# CONTINUOUS SPEECH SAMPLING FOR PHONOLOGIC ANALYSES OF SPEECH-DELAYED CHILDREN

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Five conditions for sampling the continuous speech of speech-delayed children were defined and compared. Conditions differed on variables associated with examiner behavior and stimulus materials. All sampling conditions were administered in randomized order by two examiners who each tested 6 children. The obtained speech samples were compared for productivity, intelligibility, representativeness, and reactivity. The general findings of few significant differences associated with sampling conditions support the validity of continuous speech sampling for phonologic analyses of speech-delayed children. Protocols for the five conditions are provided, and guidelines for efficient speech sampling are suggested.

Continuous speech samples are presumed to be ecologically valid for phonetic, phonologic, and prosodic analyses of speech-delayed children. Potential threats to their concurrent validity, however, can be summarized as follows: (a) Speech-delayed children may be uncommunicative and produce few utterances in the available assessment time; (b) they may not readily be understood, and many of their utterances may not be glossable for analysis; (c) they may generate glossable utterances that differ structurally from normative data, including the proportional distributions of grammatical forms, word shapes, and phonemes; and (d) they may react to the stimuli used for speech sampling by talking in playful speech registers that have consequences for segmental and prosodic analyses. These four issues, respectively, reflect concerns about the productivity, intelligibility, representativeness, and reactivity of continuous speech sampling with speech-delayed children.

Components of continuous speech sampling that can influence productivity, intelligibility, representativeness, and reactivity are examiner questions and sampling materials. The five sampling conditions described in Table 1 combine variants of these two components. These conditions reflect sampling approaches that we have used and observed others to use when sampling continuous speech. In the directed conditions, questions are used to evoke responses, whereas questions are not used in the nondirected conditions. This typology is motivated by the following two assumptions. First, questions presumably remind the child of the presence of an adult. This may prompt the use of a more articulate speech register, as described by Ferguson (1964) and Weeks (1971), which may in turn increase intelligibility. Among the 10 registers or alternative speech styles that Weeks's preschool subjects chose to use with different listeners were registers termed fuzzy speech and clarification. Weeks (1971) and also Carlson and Anisfeld (1969) described fuzzy speech as "not clearly enunciated," in contrast to the "more careful enunciation" in the clarification register. Second, questions presumably allow the examiner more direct control over the content of a child's utterances, which may also effect an increase in the proportion of intelligible words in the sample. The presumed disadvantage of questions is that they constrain "free" speech. Questions, therefore, may be associated with improved overall intelligibility at the cost of productivity and representativeness.

The second typologic component represented in the sampling conditions in Table 1 concerns the nature of the content or stimuli available to the child. The five conditions range from uncontrolled content to direct control of content. In the present context, the primary advantages for having specific toys, pictures, and other objects available to prompt verbalization are that the child's utterance about related topics may be more intelligible and stimulus conditions may be replicable. A disadvantage is that such stimuli may limit the range of topics. Productivity as indexed by a type/token ratio is lowered due to repetition of words associated with the stimulus items. Moreover, toys and other manipulable stimuli may introduce a reactive component. We have observed children to become so engrossed in play activities that they seemingly do not want to talk, will talk very softly, will talk with less articulatory precision, or will talk primarily in stereotypic play patterns (i.e., using unnatural prosody). Weeks (1971), as described above, found that in certain verbal exchanges children used registers she defined as whisper, softness, loudness, high pitch, exaggerated intonation, and mimicry. Procedures for prosodic analyses of delayed speech presently are limited to perceptual systems (e.g., Crystal, 1982; Shadden, Asp, Tonkovich, & Mason, 1980; Shriberg & Kwiatkowski, 1982); however, procedures using instrumental displays and acoustics software packages are beginning to appear. Although prosodic analyses using perceptual or instrumental procedures were not to be performed for the present study, it seemed important to examine the data from the perspective of future integrated linguistic analyses.

The twofold purpose of this paper is (a) to describe five explicit procedures that may be used to obtain continuous speech samples from speech-delayed children and (b) to determine whether samples obtained under each of these five conditions differ from each other on variables associated with productivity, intelligibility, representativeness, and reactivity.

Sampling condition	Type of continuous speech	Control of content	Selection and type of stimulus materials	Examiner's comments/prompts
l Free	Nondirected	Uncontrolled	Child-selected assorted materials and topics; topics may be related or unrelated to the materials.	Limited to nondirective comments.
2 Story	Nondirected	Indirect	Examiner-selected, single material: colorform Muppet setup; child-selected topics related to material.	Limited to nondirective comments related to stimulus material.
3 Routines	Nondirected and directed	Indirect and direct	Examiner-selected, single material: colorform house setup, including words containing all consonant sounds. Examiner- or child-selected topics may be related or unrelated to the materials.	Examiner may use both questions and comments to prompt verbalization about stimulus materials.
4 Interview	Nondirected and directed	Direct	No materials. Examiner- or child-selected topics may be related or unrelated to the current topic.	Examiner asks questions to identify and pursue topics child will talk about.
5 Scripted	Directed	Direct	Examiner-selected materials, pictures in a book, words and themes selected to evoke all consonant sounds; examiner-selected topics related only to the materials.	Examiner follows a script of questions appropriate to the pictures.

TABLE 1. Description of five sampling conditions to evoke continuous speech for phonetic, phonologic, and prosodic analyses.

Note. The five conditions are presumed to range from least to most directed types of continuous speech samples.

### METHOD

#### Procedures

Two female examiners used the five sampling conditions described in Table 1 to sample the speech of 12 children with delayed phonological development of unknown origin. Each examiner tested 3 boys and 3 girls. Children ranged in age from 2:10 to 4:5 for Examiner 1 and from 3:2 to 4:6 for Examiner 2. Subsequent information on their severity of speech involvement, as assessed by Percentage Consonants Correct (PCC) (Shriberg & Kwiatkowski, 1982) indicated mild-moderate to mildsevere involvement (PCC range 77%–62% correct consonants). Hence these children's severity levels were comparable to approximately 85% of children referred for delayed speech of unknown origin (Shriberg, in press).

Of the 12 children, 9 were within normal limits for language comprehension and production and were functioning at age level on academic tasks in preschool environments; 3 children were up to  $1\frac{1}{2}$  years delayed in these areas. All children demonstrated age appropriate social and play skills during the speech sampling session. A total of 8 of the 12 children had prior speech therapy in a school setting. All of the children were unfamiliar with the examiners. Of 15 potential subjects with whom the sampling procedures were tried, 3 were excluded because they did not meet a minimum criterion of producing five utterances in 2 min within each sampling condition. Only 1 of these children failed to produce at least one speech sample adequate for analysis. This child had severe velopharyngeal port incompetence and was judged 95% unintelligible.

Each sampling condition was maintained for approximately 8 min, with all five conditions administered in succession during the same 45-min session. Order of conditions was randomly determined for each subject but balanced so that no condition occurred more than five times in the same serial position. Protocols for each of the five sampling conditions are contained in the Appendix.

All speech samples were recorded on Sony LNX audiotapes on a Marantz C-105 audiocassette tape recorder with a Sony ECM-2 Electret external microphone set on a table approximately 15 cm from the child's lips. (The recorder was positioned to be out of children's view.)

To facilitate later transcription the content of children's intended utterances was repeated by the examiner. These responses were made as communicative comments in the nondirected sampling conditions and as transitions to questions in directed conditions. For example, if the child said, "He's here," the examiner might remark, "I see him—he's right here," in a nondirected condition. In the directed

	Tota	l words per s	sample	Number of words per minute			
Condition	M	SD	Range	M	SD	Range	
1	168.1	76.1	58-281	21.0	9.51	7.3-35.1	
$\overline{2}$	182.5	81.4	62-282	22.8	10.18	7.8-35.3	
3	179.5	67.8	90 - 279	22.4	8.47	11.3-34.9	
4	197.8	89.0	41-302	24.7	11.13	3.0-37.8	
$\overline{5}$	146.7	55.0	40-246	18.3	6.87	5.0–30.8	
All	174.9	74.2	40-302	21.9	9.28	3.0-37.8	

TABLE 2. Total number of words (intelligible and unintelligible) and number of words per minute produced by speech-delayed children in the five sampling conditions.

condition the response would be "Yes, he's here. Tell me about what he's going to do." These children, as with others with whom we have used these procedures, seemed oblivious to the presence of the microphones and to the examiner-paraphrased repetitions of their utterances.

Approximately 1 month after each sampling session, the tapes were transcribed by the examiner who obtained the sample, following the same randomized order in which they were originally obtained. All words produced by each child in each sampling condition were transcribed. A Dictaphone 2550 transcriber was used following procedures described in Shriberg (in press). Each examiner transcribed 30 samples (6 subjects, 5 conditions). The transcription system included a set of diacritics for narrow phonetic transcription (Shriberg & Kent, 1982) and decision rules for determining which phonetic distortions were to be considered incorrect (Shriberg, Kwiatkowski, & Hoffmann, 1984). All procedures for coding words, including canonical forms, casual speech forms, unintelligible forms, and morphophonemic forms, followed detailed guidelines in Shriberg (in press). These lengthy procedures, which cannot efficiently be summarized here, provided principled approaches to resolve ambiguities. Extensive reliability assessment for these two experienced transcribers (as described in Shriberg et al., 1984) indicated an overall exact interjudge percentage of agreement of 76% on segment-diacritic symbols associated with potential speech errors. Intrajudge reliability estimates were not obtained. The 60 transcripts were processed by a software package for phonetic and phonologic analysis that tallied and computed the relevant values for subsequent statistical analyses (Shriberg, in press). Only spontaneous utterances were analyzed.

# **RESULTS AND DISCUSSION**

### Productivity

Total words. Descriptive statistics for the total number of words and number of words per minute produced in each of the five conditions are presented in Table 2. Words for this analysis includes both unintelligible and intelligible words. Unintelligible syllables were segmented into words using the following rules: (a) A string of two syllables was counted as a two-syllable word when the utterance context and stress pattern suggested a two-syllable word; (b) in strings of up to four syllables the above rule was applied if appropriate, otherwise each syllable was counted as a separate word; and (c) in strings that exceeded four syllables, the first three syllables were coded as single-syllable words and the fourth and fifth syllables were counted as a two-syllable word. This latter rule is consistent with the 3:1 ratio of monosyllable to multisyllable word form production data obtained in both speech-normal and speech-delayed children (Shriberg, in press). As indicated by the means and standard deviation data in Table 2, the total word output of the 12 speechdelayed children across the five conditions was similar. A repeated measures analysis of variance calculated on total words produced in each of the five conditions was nonsignificant [F(4,44) = 1.38, p > .25]. An alpha level of .01 was selected because 13 repeated measures analyses of variance were eventually done. Inspection of the individual child data indicated that among the 12 children, 4 produced the highest number of words in Condition 2 (Story), 3 produced their highest number of words in Condition 1 (Free), 3 in Condition 3 (Routines), 2 in Condition 4 (Interview), and no child produced the most words in Condition 5 (Scripted).

Although the overall average of approximately 22 words per minute (see Table 2) is productively adequate, this figure is approximately 40%-80% lower than average values of 39 (Shriberg & Kwiatkowski, 1982) and 30 (Hodson, 19801) words per minute found in previous studies of continuous speech samples. In the two studies cited, the children were comparable in severity of involvement to children in the present study, and one study included an examiner who also participated in the present study. The difference in productivity is most likely due to experimental constraints operating only in the present study. Typical clinical procedures, such as those used by Shriberg and Kwiatkowski and Hodson, include a variety of sampling conditions as needed to evoke continuous speech from a child. In the present study the two examiners were obligated to continue with each

<sup>&</sup>lt;sup>1</sup>B. Hodson, personal communication, 1980.

	Total types		Total ut	terances	Utterances per one fifth of sample	
Condition	M	SD	M	SD	M	SD
1	54.2	23.3	54.3	23.8	10.8	4.7
2	58.7	20.8	57.7	25.7	11.7	5.1
3	61.5	20.9	61.8	20.5	12.3	4.1
4	60.4	25.1	60.4	24.0	12.1	4.8
5	56.5	19.8	51.9	16.3	10.4	3.3
All	58.3	21.5	57.2	21.9	11.5	4.4

TABLE 3. Average percentage of word types (new words) obtained in each sampling condition.

sampling condition, even if a child obviously was not responding optimally in that condition. Individual differences in children's responsiveness across conditions is reflected in Table 2 in the large range of total words per sample.

Total different words. Speech analyses may be based on word types or word tokens. For one phonetic and phonologic analysis procedure, token-based analyses have been shown to yield virtually identical qualitative and quantitative data as data from analyses based on word types (Shriberg & Kwiatkowski, 1980, 1983). Word-type analyses use only the first occurrence of a word in the sample; hence, all subsequent occurrences of the word reflect sampling inefficiency. An important productivity question is whether any of the five sampling conditions is more efficient than the others in yielding more word types in successive utterances.

As shown in Table 3, the total number of new words in each condition were not significantly different [F(4,44) <1, p > .01] ranging from approximately 54 to 62 new words per sample with an across-condition mean of 58.3. When divided by the average total number of utterances in the 8-min samples (Table 3, middle columns), these data yield an overall rate of approximately one new word per utterance. To assess the percentage of new word use over sample duration, each transcript was divided into fifths based on the total number of utterances in the sample. As shown in the rightmost columns in Table 3, each one fifth of a sampling condition averaged 11.5 utterances. New words appearing in each fifth within each condition were tabulated and expressed as a percentage of the total number of new words in each sample. Results are displayed in Figure 1.

Data in Figure 1 suggest that the five conditions did not differ in efficiency. Across all five conditions approximately 29% of the new words occurred in the first fifth of the sample. Successive fifths yielded, respectively, approximately 21%, 19%, 17%, and 14% of the word types. These data suggest that as much as one third of the word types occur in the first fifth of a continuous speech sample, including function words that will occur many times as the sample progresses. The trends shown in Figure 1 indicate that such distribution characteristics



FIGURE 1. Percentage of occurrence of new words (types) in successive fifths of the speech samples.

were essentially independent of the several differences in stimuli and materials used in the present study.

To this point the grouped productivity data suggest that the different sampling conditions did not yield statistically different amounts of continuous speech. However, the large individual differences among children in this study, together with previous clinical and research experience, suggest that productivity may be increased if the examiner has the flexibility to alternate among sampling conditions as necessary to obtain and maintain a child's interest in talking.

## Intelligibility

Table 4 contains summary data for the intelligibility of children's speech in the five sampling conditions. Intelligibility was defined as the percentage of words the examiner could gloss during transcription. For each of the variables shown in Table 4, the five sampling conditions yielded essentially similar averaged totals. The 8-min samples averaged approximately 119 intelligible words, ranging by child from 27 to 237 intelligible words per

	Number of intelligible words per sample			Number words	of intelligible per minute	Percentage of intelligible words per sample		
Condition	M	SD	Range	M	Range	M	SD	Range
1	110.3	62.0	48-219	13.8	6.0-27.4	66.1	20.3	35-89
2	122.0	72.1	34-236	15.3	4.3 - 29.5	65.1	18.4	37-87
3	128.7	64.1	46 - 237	16.1	5.8-29.6	71.2	20.1	40-93
4	125.0	64.0	27 - 200	15.6	3.4 - 25.0	68.0	20.0	25-95
5	111.3	52.5	27-218	13.9	3.4 - 27.3	75.0	16.2	45-94
All	119.4	61.5	27-237	14.9	3.4-29.6	69.2	18.7	25-95

TABLE 4. Descriptive statistics for the intelligibility of words produced by speech-delayed children in the five sampling conditions.

sample. As shown in the middle columns, these values convert to an average of approximately 15 intelligible words per minute across sampling conditions. The last three columns in Table 4 summarize data for the percentage of intelligible words in each condition. Arcsine transformations were not indicated for these data because they were distributed over a wide range, and there were no scores of 0% and only one score of 100%. A repeated measures analysis of variance was nonsignificant at the selected alpha level [F(4,44) = 3.51, .01 . Theoverall average percentage of intelligible words was just over 69%, with a trend ranging from approximately 65% in Condition 2 to 75% in Condition 5. Of the 12 children, 5 produced their greatest number of intelligible words in Condition 3 (Routines), 4 of the children in Condition 5 (Scripted), 3 of the children in Condition 4 (Interview), and none during Conditions 1 (Free) or 2 (Story).

These intelligibility data are consistent with general trends just reviewed for productivity questions. At the group level the five sampling conditions yielded essentially similar percentages of intelligible words. However, the large standard deviations and ranges of performance and the number of children who produced their highest percentages of unintelligible words in three of the five conditions indicate that individual differences are important. The findings that none of the children produced the highest number of intelligible words in the nondirected conditions (Free, Story) suggest that intelligibility can be increased by increasing control over the content of children's utterances.

### Representativeness

Previous studies have found strong structural interdependencies among the proportional occurrences of parts of speech, word forms, and consonants (Shriberg, 1982; Shriberg & Kwiatkowski, 1980, 1982). Also, the distributional data for these units from speech-delayed children appear to be similar structurally to distributions occurring in the continuous speech of speech-normal children and adults (Shriberg & Kwiatkowski, 1983).

Parts of speech. Table 5 includes percentage of occurrence data for 13 parts of speech glossed in each of the five sampling conditions. Percentages are similar across the five conditions, with Pearson correlation coefficients among the five sampling conditions ranging from .91 to .98.

Word forms. Table 6 includes data on 10 word forms intended by children in the five sampling conditions.

TABLE 5. Mean percentage of occurrence for 13 parts of speech in the five sampling conditions.

	ŀ	All conditions	Mean percentage by condition						
Part of speech	Rank	Mean percentage	1	2	3	4	5		
Noun	1	22.8	22.1	17.3	21.6	24.6	21.5		
Verb	2	21.7	21.1	21.3	21.5	22.6	23.2		
Pronoun	3	13.0	9.1	17.2	13.7	13.5	14.1		
Adverb	4	8.4	9.2	9.3	7.7	9.3	5.6		
Preposition	5	6.5	7.5	5.8	6.0	7.6	5.6		
Interjection	6	6.4	7.0	6.2	8.1	4.4	5.0		
Adjective	7	4.6	5.0	5.2	3.2	4.7	5.8		
Auxiliary	8	4.3	5.3	3.8	4.1	3.3	5.2		
Quantifier	9	4.3	3.6	3.6	4.7	3.8	5.9		
Relative	10	3.7	4.1	4.2	4.2	3.0	3.0		
Article	11	2.6	2.9	2.9	2.3	1.0	3.4		
Conjunction	12	1.7	1.0	2.7	2.5	2.0	1.1		
Indefinite	13	0.0	1.0	0.5	0.6	0.2	0.2		

		Mean perc	Comparison data <sup>b</sup>				
Intended word form <sup>a</sup>	1	2	3	4	5	Mean %	SD
CVC	32.2	32.5	33.9	21.3	34.5	29.9	5.9
CV	24.2	23.9	23.1	27.4	23.0	23.7	6.7
2-svllable	12.5	12.2	12.0	15.0	12.1	13.4	4.4
VĆ	13.4	10.9	15.0	13.2	12.3	13.0	4.6
V	7.8	9.0	7.9	10.0	9.1	9.3	4.0
CnVCn	6.3	5.5	5.6	5.4	4.2	5.3	2.7
CnVC	1.2	1.6	1.1	2.2	2.0	2.3	1.6
CnV	1.5	1.1	.6	2.8	.7	1.4	1.3
3+-syllable	.7	.8	.5	1.5	.9	1.0	1.0
VCn	.2	2.3	.4	1.1	1.1	$\frac{.7}{100\%}$	.8

TABLE 6. Descriptive statistics for 10 intended word forms in the five sampling conditions. Comparison data are continuous speech samples from 38 speech-delayed children.

<sup>a</sup>Cn indicates a sequence of two to three consonants; 3+ syllables includes intended word forms with three or more syllables. <sup>b</sup>Data are from continuous speech samples from 38 speech-delayed children (Shriberg & Kwiatkowski, 1983).

Also included are the average percentages of word forms within a sample of continuous speech obtained in a study of 38 speech-delayed children (Shriberg & Kwiatkowski, 1983). The proportional occurrence of word forms among and between the five sampling conditions and the larger study are similar, with correlations ranging from .90 to .98. However, two small but potentially interesting differences in the proportional occurrence of word forms are suggested in the data for Condition 4 (Interview) in comparison to data in the other four conditions and in the larger study. The percentage of CVC word forms is lower (by approximately 12.0%) than the average obtained in the other four conditions and the percentage of intended CV forms is higher (by approximately 3.9%) than obtained in the other four conditions. A possible explanation for these two differences is discussed in association with findings in the next section.

Speech sounds. The representativeness of intended consonant sounds in the five sampling conditions was reflected in the correlation coefficients of these distribu-



FIGURE 2. Percentage of occurrence of intended consonants in the five sampling conditions.

tions with published consonant frequency data. Figure 2 illustrates the percentage of occurrence of intended consonants for each of the five conditions. The averaged percentages for each condition yield very similar rank orderings among the 24 consonants. Intercorrelations range from .84 to .98. In Shriberg and Kwiatkowski (1983), percentage of intended consonant distributions for seven studies of normal and speech-delayed children and adults are presented. Intercorrelations among these studies also range from rs of .84 to .98. Intercorrelations of each of the five conditions in the present study with data from each of these seven studies range from .75 to .96.

Some frequency of occurrence differences associated with sampling conditions are notable on sound-by-sound inspection. For both examiners, Condition 4 (Interview) was associated with a higher frequency of occurrence of [m] and a lower frequency of occurrence of [ð]. Inspection of the transcripts indicated that in these conversational samples, the children talked more about their own experiences, frequently using the words me, my, mine, and variants of mom. The lower frequency of [o] in this condition may be explained by the absence of physical referents and materials that typically prompt use of the demonstrative pronouns this, that, those, these, and the pronoun them. These two findings may also account for the differences in word forms previously described. Specifically, the lowered proportion of CVC forms in Condition 4 (Interview) may be associated primarily with the lack of demonstrative pronouns that have CVC shapes. The higher proportion of CV forms may be related to the higher proportion of self-references (i.e., me, my).

Other than the differences in the proportional occurrence of [m] and  $[\eth]$  in Condition 4, the degree to which stimulus materials influence the occurrence of consonants appears to be unpredictable. Several consonants were proportionally more frequent for some conditions in samples obtained by one but not both examiners. Variables such as the child's current interest in the materials and the examiner's comments and manipulations of the

	Percentage Consonants Correct (PCC				
Condition	M	SD			
1	71.1	7.0			
2	68.5	7.7			
3	68.2	7.2			
4	71.4	7.1			
5	73.2	6.6			
All	70.5	7.1			

 TABLE 7. Percentage Consonants Correct (PCC) obtained by

 children in the five sampling conditions.

materials to prompt verbalizations appear to be more important sources of variance than the materials themselves.

Overall, these data suggest that proportional distributions of parts of speech, word forms, and consonants in continuous speech are essentially similar across typical clinical sampling conditions (see also Shriberg, 1982).

## Reactivity

Phonetic and speech register analyses. Subjects' phonetic accuracy in the five sampling conditions was determined by their percentage of consonants correct (Shriberg & Kwiatkowski, 1982). As shown in Table 7, group means were within 5 points of one another on percentage of consonants correct. A repeated measures analysis of variance was nonsignificant [F(4,44) = 1.60, p < .25].

Although the children's average percentage of consonants correct scores did not differ significantly across conditions, there were some differences in speech register behaviors that sometimes resulted in an initial impression of reduced intelligibility. Review of the 60 individual transcripts indicated that 8 of the 12 subjects had their lowest percentage of consonants correct in either Condition 2 (Story) or 3 (Routines). These two sampling conditions used the same type of stimulus materials, a colorform setup. Children were given the opportunity to simultaneously create content visually by setting up colorforms in some meaningful way on a storyboard and comment on the product (see Appendix). To determine possible reasons for children's lowered percentage of consonants correct in these two conditions, transcripts for all sampling conditions for Examiner 1 were coded for selected register differences. Examiner 1's samples were chosen for coding in this way because, in comparison to Examiner 2's samples, Examiner 1's speech samples were more similar in number of utterances (averaging 98-114) and total words (averaging 308-339) per sample.

Figure 3 is a display of the percentage of occurrence of three types of register variables identified in the speech samples. The category termed Reduced includes altered segmental and suprasegmental behaviors occurring in whispering, in low-intensity speech, and in mumbled



FIGURE 3. Percentage of occurrence of three register categories in the five sampling conditions.

speech with adequate volume. The category termed Playful includes utterances that were said in the voice of a play character (e.g., Oscar the Grouch) or with intentional sing-song intonation. The category termed Sound Effects includes utterances in which a child made some nonspeech noises such as simulating sounds of an engine or animals. Each utterance that showed a register change was adequately described by a single register code. As shown in Figure 3, slightly higher percentages of utterances in the Reduced category occurred in Conditions 2 and 3.

Register differences termed Reduced may have had an indirect effect on children's percentage of consonants correct in two ways. Children may actually have been less accurate in their consonant productions as they directed their attention to the propositional aspects of play constructions required by the colorform materials used in Conditions 2 and 3. The cognitive and manipulative elements of the task may have required considerable resource allocation such that children used only their well-established but incorrect articulatory behaviors rather than both their established error patterns and emerging correct forms. A second possible explanation for the lowered percentage of consonant correct scores in Conditions 2 and 3 concerns the effect of altered registers on the transcriber's task. Because more vigilance was required to transcribe the child's speech reliably, less salient articulation may have had a higher probability of being transcribed as incorrect. This observation was first proposed in a normative study by Hoffmann.<sup>2</sup> Transcribers noted that when children were both constructing play forms and talking about them, their speech was more taxing to transcribe than when children talked directly to the examiner. The present data do not allow for quanti-

<sup>&</sup>lt;sup>2</sup>Adapted from Hoffmann, K. (1982). Speech sound acquisition and natural process occurrence in the continuous speech of three-to-six-year-old children. Unpublished master's thesis, University of Wisconsin, Madison.

	Condition									
		1	-	2		3	4	4	ł	5
Process	М	SD	M	SD	M	SD	М	SD	М	SD
Final consonant deletion	5.1	8.7	4.2	7.0	3.0	3.9	2.2	3.0	4.1	4.3
Assimilation										
Regressive	0.6	0.7	0.9	1.6	6.0	19.2	0.7	1.5	0.4	0.5
Progressive	0.0	0.0	0.1	0.5	0.3	0.8	0.1	0.4	0.8	1.4
Velar fronting										
Initial	17.5	33.9	11.1	29.6	25.8	40.1	16.0	30.7	8.3	28.9
Final	0.0	0.0	4.2	14.4	8.3	28.9	6.3	21.7	6.7	23.1
Stopping										
Initial	36.9	25.7	43.0	26.4	31.9	23.7	41.1	33.6	27.6	25.2
Final	3.1	8.7	4.1	9.8	17.9	30.9	11.4	16.7	4.7	9.6
Palatal fronting										
Initial	2.1	7.2	0.0	0.0	0.0	0.0	0.0	0.0	4.2	14.4
Final	0.0	0.0	0.0	0.0	2.8	9.6	0.0	0.0	4.0	11.5
Liquid simplification	• • •									
Initial	25.0	39.9	21.1	35.5	20.6	29.4	21.1	32.6	25.1	36.3
Final	9.9	16.0	17.4	24.1	8.4	12.2	13.7	25.2	16.3	26.7
Cluster reduction										
Initial	54.1	44.5	46.8	42.1	32.8	39.1	59.6	39.5	49.9	44.4
Final	10.6	16.4	23.3	30.6	15.1	20.5	18.3	22.2	2.7	6.0
Unstressed syllable reduction	2010									
2 svilables	4.5	7.9	4.0	7.5	3.2	7.4	0.3	1.1	0.9	2.2
$3 \pm syllables$	8.3	28.9	6.9	16.6	8.3	28.9	1.7	5.8	2.8	9.6

TABLE 8. Percentage of occurrence of eight natural processes in the five sampling conditions.

tative inspection of the relative strength of each of these two explanatory hypotheses. However, transcribers' anecdotal recall suggests that both sources contributed to lowered scores, with actual reductions in articulatory precision by the children the primary source.

Phonologic analysis. Phonologic analysis of the 60 transcripts was accomplished using a computer-assisted procedure for natural process analysis (Shriberg, in press; Shriberg & Kwiatkowski, 1980, 1983). Output for each sample included percentage of occurrence data (number of process occurrences + number of possible process occurrences  $\times$  100) for each of eight sound changes proposed as natural deletions and substitutions in the acquisition of speech. Table 8 includes summary descriptive data that indicate that the means were similar across conditions. Because many of these 15 sound changes occur infrequently in word-initial and word-final position, the data were first inspected to determine which sound change categories had adequate variance for statistical analyses and which should be transformed (arcsine) if over 50% of the percentages were 0% or 100%. Of the 15 potential variables, 6 were excluded on the first criterion, and 5 variables were arcsine transformed. F values for the nine repeated measures analyses of variance ranged from < 1 to 1.76; none were statistically significant.

# CONCLUSION

Results of the several grouped analyses indicate that sampling conditions such as the five developed for this study can be used effectively to obtain spontaneous speech samples from speech-delayed children in the age range and severity levels sampled. Inspection of individual data suggests several important guidelines for speech sampling.

First, the examiner must have the flexibility to shift stimuli and questions as necessary to keep the child talking. The examiner needs to have on hand a variety of stimulus materials and be skillful in identifying and discussing a range of topics of potential interest to the child whose speech is being sampled. Young children vary, both between samples and moment by moment, in their attentiveness and disposition to talk. A one-condition protocol for sampling continuous speech, including procedures similar to any of the five conditions used in the present study, may limit total productivity for an individual child.

Second, intelligibility can be increased by increasing control over the content of the child's utterances. One way to achieve increased control is to use protocols such as those described for Conditions 3, 4, or 5 (see Appendix). For those children whose percentage of glossable words falls below approximately 66% or less than two out of every three words, data obtained from continuous speech sampling procedures might need to be supplemented with data obtained from a citation form articulation test. However, even unintelligible words, if carefully transcribed, can provide information on phonetic inventories and distributional aspects of the child's phonology.

A third suggestion concerns the influence of stimulus materials and examiner questions on the frequency of occurrence of lexical items, which in turn, may influence the proportional occurrence of intended word forms and phonemes. To optimize the representativeness of the sample, the examiner should monitor the child's output for repeated use of the same vocabulary and vary materials and prompts as necessary to increase the number of word types. Statistical distributions of intended word forms and intended consonant phonemes should be inspected before proceeding to phonetic and phonologic analyses. If a significant discrepancy from normative data is apparent in a continuous speech sample, word types rather than word tokens should be used for the analyses. The word token data can be used to examine phonetic and phonologic stability of words and related questions requiring repetitions of lexical items.

Finally, it is apparent that children's cognitive and affective states during the progress of a continuous speech sample require the examiner's careful attention. Register differences, as described within these data, may be associated with reduced articulatory precision, with reduced transcription reliability, or with both sources of variance. In a clinical milieu where "rappport" has been well established, children's natural affinity for play may be counterproductive for the goals of speech analysis. That is, as a child becomes completely comfortable within the session, talking with an examiner may become less interesting or even incompatible with the "fun things to do."

In summary, findings from this study support the use of continuous speech sampling for an eventual integrated linguistic analysis of children's speech. When the methodological care currently recommended for phonetic transcription and linguistic analysis is also given to sampling procedures, continuous speech samples should yield valid and reliable data.

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# APPENDIX

#### Five Sampling Procedures to Evoke Continuous Speech<sup>3</sup>

I. Nondirected—Uncontrolled ("Free")

efficient research and editorial assistance.

- A. Sample materials
  - 1. Fisher Price house, furniture, car, people
  - 2. Playdough, cookie cutters
  - 3. Bubbles
  - 4. National Park setup toy
- B. Verbal instructions
  - "I have a lotta toys to play with now. We can talk and play with all these things."

C. Procedures

1. When the child is not responsive

<sup>&</sup>lt;sup>3</sup>Technical considerations for obtaining usable speech samples and distributional statistics for speech-normal and speech-delayed children are reported in Shriberg (1982), Shriberg and Kent (1982), Shriberg and Kwiatkowski (1980, 1982, 1983), and Shriberg, Kwiatkowski, and Hoffmann (1984). A consolidated presentation of procedural conventions and empirical findings is presented in Shriberg (in press). Attention to procedural details in recording, glossing, and transcribing continuous speech directly determines the validity, reliability, and usability of the sample.

- a. If the child does not respond within 20 s, act upon a material and comment on your actions; use present, past, and future tense verb forms. Try also to include *s*-marked possessives and plurals.
- b. If after a comment as in 1a the child does not respond within an approximate 10-s period, make another 1a comment.
- c. If the child still does not respond within an appropriate 10-s period, ask, "What's happening?" or "What happened?"—whichever is more appropriate.
- d. If the child still does not respond within a 10-s period, repeat the sequence 1a, 1b, 1c.
- 2. When the child talks about topics unrelated to the materials
  - a. Gloss the child's utterance and allow the child to comment further on this off-task topic; do not ask any questions. b. If the child elects to continue with the off-task topic, continue to respond as in 2a.
- II. Nondirected—Indirect ("Story") (see Footnote 2)
- A. Sample materials
  - Muppet colorform setup, two gingerbread cookie colorforms
- B. Verbal instructions
  - "We're gonna take all these off" (help the child remove the colorform pieces from the background surface). "You can put them back. You can tell me a story about the picture that you make."
- C. Procedures
  - 1. When the child is not responsive
    - a. If the child does not respond within approximately 5 s, say, "Maybe you know who they are. I don't know anything about them."
    - b. If after 1a the child does not respond within an additional 5 s, say, "Someone told me they were the Muppets."
    - c. If the child still does not respond within an additional 5 s, model a possible response. Put a colorform piece on the board and say "You could tell me \_\_\_." Then remove the piece from the board.
    - d. If the child still does not respond, then point to an area of the picture's background and make a comment. Some examples: "That sure is a fancy car. My car doesn't look like that." "I wonder why they made a fire. Maybe they live out here." "I wonder what they can do in the water."
  - 2. When the child identifies a character, but does not say something about the character in approximately 5 s, then say, "I didn't know that was (*character's name*). Tell me about him/her."
  - 3. When the child's picture is completed, say, "You made a nice picture. Now tell me a story about your picture."
  - 4. When the child talks about topics unrelated to the materials, gloss the child's utterance and make a comment to direct him/her back to the materials. Do not ask questions. Try to actively prevent the child from talking about topics that do not relate to the materials.
- III. Nondirected and Directed-Indirect ("Routines")
- A. Sample materials

Colorform house and selected items to place in the house—these items were selected to contain a sampling of all the consonants. Most of the target words represented by these items are nouns; these are referred to as *material-controlled words*. Target words that are not nouns are referred to as *topic-controlled words*. Different procedures are used for creating situations for the child to use material-controlled versus topic-controlled words.

B. Verbal instructions

"Here's a house. Maybe it's like your house. We can talk about things in the house. We can talk about what the people do in the house. You can make them do things that you do in your house. I'll start. Where's the table? I'll put the table here. They can eat at the table. Now your turn. You can tell me what you'll need and what you do."

- C. Procedures for material-controlled words
  - 1. When the child is not responsive
    - a. If the child does not respond within 20 s, use an open-ended prompt. Try to include different verb tense forms. The specific content of the open-ended prompt will depend upon what is meaningful in the situation. Some examples:
      - "I'd like to know what the boy is doing.
      - "I'd like to know what you will do."
      - "I'd like to know what happened."
      - "Tell me about what you will do."
      - "Tell me about what the boy is doing."
      - "Tell me about what happened."
    - b. If after an open-ended prompt as in 1*a* the child does not respond within approximately 20 s, ask specific questions. The specific content of the question is determined by the content sought with the original open-ended prompt. Try to include different verb tense forms. Some examples:
      - "What will he do with the giraffe?"
      - "What is he doing in the kitchen?"
      - "What did he do in the kitchen?"
  - 2. When the child talks about topics unrelated to the materials, pursue the topic using the *la* and *lb* sequence.
- D. Procedures for topic-controlled words
  - 1. Use the following prompts to create the opportunity for the topic-controlled words to occur. Use these prompts only when the child acts on the particular material to which the prompt refers. Present each prompt only once. Target word/possible phrase Prompt "Look here's a picture. The picture fell down. What does somebody need to do?" Hang the picture "They're done eating. The dishes are dirty. What does somebody have to do?" Wash the dishes In the zoo (re: the giraffe) "Does he live in a house. Where does he live?" Give him a bath 'The cat is all dirty. What does Dad need to do?' Go for a ride "Dad is tired of staying inside the house. He can get in the car. What can he do with his car?" Ask a yes/no question to elicit a yes response. Yes
  - 2. When the child talks about topics unrelated to the materials, pursue the topic using the *1a* and *1b* sequence described in *C* above.
- IV. Nondirected and Directed-Direct ("Interview")
  - A. Sample materials
    - None

### B. Verbal instructions

- "I would like to know you better. Maybe you want to know about me too. We can just talk for a while."
- C. Procedures
  - 1. Use open-ended prompts to introduce topics for conversation. Try to use different verb tense forms. Some examples:
    - "I'd like to know about \_\_\_\_"
    - "I don't know how to \_\_\_\_. Tell me about this."
    - "Tell me about \_\_\_\_."

Precede open-ended prompts with yes/no questions as needed to identify topics for conversation. For example, "Do you have any brothers or sisters?" (Child responds.) "Tell me about what you do with your sister."

- Some examples of topics for conversation:
- Siblings-activities with brothers and sisters

School-activities in school, likes and dislikes

- Summer-activities in summer, summer vacations
- Winter-activities, sights
- Eating-what ate for breakfast or lunch; if eats in restaurants, favorite restaurant and what to do there
- TV-what watch on TV, favorite show, what happens on favorite show
- Special toy-what is favorite toy, where got it, who gave it, what to do with it

Weather—for example, if it's raining can talk about possible experience they have had; if got wet or how kept from getting wet Because this is to be a conversational interchange, periodically also comment on the current topic much as you might in a real conversation. For example, provide some information about yourself.

Keep changing the topic of conversation until you find one that the child will talk about. Keep talking about this topic until the child loses interest. Then attempt to identify a new topic.

- 2. When the child is not responsive to the open-ended prompt (1 above), ask specific questions. Try to use different verb tense forms.
  - Some examples:

"What do you do with your toy?"

"What happened when you dropped it?"

3. When the child talks about a topic unrelated to the immediate topic of conversation, pursue the child's topic using the sequence described in 1 and 2 above.

V. Directed-Direct ("Scripted")

A. Sample materials

Selected pages in Richard Scary's *Best Word Book Ever:*<sup>4</sup> picture of the zoo (pp. 34–35) and pictures of a bear getting ready in the morning (p. 8).

B. Verbal instructions

"Let's talk about this picture. There are lots of things happening in this picture. We can talk about them?"

C. Procedures

1. Use the following script. The script includes the verbal stimulus, the target word, and the prompt that is to be used when the child does not respond to the verbal stimulus. Target words were selected to represent a sampling of all the consonants. The child's response is to be at least a short phrase, it should not be a single word.

		Zoo	
	Stimulus	Target word/ Possible phrase	Prompt
Here's a : It's not a	fun place to go. circus.	a ZOO	Tell me about what this place is.
I like to a (point to Look, thi (point to bears). Look at t	go to the zoo the deer). s animal has to stand the panda and brown hese bears.	they SIT	Tell me about what the bears do.
Oh, look do (point tail).	at what the mokey likes to to monkey hanging by his	he likes to hang by his TAIL	Tell me about what this monkey likes to do.
Let's lool	on this other page.		
This anin ground (p	nal is just standing on the point to rhino).		
Look at t did (poin	his animal. Look what he t to hippo's mouth).	opened his MOUTH	Tell me about what the hippo did.
(continue He's in th him (poir	to point to hippo) ne water. I can't see all of nt to head).	only the HEAD	Tell me about what part of the hippo is sticking out of the water.
<sup>4</sup> Golden Press, New York.	1974.		

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	Here's another animal (point to giraffe). I can see his feet and his legs and look what else (point to the length of neck).	a LONG NECK	Tell me about what the giraffe has (tell me if that's a short neck).
	Here's the zoo helper (point). He's gonna feed the seal. He can't get too close. He has to throw the fish to the seal. Look what the seal's gonna do (follow track of fish from zookeeper to seal).	CATCH it	Tell me about what the seal's gonna do.
	Look here. The cat has lots of balloons (point) but look (point to mouse with just one yellow balloon).	ONE balloon	Tell me about how many balloons the mouse has.
	This mouse doesn't have a balloon. He needs one. (point to the mouse receiving the balloon) Look what the cat will do.	GIVE him a balloon	Tell me about what the cat will do.
	I see a yellow balloon here (point to mouse with yellow balloon). But look (point to a red balloon).	a RED balloon	Tell me about the color of this balloon.
	I wish I had that balloon (point to a balloon and look at the child as if to say, "How about you?").	I want THAT balloon	Tell me about the balloon that you want.
	We can look at one more new picture (rustle pages but hesitate turning).	TURN THE PAGE	Tell me about what I need to do so we can look at a new picture.
		Bear's Morning Routine	
	Stimulus	Target word/ Possible phrase	Prompt
	Here's an animal who lives in the zoo.	It's a BEAR	Tell me about what kind of animal this is.
	Let's pretend he's getting ready to go to the zoo. He wakes up. He looks out his window (point to window). It looks like nighttime.	It's DAY	Tell me about what time it is.
	He has to get ready to go to the zoo. He can't be dirty and messy. Look what he needs to do (point to wash face).	WASH HIS FACE	Tell me about what he needs to do.
	You've talked about a lot of pictures. Here's another picture. Who do you think should talk about this picture?	YOU should	Tell me about who should talk about this picture.

2. When the child is not responsive to the prompt, tell the child the intended response in a conversational manner and proceed to the next verbal stimulus/target word in the script. Later, return to the picture and repeat the original verbal stimulus, asking the child if he/she remembers the intended response. For example, "Here's a fun place to go. It's not a circus. Do you remember what this place is?"

3. When the child talks about topics unrelated to the materials, gloss the child's utterance and return to the script. Try to actively prevent the child from talking about topics that do not relate to the material.

# **Continuous Speech Sampling for Phonologic Analyses of Speech-Delayed Children**

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