

SOME PHONOLOGY PROBLEMS FROM FUNCTIONAL SPEECH DISORDERS

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Introduction

One area where linguistics has applications in other disciplines is in the analysis of speech disorders. Speech pathology researchers and clinicians have traditionally appealed to various aspects of linguistics for the purpose of description and diagnosis of children's misarticulations. A number of linguistically oriented tests have been developed within speech pathology to identify (1) the sounds that occur in the child's phonetic inventory (Goldman-Fristoe *Test of Articulation*, 1969), (2) the role of context on articulation (McDonald *Deep Test*, 1964), and most recently, (3) the phonological processes presumed to be operating in the child's misarticulated speech (Weiner's *Phonological Process Analysis*, 1979; Hodson's *Assessment of Phonological Processes*, 1980). To the extent that these tests appeal to fundamental aspects of linguistics, it should be clear that linguists can contribute to the understanding of these and other concepts. The Speech and Hearing Sciences Department at Indiana University recognizes the benefits of training in linguistics by requiring their students to take at least one introductory-level course on linguistic analysis. Analysis courses here are typically taught through a data-based, problem-solving approach. These data-based problems are drawn from foreign languages, which may not always seem especially relevant to the concerns of speech pathologists. While we believe that it is important for all students to be exposed to the workings of language generally, the issue of relevance to speech pathology can be addressed easily with the introduction of a few data-based problems drawn from children's speech disorders. These problems not only address directly the interests of speech pathology students but also serve the function of acquainting other students with the (mis)workings of language.

The purpose of this paper is to present four data-based problems drawn from children's speech disorders. The nature of these disorders is FUNCTIONAL as opposed to organic. Functional misarticulations have no apparent organic basis such as brain damage, hearing impairment, cleft palate, etc. The problems to be presented below illustrate a number of fundamental linguistic concepts and points, some of which bear on some controversial issues from the speech pathology literature. The points dealt with here include claims about possible phonetic inventories, the postulation of underlying representations, and phonological rules. One of the most controversial issues has been the question of whether the underlying representations of functionally misarticulated speech are the same as those of the surrounding adult speech community.

There have been at least two opposing positions on this question. Some have simply ASSUMED that the child's underlying representations are the same as the adult's (Ingram, 1974, 1976 a, b¹; Compton, 1970, 1975; Weiner, 1979). Others have attempted to argue that the determination of underlying representations is an empirical issue (Dinnsen, Elbert and Weismer, 1979, 1980; Dinnsen, 1980; Weismer, Dinnsen and Elbert, to appear; Maxwell, 1979). A consequence of this latter approach is that some children can be shown to have the same underlying representations as adults while others cannot. The different characterizations resulting from this latter approach may provide important diagnostic differentials among children and may in turn suggest appropriate bases for the remediation of the individual child's speech. For a more thorough review of the controversy surrounding the issue of underlying representations see Maxwell (1981).

Ingram (1976a), *Phonological Disability in Children*, is a current textbook which reviews the issues involved in the analysis of both functional and organic speech disorders in children. It could serve as an additional source of examples and background when the problems in this article are being discussed.

Problems

Problem 1.

Child: C.P. Age: 3 years, 6 months

1. From Part I below, identify the full set of consonants that occur in this child's phonetic inventory.
2. What consonant contrasts are evident in this sample?
3. Specify the distributional constraints for vowel-consonant sequences.
4. From Part II below, identify alternations involving consonants as well as non-alternating forms. What do these forms suggest about this child's underlying representations?
5. What rules or constraints would account for these facts? Determine the obligatory/optional character of these rules.

DATA

Part I

- | | |
|-------------------------------------|----------------------|
| 1. [ə beɪbi dū]
what baby doing? | 8. [waɪnɪ]
riding |
| 2. [bɪbi]
baby | 9. [tæʔ]
Pat |
| 3. [ɛi tɛiɔ]
say table | 10. [pai]
Patty |
| 4. [pɪ]
pig | 11. [bʌ]
Bud |
| 5. [pɪi]
piggie | 12. [bʌi]
Buddy |
| 6. [xip] [ʃi]
sheep | 13. [dʌʔ]
duck |
| 7. [waɪ]
ride | 14. [dʌʔi]
duckie |

- | | |
|-------------------------|--------------------------|
| 15. [hɛɪ̩ aɪ̩ da wʌn] | 29. [ʃeɪ̩] [θeɪ̩] [teɪ̩] |
| hey I got one | say |
| 16. [tasi] | 30. [tʃi tʃa] |
| coffee | see sock |
| 17. [dæ maɪ̩ taɪ̩] | 31. [muːz] |
| that's my tie | move |
| 18. [baɪ̩b] | 32. [muːzi] [mudzi] |
| Bob | moving |
| 19. [bʌbi] | 33. [daɪ̩] |
| Bobby | dive |
| 20. [wa mama do] | 34. [daɪ̩ɪ] |
| where'd mama go? | diving |
| 21. [dɛɪ̩ps] | 35. [pri roz] |
| scrape | pretty rose |
| 22. [da] | 36. [guːʃ] [duːʃ] |
| dog | goose |
| 23. [daɪ̩] | 37. [væɪ tɪr] |
| doggie | vacuum cleaners |
| 24. [bɔɪ̩] | 38. [wɪŋ] |
| bird | ring |
| 25. [tæʊboɪ̩] [kæʊboɪ̩] | 39. [jɛɪ̩] |
| cowboy | yellow |
| 26. [kʌ] | 40. [hɔəsi] |
| color | horsey |
| 27. [deɪ̩] | 41. [fɛɪ̩ wɔɪ̩] |
| grape | fell in water |
| 28. [fwai] | |
| froggie | |

Part II

- | | |
|------------------------|----------------------|
| 1. [xip] [ʃi]
sheep | 7. [pri]
piggie |
| 2. [dɛi]
grape | 8. [bʌ]
Bud |
| 3. [bu]
bulb | 9. [bʌi]
Buddy |
| 4. [baɪb]
Bob | 10. [dʌʔ]
duck |
| 5. [bʌbi]
Bobby | 11. [dʌʔi]
duckie |
| 6. [pɪ]
pig | |

Solution and Discussion of C.P.

1. Phonetic inventory of consonants

pb	td	kg	?	
fv	θ	sz	ʃz	x
		tʃ	dʒ	
	r			
m	n	ŋ		
w	j		h	

The phonetic inventory is reasonably complete. However, it should be noted that there is no [ð] or [ɹ].

2. There is evidence of a voice contrast, stop-fricative-affricate contrast, and so on. The place contrast within fricatives is not totally comparable to adult contrasts.

3. Vowel-consonant sequences: The only obstruent stops that can appear after vowels are labials. No dental/alveolar or velar stop obstruents appear after vowels word-internally or word-finally. Fricatives and affricates can appear after vowels.

4. The consonantal alternations in Part II show labial stops word-finally alternating with null optionally. That is, labials may or may not appear word-finally in a given morpheme, e.g. [xɪp] ~ [ʃi] 'sheep' and [baɪb] ~ [babi] 'Bob' ~ 'Bobby'. There are other forms that show no alternation--evidencing no post-vocalic obstruent in any realization of the morpheme, e.g. [pɪ] ~ [pɪi] 'pig' ~ 'piggie' and [bʌ] ~ [bʌi] 'Bud' ~ 'Buddy'. These forms suggest that some of this child's underlying representations are the same as those of the adult but others are not. That is, the alternating forms involving post-vocalic labials are the same as the adult's, e.g. /ʃɪp/ 'sheep' and /baɪb/ 'Bob'. The non-alternating forms are represented differently in underlying representation, e.g. /pɪ/ 'pig' and /bʌ/ 'Bud'.

5. These facts are accounted for in part by a rule which optionally deletes obstruents in word-final position--although there is only evidence of labials undergoing deletion. There seems to be no motivation for restricting the rule to labials, however, since the other obstruents noted above are more generally precluded from occurring after vowels by a phonotactic constraint. Thus, the only obstruents that could come to appear in word-final position are labials. Labials are, therefore, the only obstruents subject to deletion.

Problem 2.

Child: P.P. Age: 4 years

1. From Part I below, identify the full set of consonants that occur in this child's inventory. How does this child's inventory differ from that of C.P.?
2. What consonant contrasts are evident in this sample?
3. Specify the distributional constraints for vowel-consonant sequences.
4. From Part II, identify alternations involving consonants as well as non-alternating forms. What do these forms suggest about this child's underlying representations?
5. What rules or constraints would account for these facts? Determine the obligatory/optional character of these rules.

DATA

Part I

- | | |
|--|---|
| 1. [paʔ dʒip]
park jeep | 8. [aᵢ wai]
I ride |
| 2. [heᵢ dʒi]
hate jeep | 9. [wain]
riding |
| 3. [m eᵢ bi]
maybe | 10. [wai]
write |
| 4. [næɔ aᵢ no]
now I know | 11. [wain]
writing |
| 5. [mi babo pa]
my bubble popped | 12. [him neᵢm bʌ]
him name Bud |
| 6. [hi ɪ wʌ da]
here is one dog | 13. [kamin ʌ]
coming up |
| 7. [hi ɪ wʌ dai]
here is one doggie | 14. [a ka m wæʔ ʌp ka]
I call them wreck up cars |

- | | |
|--|--|
| 15. [wɛʔin ka]
wrecking cars | 29. [fæ]
fast |
| 16. [paʔin]
parking | 30. [kɪo piɔ]
kill people |
| 17. [gɛ i fiŋ æŋʔ hiə]
get these things out of here | 31. [am tæŋ
I'm going to tell her,
fɔmfɪn]
something |
| 18. [kæp] [kæ]
cap | 32. [aɪ̇ naʔ ni tu]
I not need to |
| 19. [paʔ]
park | 33. [u naʔ o keɪ̇ kɔm maɪ̇
you not O.K. come my
buʔi]
birthday? |
| 20. [ʌp] [ʌ]
up | |
| 21. [kæbi]
cowboy | |
| 22. [ba] [bab]
Bob | |
| 23. [babi]
Bobby | |
| 24. [væ̃]
van | |
| 25. [tɪʔɪʔ]
tickets | |
| 26. [go]
go | |
| 27. [ko plɛɪ̇]
coke place | |
| 28. [treɪ̇]
trade | |

Part II

- | | |
|-----------------|-------------|
| 1. [dʒɪp] [dʒi] | 14. [paʔ] |
| jeep | park |
| 2. [bʌb] [bʌ] | 15. [paʔɪn] |
| Bob | parking |
| 3. [bʌbi] | |
| Bobbie | |
| 4. [ʌp] [ʌ] | |
| up | |
| 5. [kæp] [kæ] | |
| cap | |
| 6. [pɛ] | |
| pep | |
| 7. [pʌpi] | |
| peppie | |
| 8. [bʌbʊ] | |
| bubble | |
| 9. [meɪ̃bi] | |
| maybe | |
| 10. [dʌ] | |
| dog | |
| 11. [dʌɪ] | |
| doggie | |
| 12. [waɪ̃] | |
| write, ride | |
| 13. [waɪn] | |
| writing, riding | |

Solution and Discussion of P.P.

1. Phonetic inventory of consonants

pb	td	kg	ʔ
fv			
	dʒ		
	r l		
m	n	ŋ	
w			h

This phonetic inventory is considerably less elaborate than that of C.P. in Problem 1. In this instance, all fricatives are labial.

2. Obstruents contrast in voice and place. The stop-fricative contrast is limited to labials.

3. Vowel-consonant sequences: The only obstruents that can occur after vowels word-medially or word-finally are labials. There are no dental/alveolar or velar obstruents after vowels. Nasal consonants can occur after vowels.

4. The forms in Part II reveal an alternation between labials and null word-finally. This alternation appears to be optional since a given morpheme may or may not appear with a word-final labial. Other forms show no alternation, e.g. [da] ~ [dai] 'dog' ~ 'doggie' and [wai] ~ [wain] 'write' ~ 'writing'. The forms evidencing an alternation motivate postulating underlying representations that are the same as those of the adult, e.g. /kæp/ 'cap', /pɛp/ 'pep', /bɑb/ 'Bob'. Those forms evidencing no alternation fail to motivate underlying representations that are the same as the adult's, e.g. /dɑ/ 'dog', /wai/ 'write'.

5. The rule accounting for these facts is the same as that for C.P. in Problem 1. That is, an optional rule of word-final obstruent deletion is needed. There is also a general phonotactic constraint which excludes any but labial obstruents after vowels.

Problem 3.

Child: M.B. (early stage) Age: 3 years, 11 months

1. Identify the full set of consonants that occur in this child's phonetic inventory. What generalizations can be made about the inventory?
2. Is voice contrastive in obstruents?
3. Specify the distributional constraints for vowel-consonant sequences.
4. How do the forms in Part II below compare with the forms from Part I in the two previous problems? What do these forms suggest about this child's underlying representations?
5. What rules or constraints would account for these facts? Determine the obligatory/optional character of the rule.

DATA

Part I

- | | |
|--|---|
| 1. [wi da ə jɛo bɛ du]
we got a yellow bed too | 8. [hi dɛʔin dɛi̯ bai̯ ə wai̯ən]
he's getting chased by a lion |
| 2. [hi mai̯ bi̯ mami̯ dən]
he might be mommy then | 9. [buʔ an ɪ əə ju]
put on his other shoe |
| 3. [dai̯ du bæ]
driving too fast | 10. [dæon]
clown |
| 4. [æʔ ɪ dɛ]
at his desk | 11. [dɪ]
dish |
| 5. [du bæwi]
tooth fairy | 12. [dæ]
cab |
| 6. [hoin ə bæə̯ai̯n]
holding a valentine | 13. [du]
zoo |
| 7. [mai̯ diŋ ɪ dan]
my thing is gone | 14. [bai̯]
fly |

- | | |
|-------------------------|--|
| 15. [bɛ]
Fred | 26. [dɑ? ɔwə]
cross over |
| 16. [bu]
blue | 27. [dæ]
glass |
| 17. [bɛ]
bread | 28. [dɛ]
sled |
| 18. [beɪ̯]
plate | 29. [ɔɪn ə bæ ʌ]
holding a flag up |
| 19. [beɪn]
spreading | 30. [dɔ ə baɪ̯]
throw the pie |
| 20. [dʌ]
just | 31. [mɛwɪn ə wɔ]
smelling a rose |
| 21. [di]
ski | 32. [dɛ nɛɪ̯? ən dɛɔ̯]
there's a snake on there |
| 22. [dɪn]
queen | 33. [wɪ?ən]
sleeping |
| 23. [dɪn]
twin | 34. [wɪn̩]
sweeping |
| 24. [wʊ]
roof | 35. [ɑ]
saw |
| 25. [bæ]
bad | 36. [dʌ]
glove |

Part II

- | | | |
|-------------------|--------------------|-----------------------|
| 1. [dæ]
dad | 4. [dai]
doggie | 7. [da?]
talk |
| 2. [dæi]
daddy | 5. [i]
eat | 8. [da?n̩]
talking |
| 3. [da]
dog | 6. [iin]
eating | |

Solution and Discussion of M.B. (early stage)

1. Phonetic inventory of consonants

b	ɗ	ʔ
m	n	ŋ
w	j	h

Generalizations: All obstruents are voiced, non-continuant and anterior. All sonorant consonants are nasal, i.e., there are no liquid consonants.

2. Voice in obstruents appears to be non-contrastive. However, this claim is based on the above inventory, which involves transcriptions of the child's speech without the benefit of instrumental validation. Maxwell and Weismer (1980) establishes that M.B. does in fact have a voice onset time (VOT) distinction which corresponds to a voice contrast in obstruents, although the VOT values fall within the adult English perceptual range for only voiced stops; this is why they are heard as voiced by adult listeners and transcribers.

3. Distributional constraints on vowel-consonant sequences: The only consonants that can follow vowels are nasals. There are no vowel-obstruent consonant sequences anywhere within a word.

4. The forms in Part II of this problem show no consonantal alternations whereas some morphemes in the other problems did alternate. The absence of alternations in this data and the general absence of post-vocalic obstruents suggests that this child's underlying representations may be quite different from those of the adult. For example, some of the underlying representations would be the following: /dæ/ 'dad', /dɑ/ 'dog', /i/ 'eat', /dɑʔ/ 'talk'.

5. The absence of obstruents word-finally and after vowels word-internally would be accounted for by one general phonotactic constraint, which excludes all obstruents after vowels. This constraint would govern the construction of morphemes as well. The constraint in this instance is different from the previous rules in that this is obligatory, i.e., there are no surface violations of the constraint.

Problem 4.

Child: M.B. (4 months later)² Age: 4 years, 3 months

1. How has this child's phonetic inventory changed?
2. Identify the alternations evident in Part II. What are the distributional facts concerning voiceless stops? What do these forms suggest about some of this child's underlying representations? What rule would account for these facts?
3. Identify the alternations evident in Part III. What do these forms suggest about this child's underlying representations? What rule would account for these facts? Determine the obligatory/optional character of the rule.
4. Identify the alternations evident in Part IV. What rule would account for these facts? Determine the obligatory/optional character of the rule.

DATA

Part I

- | | |
|--|---|
| 1. [bɛi bɛɪ]
baby bed | 8. [dɛi wə hæʔi]
they were happy |
| 2. [dɛ no bɛi bi]
there's no baby | 9. [dɛi taʔ nobai wu luk]
they thought nobody would
look |
| 3. [haʔ taʔɪʔ]
hot chocolate | 10. [dɛi ka θam fi]
they caught some fish |
| 4. [fæwɪ gaɪn]
flower garden | 11. [hi n du ɛniθɪŋ ju]
he can do anything you
to m tu]
told him to. |
| 5. [nai] [nai f]
knife | 12. [ai æ ə hɛɔp hɪm]
I have to help him |
| 6. [waf]
roof | 13. [dʌmpwɔp]
jumprope |
| 7. [ai mɛi ɛisɪŋ]
I make everything | |

- | | |
|---|---|
| <p>14. [aɪ̣ ṇ dʌm o:wɪ? ə daɪ̣
I can jump over it, the sky
ən wæ̣ ã maɪ̣ fɪt]
and land on my feet</p> <p>15. [aɪ̣ hæ ə baɪ̣k]
I have a bike</p> <p>16. [aɪ̣m na? o ɪnʌ]
I'm not old enough</p> <p>17. [am foə]
I'm four</p> <p>18. [maɪ̣ tʃiə]
my Cheerios</p> | <p>19. [maɪ̣ dæi dʌz]
my daddy does</p> <p>20. [tʃeɪ] [tʃeɪ]
cherry</p> <p>21. [aɪ̣ gɪ ʌp]
I give up</p> <p>22. [hʌ? dʌg]
hot dog</p> <p>23. [bʌ aɪ̣ aɪ̣k kɔn ṇ
but I like corn and
hæmbʊgə ṇ pɪ?o
hamburgers and pickles,
fwi? pɪ?o]
sweet pickles</p> |
|---|---|

Part II

- | | |
|--|--|
| <p>1. [dʌk]
duck</p> <p>2. [dʌ?i]
duckie</p> <p>3. [pɛp]
pep</p> | <p>4. [pʌ?i]
peppie</p> <p>5. [hæ?i]
happy</p> <p>6. [pɪ?o]
pickle</p> |
|--|--|

Part III

- | | |
|--|---|
| <p>1. [dʌg]
dog</p> <p>2. [daɪ] [dʌgi]
doggie</p> <p>3. [beɪ] [beɪbi]
baby</p> | <p>4. [nɒbʌɪ]
nobody</p> <p>5. [wʌɪ]
rabbit</p> |
|--|---|

Part IV

- | | |
|--------------------------------|--------------------------|
| 1. [hæ] [hæd]
had | 7. [mɛə] [mɛək]
milk |
| 2. [dæg] [dæ]
dog | 8. [naɪ] [naɪf]
knife |
| 3. [dægi] [dai]
doggie | 9. [hɪm]
him |
| 4. [dʌm] [dʌmp]
jump | 10. [θʌm]
thumb |
| 5. [jɛɪ] [jɛɪk]
shake | 11. [kɔ:n]
corn |
| 6. [bæʔtʌ] [bæʔtʌb]
bathtub | 12. [gɑ:n]
garden |

Solution and Discussion of M.B. (4 months later)

1. Phonetic inventory of consonants

pb	td	kg	ʔ
fv	θ	sz	ʃ
		tʃ	
m	n	ŋ	
w		j	h
	l		

The phonetic inventory has obviously been elaborated substantially. Voiceless obstruents, velars, fricatives, a voiceless affricate and /l/ have been added.

2. The consonantal alternations in Part II show voiceless stops word-finally alternating with glottal stop between vowels. It can also be observed that voiceless stops such as p t k cannot occur between vowels. These facts suggest that the underlying representations for at least those forms evidencing this alternation are the same as those of the adult. For example, the underlying representations for 'duck' and 'pep' are /dʌk/ and /pɛp/, respectively. The rule accounting for these alternations will change voiceless stops into glottal stop intervocalically.

3. The consonantal alternations in Part III show voiced obstruent stops word-finally alternating with null intervocalically. These forms also suggest that the underlying representation for alternating forms are the same as those of the adult, e.g. /dag/ 'dog', /bɛɪbi/ 'baby'. The rule accounting for this alternation would delete voiced obstruent stops between vowels. This rule is evidently optional since there are some forms which may or may not appear with an intervocalic voiced stop.

4. The alternations in Part IV show word-final obstruents alternating with null optionally and word-medial voiced obstruents alternating with null word-finally. These facts motivate a rule optionally deleting word-final consonants.

NOTES

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¹ Ingram (1974, 1976a, pp. 48-50 and following, 1976b) has suggested in some of his discussions that children may in some cases have their own unique underlying representations; however, Ingram never pursues this suggestion nor supports it by empirical evidence.

² This data from M.B. was elicited four months after the first elicitation, during which time the child was undergoing remediation in the Speech and Hearing Clinic. This remediation program focused on training word-final stop consonants.

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