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GENERATIVE PHONOLOGY: CLINICAL APPLICATIONS IN SPEECH PATHOLOGY

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The purpose of this paper is to present phonological data from three children with functional misarticulations. 'FUNCTIONAL MISARTICULATION' is a term used to describe sound production errors which have no known motor, neurological, or cognitive basis, but which require clinical attention. These data will then be analyzed using standard methods of Generative phonology.

The methodology of Generative phonology is relatively new to the clinical field of Speech-Language Patnology. There have been very few Generative analyses of misarticulated speech. However, those available analyses have been instrumental to our understanding of this clinical population. In a preliminary way, we have attempted to typologize functional misarticulators (Dinnsen, Elbert, and Weismer 1979, 1981; Maxwell 1981), to assess misarticulators' phonological knowledge (Gierut and Elbert 1983; Elbert, Dinnsen, and Powell 1984), to plan remediation programs based upon phonological knowledge (Gierut and Elbert 1983; Rockman 1983), to describe the relationship between misarticulators' phonological systems and subsequent learning in remediation (Dinnsen and Elbert 1984; Elbert, Dinnsen, and Powell 1984), and to explain individual differences in learning by examining phonological data (Dinnsen and Elbert 1984; Elbert, Dinnsen, and Powell 1984). For a complete review of these and related findings, see Elbert, Dinnsen, and Weismer (1984). Obviously, Generative theory and its approach to phonological analysis has stimulated a considerable number of descriptive and experimental studies in this applied field.

The analysis of misarticulated speech also has implications for phonological theory. Applying standard methods of analysis to a non-standard population can give us a new source of data for testing the constructs of phonological theory. For instance, the study of misarticulation offers a unique, advantageous way to examine language change and variation. Changes can be induced in the phonological systems of children enrolled in clinical remediation programs. These experimentally controlled and accelerated changes can be monitored over time, comprising a set of descriptions of developing sound systems. These descriptions can then be compared to existing historical sound changes in languages of the world, allowing us to identify various types of sound change in this population. Analyses of this type aid in the identification of those necessary and specific properties of language.

In the problems which follow, some basic concepts of Generative phonological analysis will be illustrated. The problems will describe clinical applications of these analysis procedures. The discussion will emphasize the utility of Generative phonology in our understanding of the population of functional misarticulators. The first set of data presented below, examines a child's use of fricatives and word-final obstruents.

Child K.A.
Age 5;7 years

I.	[kɔpɪn] ~ [kɔp]	'coughing' - 'cough'
	[pʌpi] ~ [pʌp]	'fluffy' - 'fluff'
	[w æpɪŋ] ~ [w æp]	'laughing' - 'laugh'
	[do]	'throw'
	[nətɪŋ]	'nothing'
	[mɛti] ~ [mɛt]	'messy' - 'mess'
	[gu?i] ~ [gut]	'goosey' - 'goose'
	[bwɔɪŋ] ~ [bwʌt]	'brushing' - 'brush'
II.	[juɪŋ] ~ [ju]	'using' - 'use'
	[nɔ͡ɪi] [nɔ͡ɪ]	'noisy' - 'noise'
	[ənədə]	'another'
	[d æt]	'that'
	[h ævɪŋ] ~ [h æv]	'having' - 'have'
	[gwa͡ɪvɪŋ] ~ [gwa͡ɪ]	'driving' - 'drive'
	[wevɪŋ] ~ [wep]	'waving' - 'wave'
III. a.	[h ævɪŋ] ~ [h æ]	'having' - 'have'
	[gwa͡ɪvɪŋ] ~ [gwa͡ɪ]	'driving' - 'drive'
	[mɛdi] ~ [mɛ]	'messy' - 'mess'
	[bɪtɨ] ~ [bɪ]	'fishy' - 'fish'
	[pɪgɨ] ~ [pɪg]	'piggie' - 'pig'
	[waɪdɪŋ] ~ [waɪd]	'riding' - 'ride'
	[kw͡æ pɪŋ] ~ [kw͡æp]	'clapping' - 'clap'
b.	[gu?i] ~ [gut]	'juicy' - 'juice'
	[bʌ?ɪ] ~ [bʌg]	'buggie' - 'bug'
	[ɪ?] ~ [ɪt]	'it'
	[da?] ~ [d æt]	'that'
	[bɪtɨ] ~ [bɪt]	'fishy' - 'fish'
	[dɔgi] ~ [dɔg]	'doggie' - 'dog'

Child K.A.'s phonological system can be characterized by a restricted phonetic inventory. While voiced and voiceless were used contrastively in all positions, notice that K.A.'s use of fricatives was more limited. The data in (I) show that, although there was an opportunity for production, the voiceless fricatives, [f, θ, s, š], were never produced in any position. K.A. represented morphemes underlyingly without voiceless fricatives. This can be accounted for by a general context-free inventory constraint:

$$\begin{bmatrix} -son \\ -voice \end{bmatrix} \quad \text{---------}> \quad [-cont]$$

(All voiceless obstruents are stops.)

With regard to K.A.'s use of voiced fricatives, the data in (II) indicate that [z, ð] were never produced. However, this child did have knowledge of at least one voiced fricative, i.e., [v]. In fact, [v] was the only voiced fricative K.A. used. A second context-free inventory constraint accounts for these data:

$$\begin{bmatrix} +ant \\ +cont \\ +stri \end{bmatrix} \quad \text{---------}> \quad [-cor]$$

(All voiced continuants are labiodental, i.e., [v].)

In addition to the two inventory constraints prohibiting production of voiceless fricatives and limiting production of voiced fricatives to [v], two neutralization rules were motivated to account for K.A.'s production of post-vocalic obstruents (III). Notice in (a) that K.A. omitted obstruents word-finally, but this child did evidence some knowledge of word-final obstruents, illustrated by other alternating and non-alternating forms. The occurrence of word-medial, morpheme-final obstruents suggested that morphemes were represented underlyingly with post-vocalic obstruents; an optional neutralization rule deleting obstruents word-finally then applies:

$$[-son] \quad \text{------}> \quad \emptyset \; / \; \underline{\quad\quad} \; \# \qquad OPT$$

(Obstruents are optionally deleted word-finally.)[1]

In (b), oral stops were neutralized to glottal stops in the post-vocalic position. However, post-vocalic stop contrasts were always maintained for some morphemes. A second optional neutralization rule is formulated which glottalizes post-vocalic obstruents:

$$\begin{bmatrix}\text{-cont}\\ \text{-son}\end{bmatrix} \quad \text{------} > \quad [\text{-cons}] \;/\; V \_\_\_\_ \; \text{OPT}$$

(Stops are optionally realized as glottals post-vocalically.)

In summary, K.A. exhibited a limited phonetic inventory characterized by the nonoccurrence of various fricatives, i.e., [f, s, z, θ, ð, ʃ]. Two context-free inventory constraints were proposed to account for the absence of these segments. In addition, K.A. did not produce post-vocalic obstruents consistently. Underlying representations with post-vocalic obstruents were posited, but two optional neutralization rules apply to delete and glottalize post-vocalic obstruents.

Given this description of K.A.'s phonological system, three additional comments are in order. First, not all of K.A.'s underlying representations were identical to those of the surrounding (or ambient) speech community. There was not always a one-to-one correspondence between those underlying representations maintained by this misarticulating child, and those maintained by adult speakers. In this case, inventory constraints restricted K.A.'s production of certain sounds which are otherwise used by adult speakers.

Secondly, this child had adult-like underlying representations for some morphemes, but still evidenced production errors relative to the surrounding speech community. For example, K.A. had underlying representations for post-vocalic obstruents which were comparable to those of the ambient. However, this child's use of optional rules altered ambient-like underlying representations, resulting in production errors.

The final point about K.A.'s phonology regards markedness. Recall that K.A. produced the voiced fricative [v], but not [f]. This constitutes an apparent violation of markedness, i.e., the presence of a voiced obstruent implies the presence of a voiceless obstruent. It has been suggested that markedness violations of this type can serve as a criterion for differentiating subgroups among the population of functional misarticulators (Connell 1982). Children evidencing quantitatively more violations of markedness would be classed as 'deviant', vs. others classed as 'delayed'. Moreover, this distinction between 'deviant' and 'delayed' misarticulators may have empirical consequences in the course of remediation, with very different learning strategies being employed by each subgroup.

In the next sample of data, a child's use of fricatives will be examined.

Child R.P.
Age 4;4 years

I.	[sa͡ɪd]		'side'
	[soʊ͡p]		'soap'
	[sɪk]		'sick'
	[ǰusi]	~ [ǰus]	'juicy' - 'juice'
	[re͡ɪsɪŋ]	~ [re͡ɪs]	'racing' - 'race'
	[č͡e͡ɪsən]	~ [č͡e͡ɪs]	'chasing' - 'chase'
	[zu]		'zoo'
	[zibrə]		'zebra'
	[zɪpɚ]		'zipper'
	[noʊ͡zi]	~ [noʊ͡z]	'nosey' - 'nose'
	[č͡i͡zi]	~ [č͡i͡z]	'cheezy' - 'cheese'
	[fʌzi]	~ [fʌz]	'fuzzy' - 'fuzz'
	[šɪp]		'ship'
	[šæmpu]		'shampoo'
	[šark]		'shark'
	[fɪšɪn]	~ [fɪš]	'fishing' - 'fish'
	[brʌsɪŋ]	~ [brʌš]	'brushing' - 'brush'
	[wɔšɪn]	~ [wɔš]	'washing' - 'wash'
II.	[fæn]	~ [væn]	'fan' - 'van'
	[fe͡ɪs]	~ [ve͡ɪs]	'face' - 'vase'
	[fa͡ɪd]	~ [va͡ɪn]	'five' - vine'
	[tɔhɪn]	~ [tɔ]	'coughing' - 'cough'
	[læhɪn]	~ [læ]	'laughing' - 'laugh'
	[lihi]	~ [li]	'leafy' - 'leaf'
	[wedɪŋ]	~ [wed]	'waving' - 'wave'
	[šedɪŋ]	~ [šed]	'shaving' - shave'
	[dra͡ɪdɪŋ]	~ [dra͡ɪd]	'driving' - 'drive'
III.	[fʌm]		'thumb'
	[fɪrsɾi]		'thirsty'
	[bæhi]	~ [bæ]	'bathie' - 'bath'
	[tuhi]	~ [tu]	'toothie' - 'tooth'
	[ma͡ʊhi]	~ [ma͡ʊ]	'mouthie' - 'mouth'
	[dɪs]		'this'
	[dæt]		'that'
	[ədə]		'other'
	[mʌdə]		'mother'
	[brʌdɚ]		'brother'

The data presented in (I) indicate that R.P. used some fricatives, i.e., [s, z, š], in all positions. Labiodental fricatives however, were only produced in word-initial position (II). When given an opportunity to produce these fricatives in other word positions, target [f] was realized as [h] and target [v] was realized as [d]. This evidence suggests that R.P. did not represent morphemes underlyingly with intervocalic or word-final labiodental fricatives. R.P. did however, represent morphemes with word-initial labiodental fricatives. The absence of intervocalic and word-final labiodental fricatives can be accounted for by the sequence constraint formulated below:

$$[+\text{stri}] \quad \text{------} > \quad [+\text{cor}] \;/\; V \_\_\_\_\_$$

(All post-vocalic continuant consonants are lingual.)

In addition to this sequence constraint, notice the morphophonemic alternations which occurred word-finally between [h] and null (II). To account for these alternations, underlying representations were posited with the morpheme-final glide, [h]. An obligatory neutralization rule deleting the final glide applies:

$$\begin{bmatrix} -\text{cons} \\ -\text{son} \\ +\text{cont} \end{bmatrix} \quad \text{------} > \quad \emptyset \;/\; \_\_\_\_\_ \;\#$$ OBLIG

([h] is deleted word-finally.)

R.P. never produced dental fricatives, i.e., [θ, ð], as the data in (III) illustrate. There was no evidence which would support positing [θ, ð] in either phonetic or underlying representations. The lack of dental fricatives in R.P.'s speech can be characterized by a context-free inventory constraint, such that the only fricatives produced were strident. (Recall that R.P. produced [s, z, š], and [f, v] word-initially.) The inventory constraint below represents this limited knowledge of fricatives:

$$\begin{bmatrix} +\text{cons} \\ +\text{cont} \end{bmatrix} \quad \text{------} > \quad [+\text{stri}]$$

(All fricatives are strident.)

In summary, a context-free inventory constraint was proposed to account for the absence of dental fricatives in R.P.'s speech. A context-specific sequence constraint excluded production of labiodental fricatives in all but word-initial position, and an obligatory neutralization rule of word-final h-deletion was motivated.

Like the previous case of Child K.A., R.P. had unique underlying representations. Non-ambient underlying representations were posited for target labiodental and target dental fricatives. Also, like Child K.A., R.P. had some ambient-like underlying representations, although errors in production were still evident. Specifically, R.P. had ambient-like underlying representations in some word positions, but not others; the context-specific sequence constraint which restricted production of [f, v] to word-initial position accounted for these errors.

These two samples illustrate how a Generative phonological analysis can be used to characterize misarticulated speech at a given point in time. From these characterizations, we observed that a child may have unique underlying representations which are not identical to those of adult speakers. Or, a child may have adult-like underlying representations, but still have a speech production problem. We accounted for these production errors by rules, which altered adult-like underlying representations, and by sequence constraints, which restricted adult-like underlying representations to specific contexts. For any given child then, we may posit both unique and adult-like underlying representations.

The last sample of data focuses on a child's acquisition of fricatives by examining aspects of the child's speech at two points in time.

Child A.J.
Age 4;7 years

I.	[dəɹɚ]	'fire'
	[dʌ͡ni]	'funny'
	[kɒsɪŋ] ~ [kɔs]	'coughing' - 'cough'
	[æsɪŋ] ~ [æs]	'laughing' - 'laugh'
	[bækum]	'vacuum'
	[dæləndaɪn]	'valentine'
	[tosi] ~ [tots]	'stove-i' - 'stove'
	[tesɪŋ] ~ [tes]	'shaving' - 'shave'
	[dʌpɚ]	'supper'
	[deɪoʊboʊt]	'sailboat'
	[maʊsi] ~ [maʊs]	'mousey' - 'mouse'
	[mɛsi] ~ [mɛs]	'messy' - 'mess'
	[wipɚ]	'zipper'
	[u]	'zoo'
	[tʌsi] ~ [tʌs]	'fuzzy' - 'fuzz'
	[kisi] ~ [kis]	'cheezy' - 'cheese'
	[dʌm]	'thumb'
	[taku]	'thank you'
	[maʊsi] ~ [maʊs]	'mouthy' - 'mouth'
	[tisi] ~ [tis]	'teethy' - 'teeth'
	[dɛm]	'them'
	[dæt]	'that'
	[isi] ~ [is]	'feathery' - 'feather'
	[ʂɪp]	'ship'
	[ʂu]	'shoe'
	[tɪsən] ~ [tɪs]	'fishing' - 'fish'
	[pusən] ~ [pus]	'pushing' - 'push'

Child A.J.
Age 4;11 years

11. [fes] 'face'
[fæni] 'funny'
[kɔsuən] ~ [kɔs] 'coughing' - 'cough'
[æsɪŋ] 'laughing'

[fes] 'vase'
[faɪn] 'vine'
[tos] 'stove'
[tisi] 't.v.'

[dop] 'soap'
[tɪk] 'sick'
[dzusi] ~ [tsus] 'juicy' - 'juice'

[u] 'zoo'
[fipæ] 'zebra'
[nosi] ~ [nos] 'nosey' - 'nose'
[kisi] 'cheezy'

[fɛrsi] 'thirsty'
[fɪn] 'thin'
[tusi] ~ [tus] 'toothy' - 'tooth'
[nʌsɪŋ] 'nothing'

[fɛm] 'them'
[fæt] 'that'
[fɛdɚ] 'feather'

[tu] 'shoe'
[tsek] 'shake'
[fɪsɪn] ~ [fɪs] 'fishing' - 'fish'
[pusun] ~ [pus] 'pushing' - 'push'

Notice that although afforded the opportunity, this child never produced the fricatives [f, v, θ, ð, z, š] in any position (1). The fricative [s] was used instead, and this was the only fricative A.J. ever produced. Moreover, production of [s] was restricted to intervocalic and word-final positions. A context-free inventory constraint and a context-specific sequence constraint are necessary to account for these data. The context-free inventory constraint formulated below limits production of continuant consonants to [s]:

$$\begin{bmatrix} +\text{cons} \\ +\text{cont} \end{bmatrix} \quad \text{------} > \quad \begin{bmatrix} +\text{stri} \\ -\text{voice} \\ +\text{cor} \\ +\text{ant} \end{bmatrix}$$

(All continuant consonants are the voiceless alveolar, i.e., [s].)

The context-specific sequence constraint presented below accounts for the lack of word-initial continuant consonants. The sequence constraint is formulated such that all pre-vocalic obstruents are stops; it follows that stops or the fricative [s] can occur post-vocalically.

$$\begin{bmatrix} +\text{cons} \\ -\text{son} \end{bmatrix} \quad \text{------} > \quad [-\text{cont}] \quad / \quad \underline{\quad} \; V$$

(All pre-vocalic obstruents are stops.)

Following the preliminary phonological analysis in (1), A.J. was enrolled in a speech remediation program. The goals of this program were to increase A.J.'s phonemic inventory to include other fricatives besides [s], and to use fricatives in word-initial position. The fricative, [f], was selected as the target for production in the word-initial position. This fricative was selected since it is typically acquired early, it is a frequently used fricative, and its production provides some visual cues to the child. The remediation program consisted of imitation and spontaneous production of minimal (and near minimal) pairs. Specifically, the target, [f], was paired with the contrasting sound, [t], in pictured pairs such as *fan-tan, fall-tall, four-tore, fight-tight,* etc. Remediation continued until A.J. spontaneously produced the target pairs with 90% accuracy over two consecutive sessions. For A.J., this remediation program was completed in approximately 4 months.

Following the remediation program, a second phonological analysis was completed to determine the effects of intervention on A.J.'s system. The data are presented in (11). Notice that A.J. began producing other fricatives besides [s], and used fricatives word-initially. However, in the reorganization of his phonology, A.J. created a case of complementary distribution. That is, [f] was produced word-initially for all target fricatives, and [s] was produced intervocalically and word-finally.

The resulting case of complementary distribution is interesting for a number of reasons. First, when compared to previously reported patterns of generalization, A.J.'s reorganization of his phonological system is rather unusual. For example, teaching production of a sound in one word position has resulted in production of that same sound in other word positions (Powell and McReynolds 1969; Elbert and McReynolds 1975; Elbert and McReynolds 1978). For A.J., this was not the case; production of [f] was restricted to word-initial position only. As another example, teaching production of one member of a cognate pair has resulted in accurate production of the second sound as well (Elbert, Shelton, and Arndt 1967; Shelton, Elbert, and Arndt 1967); A.J. did not produce [v] after training on [f]. Consistent with reported patterns of generalization (Mowrer 1971) was the fact that A.J. accurately produced new [f] words although he was only taught a very limited set of exemplars. These comparisons suggest that A.J. did not generalize in a totally predictable manner. Perhaps this child used unique learning strategies, different than those previously reported in the literature. Additional Generative phonological analyses, repeated over the course of clinical intervention, should be valuable in describing and characterizing unique learning strategies and patterns of generalization, as in this case of A.J.

These data also have implications for planning a continued remediation program for this child. Given the case of complementary distribution, an appropriate remediation goal would be accurate production of [s] word-initially and [f] word-finally, thereby motivating a phonemic split. An intervention program could be developed to contrast [s] with [f] in these critical positions.

Finally, from a descriptive point of view, there have been relatively few reported cases of complementary distribution in misarticulators (Maxwell 1981; Camarata and Gandour, 1984. Furthermore, the existing cases were not the result of reorganization of the phonological system following clinical intervention.

In conclusion, three samples were presented to illustrate some basic concepts of the Generative approach to phonological analysis.

In addition, the Generative approach was shown to be useful in describing the speech of a clinical population. Additional Generative phonological analyses obtained prior to, and following clinical intervention are needed to further describe and characterize the speech of these functional misarticulators. Generative phonological analyses of misarticulated speech can contribute greatly to our understanding of this population.

NOTES

[1]The optional rule of word-final deletion may be more specific than formulated here. Notice that all the optional omissions presented in (IIIa) involve target fricatives (e.g., *have, drive, mess, fish*). Although K.A. only produced one fricative [v], it may have been the case that this child marked the target class of fricatives in some way, and applied the deletion rule to this target class.

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