]. /ð/, on the other hand, has entered, although marginally. It is recorded 11 times, but [d] substitutes for it an additional 96 times. The lack of phonetic data precludes any definitive explanation of what is happening, but I would hypothesize that both [d] and [ð] are articulated with the flat front of the blade of the tongue, rather than with the tongue-tip, and thus the two consonants have identical place of articulation. Thus Mackie's problem with /ð/ is that he has not yet acquired the feature of continuance for this consonant.[7]

Labiodental /f/ is fairly stable, being pronounced correctly a total of 19 times out of a potential 23, while /v/ is still certainly marginal. Out of eight potential occurances, only one is recorded as [v]. Of the others, five substitutions are stop consonants, indicating

that manner of articulation is problematic here; two are voiceless; and six locate the place of articulation incorrectly.

1.3. Mackie has mastered the distinctive features[8] [±high] and [±anterior] which distinguish the velar stops ([+high, -ant]) from the labials and dentals ([-high, +ant]). Insofar as these features extend into his spirant system, they are utilized: [s] ([-high, +ant]) is never confused with [š] ([+high, -ant]). The feature [± coronal] has also been mastered, as, with only one exception ([-d] substituting for [-v]) [αcor] never is confused with [-αcor]. Stridency has not been well-learned as a feature. The [+strid] [f] is not confused with [-strid] [p], but [+strid] [v] is confused with [b], [d], and [p], all of which are [-strid]. Both [t] ([-strid]) and [s] ([+strid]) substitute for [θ] ([-strid]). At this stage, then, place of articulation is a problem for Mackie only with respect to [v], but not with respect to [f] or any other spirant.

The feature [±voice] is handled correctly for all stop consonants; thus we might conclude that Mackie has learned this feature. He never substitutes a voiced consonant for any of the four voiceless spirants; he very rarely substitutes a voiceless consonant for /v/ or /ð/; but he frequently substitutes [s] for /z/.

For the pairs [p]:[f], [t]:[s], and [d]:[z], the feature [± cont] has been learned; for the pairs [b]:[v], [t]:[θ], and [d]:[ð] the feature is "coming in" in the following skewed way: the spirants never substitute for the stops, but the stops often substitute for spirants.

Thus we see that for the three consonants which Mackie is

acquiring, the acquisition process is approached in entirely different ways. Mackie has essentially learned all of the distinctive features relevent to the correct production of /f/, /v/, /s/, /z/, /θ/, and /ð/. Yet only two of these six are integrated into his system well enough to be specified as "learned". The situation sugests that the learning of distinctive features per se is not a primary goal of Mackie's linguistic practice at this time. Once learned, then, a feature does not necessarily spread rapidly throughout the system to all relevant segments.

1.4. There are only a few generalizations which can be made about substitution behavior in consonant clusters. Stop consonants are often preserved in clusters, except in the medial or final cluster /ts/, where usually only /s/ is preserved. /f/ and /s/ are also retained, and [z] and [s] occur equally for /z/. When /l/ and /r/ are not preserved, [w] is frequently substituted for both. In clusters where /v/ should occur, however, it is often dropped, except after /h/.

2. Hildegard. The second set of data is a complete vocabulary of about 200 words for Hildegard Leopold at age 2, reported in Leopold (1939, vol. 1). Hildegard heard both English and German spoken at home, but her phonetic development seems to be only very slightly affected by the latter language, possibly because it was her mother who spoke English.

2.1. Hildegard's vowel system consists of 12 phonemes. One (/æ/) is marginal, as it occurs in only one word ([ŋæŋæ] 'grandpa')[9];

the other .1 are stable, and occur in simple nuclei as well as in combination to form long vowels, diphthongs, or both. Table 3 shows the distribution of Hildegard's vowels and Table 4 gives examples from her vocabulary. Although Hildegard certainly does not have examples in her speech of diphthongs and long vowels which would fill all cubicles of and 11-by-11 matrix, she is obviously experimenting beyond the model which English provides. For example, although English makes no use of vowel length, Hildegard does: compare [wɔk] and [wɔ:k]; [bu], [nu], and [mu:][10]. In addition, there are several diphthongs in Table 4 which do not occur in the adult model; especially note [ɯ], [ɛa], [ea], [oi], and [ɑ]. In other words, Hildegard is using her ability to combine two vowel qualities into a diphthong as a productive process by which she may construct new words with complex vowel nuclei not present in standard English.

2.2. Hildegard has 15 consonant phonemes[11] (see Table 5). In initial position all 15 phonemes are needed to account for the 15 phones which occur. In medial position there are 16 phonetic "contrasts" but only 10 of the phonemes are needed to describe the situation. In other words, medial position is the location of maximal phonetic experimentation while initial position is the location of maximal contrast and stability.

Almost all of the rules which describe the variation occuring in medial position actually describe a situation of syllable reduplication. Despite the complexity of such rules, they seem to be significant in Hildegard's speech development at the moment for a variety of reasons. (1) Hildegard does not reduplicate syllables of neces-

sity, as the majority of her two-syllable words are not reduplications. (2) At least one rule, that for /j/, does not apply strictly to reduplicated forms but is rather more general (and perhaps newer). Thus it applies to such words as [haja] and [nɔjɔ·k] as well as to [jojo]. (3) Although the phonemes /t/ and /d/ do not occur in the distribution

$$-d-/[dV_i\_\_V_i]; \; -t-$$

their actual distribution gives evidence that they may have once occured so but have since expanded. (And indeed the dental stop phonemes would not be an unreasonable place for innovation to begin.) Thus we do find [dɔdɔ], [dada], [doti], [dita], and [titi], none of which violate the above rule, but also [dadi], which does. And there are no forms $[kV_ikV_i]$ or $[pV_ipV_i]$ parallel to [titi].

In final position, only voiceless phones occur. (Final /n/ is simply a notational way of accounting for Hildegard's final nasal vowels.) Where Hildegard has a voicing contrast phonemically in final position, it is manifested as an aspiration-non-aspiration contrast.

(Because of the unattainability of the Leopold volumes, Table 6 contains the complete vocabulary with phonemic and phonetic transcription.)

3. Erica. The third analysis is based on a corpus which I collected on August 5, 1968. The longest utterance of the 526 in the sample is 9 morphemes; the average sentence length is three morphemes. The child, Erica, was two years and 12 days old. Her parents speak standard General American English, but she hears additional dialects (and several other languages) spoken by other

adults in the neighborhood.

3.1. Many adults who have considerable contact with Erica have independently reported to me the fact that her speech sounds to them amazingly correct. It is difficult to completely reconcile such impressions with the fact that Erica's speech falls short of being "correct" in a great many respects. Two contributing factors may be her mastery of the English vowel system and her control over intonation contours. Although in a few tokens her vowels are different phonemically from the expected, she has learned the complete vowel system, including glides, and uses it correctly a large percentage of the time, even in new words. Her sentence contours are those of the adult language; in imitation situations she is able to produce fundamental frequency contours which look very much like those of her mother although her pitch peaks are consistently higher. In free speech, Erica's average syllable duration is considerably longer than that of her mother, but when she imitates (2-, 3-, and 4-syllable phrases) her total syllable duration is quite close to that of her mother, and in one sample differed only by 2 ms.

A phonological analysis of Erica's speech reveals a system very close to the adult model in structure but different in small detail: there are slightly different restrictions on co-occurence and allophonic distribution. Almost all of her pronunciation problems remain within the consonant system.

A phonological rule which seems to be typical of many children is also shared by Erica, although it seems to be an optional rule in her speech: that of dropping an initial zero-stress syllable

before a subsequent one-stress syllable.[12] This rule is utilized for ten tokens and ignored for another eight, so that we have side by side such examples as [t^hét^{h}u·] 'potato', [ʈ^{h}ɑ·mis] 'pajamas', [mɛ́ɖəʈš] 'tomatoes', [mə́nt^{h}e] 'banana'; and [hól bə̌nànə] 'whole banana', [əwɛ́i] 'away', [ɛlf·á·səʊ] 'El Paso'. As further evidence that this situation reflects a stress rule, and is not due to word length alone, it should be noted that none of the words which occur without the first syllable which the model shows are more than three syllables in length, while Erica has other words in her own speech of up to five syllables.

3.2. Erica has almost completely mastered the stop consonants and nasals. (Vowels are redundantly, and correctly, nasalized between nasalized consonants.) Voicing is incompletely learned for the stop consonants; however, where a voiceless consonant is substituted for the corresponding voiced one, it is often not of quite the same quality as the usual voiceless counterpart. There seems, in fact, to be some range of "quality" which she uses more consistently than voicing to distinguish in her own speech the voiced and voiceless stops of the adult model. It is difficult to describe the exact physical nature of this contrast, although it might be labelled subjectively a tense-lax distinction. Aspiration is a freely occuring feature with all stop consonants, although it occurs most frequently by far with the voiceless "tense" stops. There seems to be only one environment, in fact, in which Erica consistently does not aspirate stops: where the adult model would have a cluster of /s/ plus stop, Erica always has simply an unaspirated stop without an /s/.[13] For example, [k$^{=}$ɛɹ] 'square', [dɔ́di·]

'study', [dɔɹ] 'store', [t͡ʃakʰ] 'stack'.

Place of articulation has been learned for stops also, but there are a few words, apparently a residue from an earlier stage, in which stops occur with incorrect place of articulation. For example, "dog" and "duck" are imitated correctly, but in free speech both words begin with [g]: "gog" and "guck".

Like Mackie, Erica is having difficulty with fricatives. The problem seems to be one of motor control. Except for the bilabials, all fricatives suffer from Erica's inability to maintain her articulators in such a finely adjusted position as is required. As a result, fricatives are either too open or too closed -- in the latter case, becoming affricated. It is the same process that converts many of her /l/'s to a [j]-like quality.

/s/ and /š/ are rarely affricated, and are almost always too open. Both are "blade", not "groove", spirants. The place of articulation for /š/ is always correct, but /s/ varies along a continuum from dental to palato-alveolar. Thus it seems that the blade articulation and the more central position of contact are more neutral in some sense.

[ž] occurs initially as a substitute for adult [š] in a few tokens; and Erica is able to imitate [ž] in nonsense syllables. But there are no examples in her free speech where the adult phoneme /ž/ would be expected. Erica has exactly the same articulatory problems with /z/ as with /s/, but also the additional problem of voicing, which is a freely variant feature for this consonant.

/f/ is well-established but /v/ is not. Initially, /v/ is a voiced bilabial stop. Finally it is a voiceless fricative. Medially

it covers a larger range, although it is always characterized by voicing and the participation of at least one lip in the articulation; the manner of articulation covers the range from pure stop to pure fricative, encompassing some intermediate positions.

But the most interesting aspect of Erica's acquisition of fricatives is that of /θ/ and /ð/. Where /ð/ should occur initially, [d] occurs about half of the time, and the consonant is omitted completely the other half of the time. Medially, the same situation obtains, except in the following environments: after any nasal consonant (including both velars and dentals), after a nasalized vowel, and after a dental stop consonant. In these positions, /ð/ is pronounced correctly as [ð]. In fact, in one word which is not nasalized in the adult model, Erica added nasalization to the vowel preceding the correctly-pronounced /ð/. This particular subsystem is an instance of a phonological structure employed by a child which is quite unusual by the standards of the adult model. This fact suggests that the study of child phonology may be able to contribute to the theory of phonological universals by calling our attention to unusual phonological situations which may not occur in full natural languages but which the human mind seems to be programmed to cope with.

4. Summary. For many decades those interested in the acquisition of phonology collected data about the order in which different children acquired phones or phonemes; and the comparison of such data caused despair, as almost no two children acquired such units in the same order, and no patterns could be found.

In 1941 the study of child phonology took a great leap forward as Jakobson's highly significant work integrating the studies of phon-

ology acquisition, sound change, and aphasia switched the emphasis from units of sound to distinctive features. Although subsequent workers have found that some of Jakobson's proposals concerning the order of acquisiton of distinctive features are inaccurate, and others are not explicit enough to be tested, the framework was then available for many of the regularities of phonology acquisition to be discussed. It is interesting and significant that despite the considerable changes and advances in the theory of distinctive features, and the long-standing knowledge that Jakobson's theory is not completely accurate, no advances in the theory of phonology acquisition have been made.

Just as a theory based only on segmental units cannot explain what happens when a child learns to pronounce his language correctly, so also a theory based on only distinctive features cannot in isolation explain this process adequately. The data given in this paper exemplify some instances of the learning of features: e.g., within the stop consonant system those features which distinguish places of articulation have been learned. This same small set of data also exemplifies the learning of individual phonemes as just that; examples are easily to be found among the discussions of fricatives. In addition, we find that the child learns some phonemic or feature contrasts in a differential way which may be related to the universal constraints described by marking conventions.[14] For example, we may refer to Mackie's skewed learning of the contrast described by the feature of continuance; he has clearly learned the unmarked value of the feature but is still acquiring the marked value. The same situation is impossible to explain logically with a theory which describes the acquisition process as one

of successive splits, implying that the minus and plus values of a feature are learned concurrently.

Even with a vocabulary of fewer than 200 words, Hildegard already has an incipient rule structure: and even though that rule structure bears little resemblance to the one which she will develop during the ensuing five or so years, it may be viewed as a reflection of the child's ability to handle rules in phonology and perhaps even the predetermined capacity to process phonological information in a rule-structured way. Erica's unique rule determining the distribution of /ð/ indicates that we may find very little uniformity among children along their respective paths from babbling (with no rule structure) to mastery of their languages (with almost-complete rule structures). Further research may show that there is a finite although large set of possible rule forms which the child may attempt to incorporate into sound systems, and such knowledge will contribute greatly to our notion of "possible phonological rule".

I have tried to show in this paper that the child does not adopt one integrated strategy for coping with several unique facets of the same situation. Despite the stability of a relevent feature in other parts of his vocal system, the child may encounter considerable difficulty in transferring that feature to a new segment. The roots of this problem may lie in articulation, as the motor control necessary for speech is far more exacting than that required for any other activity the two-year-old child encounters or attempts. Returning to the example of Anthony Weir's speech given in the introduction, the distributional evidence leaves no doubt that the consonant segment /θ/ is part of his

competence; performance is being inhibited by articulatory interference.

A new theory of phonology acquisition must incorporate the contributions of segmental, distinctive feature, and rule structures; of articulatory, perceptual, and kinesthetic problems; and of universal phonological phenomena, which may "emerge" at various pre-determined times, in comparison with language-idiosyncratic phenomena, which are learned at specific times. It must be able to account for such diverse facts as the early acquisition of the nasal consonants vs. the late acquisition of most voiced fricatives, and the early production of [s] and [f] vs. the late production of [θ], and the relatively early stability of the incredibly complex system of vocalic segments which English presents to the learning child.

footnotes

1. This paper was supported in part by the American Council of Learned Societies and the Social Science Research Council. I am indebted to Charles A. Ferguson and William S.-Y. Wang for helpful discussions of the ideas contained in this paper, which is a slightly expanded version of a paper presented at the Linguistic Society of America, December 29, 1968.

2. see, for example, Jakobson (1941).

3. see Ferguson (1968) for an example of this longitudinal approach, as well as one of model-and-replica (= analysis of substitutions).

4. Chomsky and Halle (1968).

5. see, for example, Bloch (1948), esp. section 54.3.

6. for other relevent arguments, see Braine (forthcoming), esp. section 1.1.

7. It should especially be noted that this seems to be the only voiced-voiceless spirant pair of which the voiced phoneme is learned first.

8. Chomsky and Halle (1968).

9. This is also the only word in which /ŋ/ occurs, but the decision to label one and not the other of the two phones [ŋ] and [n] a phoneme would have to be arbitrary.

10. In a few words, Hildegard would seem to have "triple" vowels. These are considered here to consist phonetically of a long vowel and a short one separated by a syllable boundary of some sort. Examples are [ʔa.i] 'alley', [da.i] 'candy', [da.ɨ] 'dolly', [dɑ.i] 'Joey', [nɔ.i] 'naughty'.

11. /ŋ/ is actually marginal -- see footnote 9.

12. Chomsky and Halle (1968).

13. This phenomenon was first noticed by W. W. Gage and is reported in Braine (forthcoming).

14. Chomsky and Halle (1968).

tables

Model	Substitutions Initial	Intervocalic	Final
/p/	p 16	p 5 (β 1)	p 5 (ø 2)
/t/	t 43 (h 1, k 1)	t 14 (ø 2, y 1, x 1, k 1)	t 55, ø 33 (k 1, d 1)
/k/	k 23 (t 2, g 1, st 1)	k 39 (ø 2, g 1, kx 1, t 1, ʔ 1)	k 13 (ø 3)
/b/	b 60 (t 1, p 3, d 1, β 1)	b 4	(b 2, bp 1, t 1)
/d/	d 32 (t 5, ʃ 4)	ø 22, d 14 (t 3)	d 10 (ø 4, t 3)
/g/	g 24 (b 2, d 1, k 1)	----------	g 4
/s/	s 14	s 15	s 22 (ø 2)
/š/	(š 2)	(š 1)	----------
/z/	----------	z 4, s 3 (ø 1)	z 14 (š 1, ø 3, s 7)
/ž/	----------	----------	----------
/f/	f 17 (t 1)	(f 2, φ 1)	(φ 1, ø 1)
/v/	----------	(v 1, β 1, vf 1, b 1)	(d 1, b 2, p 1)
/θ/	(t 1, s 1)	---------- -----	(θ 1)
/ð/	d 96, ð 10 (ø 11, (t 5, y 1, s 1)	(ð 1)	----------
/m/	m 31	m 21	m 7 (n 1)
/n/	n 16	n 14 (t 1)	n 46 (ŋ 1, d 1, [ṽ]ø 2)
/ŋ/	----------	(ŋ 2)	ŋ 22, n 3 (ø 2)
/l/	l 8 (w 2)	l 6 (ø 3)	ø 14, w 5 (l 3, d 1)
/r/	r 12 (w 2, y 1, ø 1)	r 3, w 3 (y 1, t 1, ø 1)	r 19, ø 15 (w 1)
/č/	č 4	(č 2)	(č 1)
/ǰ/	ǰ 14 (d 1)	----------	----------
/h/	h 23 (ø 2, ʔ 1)	h 6	----------
/y/	y 3 (ø 1)	(y 1)	----------
/w/	w 19 (ɸ 3, β 1, y 1)	w 6	----------

Table 1. Mackie: Consonant Substitutions
Phones in parantheses are less significant because of their small number of occurances.

position	correct	incorrect	omissions	# of tokens
initial	88.8%	11.2%	0.0%	223
medial	83.4%	12.1%	4.4%	91*
final	64.5%	5.1%	30.4%	138

Table 2. Mackie: Stop Consonants

* There were actually 26 omissions in medial position. Only four are considered in this data, as the other 22 occured in pronunciations of the word "daddy". Of those 22, 21 are one-syllable renditions (typically transcribed as [day]) which probably represent a a residue pronunciation from an earlier stage. The one additional occurance is probably two syllables long ([da:iy]); and there are three occurances which do show a dental stop in medial position. Mackie is probably just beginning to "correct" his pronunciation of this residue word to fit into his system.

alone	i	ɪ	e		a	(ɯ)	ɑ	ɔ	o	ʊ	u	ə
first element	i		e	ɛ	a		ɑ	ɔ	o	ʊ	u	
second element	i	ɪ			a			ɔ	o	ʊ	u	ə

Table 3. Hildegard: Vowel Distribution

simple vowels

/i/	[mi] 'me', [bi] 'peas'
/ɪ/	[hɪ] 'here', [bɪg] 'big'
/e/	[he] 'hang', [we] 'way'
/a/	[ma] 'come on', [na] 'now'
/ɑ/	[mɑn] 'man', [jɑbɑk] 'sandbox'
/ɔ/	[dɔ] 'gone', [nɔ] 'no'
/o/	[do] 'cold', [bo] 'blow'
/ʊ/	[bʊt] 'put', [nʊk] 'coat'
/u/	[du] 'do', [bu] 'spoon'
/ə/	[dɪ kə] 'chicken', [ʔəwe] 'away'

long vowels

/aa/	[ha:] 'Haar'
/ɔɔ/	[wɔ:k] 'fork'
/oo/	[do.i] 'Joey'
/uu/	[mu:] 'moo'

diphthongs

/iə/	[biə] 'pillow'
/ea/	[bea] 'pail'
/ɛə/	[mɛə] 'mehr'
/ɛɪ/	[ʔɛɪ pi] 'airplane'
/ɛa/	[bɛa] 'bear'
/aɪ/	[ʔaɪ] 'eye'
/ɑu/	[ʔɑu] 'au!'
/au/	[ʔaux] 'out'
/ɔɪ/	[bɔɪ] 'boy'
/oi/	[noiš] 'noise'
/oɹ/	[doɹš] 'stone'
/uɪ/	[buɪ] 'pudding'

Table 4. Hildegard: Vowel Nuclei

Phoneme	Initial	Medial	Final
/p/	p-	-b-/[bV$_i$⟨V$_j$⟩_V$_i$⟨V$_j$⟩]; -p-/[ʔV_]: -b-	-p
/b/	b-		
/t/	t-	-t-	-t'
/d/	d-	-d-	-t
/k/	g-	-g-/[gV$_i$_V$_i$]; -k-	-k'
/g/	ʔ-	-ʔ-	-k
/m/	m-		
/n/	n-	-m-/[mV$_i$_V$_i$]; -ŋ-/[ŋV$_i$_V$_i$]; -n-	-n
(/ŋ/)	ŋ-		
/s/	s̆-	-s̆-	-s̆
/h/	h-		-x
/c/	c-	-c-/[cV$_i$_V$_i$]; - -	-c
/w/	w-	-w-	
/l/	j-_l-		
/j/	j-	-j-/[V$_i$_V$_i$]; -l-	

Table 5. Hildegard: Consonant Phonology

phonetic	phonemic	gloss	phonetic	phonemic	gloss
ʔa	ga	all	ʔawa	gawa	allright
ʔã	gan	on	ba	ba	piano
ʔaʔa	gaga	(G. nurs. wd.)	baba	bapa	papa
ʔa.i	gaai	alley	babi	bapi	bobby-pin
ʔa	ga	ei!;egg;eye;I	ba	ba	buggy
ʔa ni	ga ni	ironing	ba ba	ba pa	bye-bye
ʔa˜	ga˜	eins	ba k	ba g	bike
ʔa s̆	ga s̆		ba t'	ba t	bite
a ta	a ta	highchair	bak	bag	block;box
ʔale	gale	alle	bake	bake	backe
ʔap	gap	up	balu	baju	bottle
ʔapa	gapa	apple	baš	baš	brush
ʔapu	gapu	open	bati	bati	button
ʔati	gati	ice-cream	bau	bau	ball;bauen; bell; Baum
ʔatobie	gatopie	automobile			
ʔau	gau	aul	bauk'	bauk	Bauch
ʔaux	gauh	auf;ans;out	bea	bea	pail
ʔauto	gauto	auto	bɛa	bɛa	Bar;bear

Table 6. Hildegard: Vocabulary

phonetic	phonemic	gloss
bebl	bepl	baby
bek	beg	bake
beke	beke	bacon
beš	beš	bathe
bet'	bet	Bett
bl	bl	pe̤ls
bɪ	bɪ	big
ble	blə	pillow;spiel(en)
blš	blš	piece;please
bɪ t	bɪ d	pick
bɪ te	bɪ te	bitte
bltš	blč	beads;beach;Brief
bo	bo	blow
bɔɪ	bɔɪ	boy
bok	bog	bug
bok'	bok	broken;book
bot'	bot	boot;boat;Brot
bu	bu	balloon;spoon
bu	bu	put
bubu	bupu	paper
bʊɪ	bʊɪ	pudding
buš	buš	push
but'	but	kaputt
da	da	cover;da;down; trag(en)
dada	dada	thank you;danke
dadl	dadl	stocking;Nackedei
da·l	daal	candy
da·ɪ	daaɪ	dolly
dɑɪ	daɪ	cry;drei;dry
dak	dag	duck
daš	daš	crash;dress
daš	daš	Katz;scratch
dat'	dat	forgot
dau	dau	towel
dle	dla	dear
dɪ k	dɪ g	drink;stick
dɪ ke	dɪ ke	chicken
dɪ š	dɪ š	kiss
dɪ t	dɪ d	this
dlta	dlta	there's a...
do	do	cold;comb;door; go;throw
dɔ	dɔ	gone
dɔdɔ	dɔdɔ	Dodo
do·l	dool	Joey
dɑɪ š	dɑɪ š	stone

phonetic	phonemic	gloss
dok	dog	toast
dot	dod	coat;don't
dotl	dotl	doggie
du	du	do;too
dukɔ	dukɔ	dunkel
duš	duš	juice
ʔɛɪ pl	gɛɪ pl	airplane
ʔɛk	gɛg	egg
ʔɛt'	gɛt	in
ʔəwe	gəwe	away
gaga	kaka	cracker
gek	kag	cake
ha:	haa	Haar
hã	han	hand
haɪ	haɪ	high;ride
haɪ š	haɪ š	heiss
haɪ t'	haɪ t	light
haɪ ta	haɪ ta	Hildegard
haja	haja	Helen
hat	had	hot
hat'	hat	hat
haudžu	hauču	handschuh;Taschentuch
haux	hauh	soap
hauš	hauš	house
he	he	hang(en)
hea	hea	hair
hɪ	hɪ	here;hier
hɔ	hɔ	home
hotl	hotl	hottey(horsey)
hu	hu	room
ʔlə	gle	ear
ʔlt'	glt	eat
ja	ja	ja
jabak	japak	sandbox
jaɪ	jaɪ	lie;slide;write
jašut	jašud	sun-suit
jojo	jojo	hello
jok'~lok	lok	Loch
ma	ma	come on
ma	ma	man
maɪ	maɪ	mine;money
mama	mana	mama
maš	maš	much
mauš	mauš	mouse;mouth
meʔa	mega	Mary Alice
mee	mee	mehr
mek	meg	make

Table 6, cont.

phonetic	phonemic	gloss
meme	mene	Marion
mɪ	mɪ	me
mɪʔau	mɪgau	meow (for cat)
mɪk	mɪg	milk
mɪt!	mɪt	meat
mu:	muu	moo (for cow)
na	na	now
naɪš	naɪš	niece
naɪt'	naɪt	night
naš	naš	nass
nɑt	nɑd	not
nɪ	nɪ	knee
nɪk	nɪg	neck
nɔ	nɔ	no
nɔ·ɪ	nɔɔɪ	naughty
nɔɪš	nɔɪš	noise
nɔjɔ·k	nɔjɔɔk	New York
noš	noš	nurse
nu	nu	new
nuk	nug	coat
ŋəŋə	ŋəŋə	Grandpa
ʔɔɪ lo	gɔɪ jo	oil
ʔɔɪ no	gɔɪ no	Onkel
pɪk	pɪk	pieks!
pɪkəbu~ pɪkb	pɪkəpu pɪkp	peek-a-boo
pɪ tɪ	pɪ tɪ	pretty
pu	pu	poor;pooh
žu	šu	shoe
žuš	šuš	zu
te·	te	train
tɪ·ta	tɪ ta	tick-tock
tɪtɪ	tɪtɪ	sticky
tsutsu	čuču	choo-choo
tu	tu	through;two
tušbaš	tušbaš	toothbrush
tutɪš	tutɪš	cookie(s)
ʔutš	guč	Fuss
wɑɪ	wɑɪ	fly;zwei
wɑɪt'	wɑɪt	right
wɑlu	wɑlu	water
wɑš	wɑš	wash;watch
wɑ·tɪ	wɑɑtɪ	Milwaukee
wau	wau	flower
wɑu	wɑu	Frau
wauwau	wauwau	Wauwau (G. nurs. wd.)
wɑuwɪ	wɑuwɪ	Milwaukee
["phonetic &semantic interference from 'way', 'away', 'far away'"]		
we	we	way;where
wek ʔap	weg gap	weak up
wet	wed	wet
wet'	wet	wait
wewe	wewe	(G. nurs. wd.)
wɪ	wɪ	feed;read;three
wɪ	wɪ	rug
wɪə	wɪə	wheel
wɪt'	wɪt	feet
wɪ t'	wɪ t	fix
wɪ tɪ	wɪ tɪ	Fritzchen
wɪwɪ	wɪwɪ	Rita
wɔ	wɔ	fall;roll
wɔ:k	wɔɔk	fork
wɔk	wɔk	walk
wɔkəbəbɪ	wɔkəpəpɪ	rock-a-bye baby
woš	woš	Florence

Table 6, cont.

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