Journal of Speech and Hearing Research, Volume 37, 1100–1126, October 1994

Developmental Phonological Disorders I: A Clinical Profile

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Detailed information on the speech, language, prosody, and voice characteristics of children with developmental phonological disorders is central to diverse research questions. The present study provides a clinical profile of 178 children with developmental phonological disorders. It includes information from prior reports (Shriberg & Kwiatkowski, 1982a; Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986) and from several new measures on a sample of 64 children. The speech, prosody-voice, and causal-correlates profiles for the most recent sample are consistent with prior findings, providing a descriptive profile for forthcoming subgroup research and companion studies addressing short-term (Shriberg, Kwiatkowski, & Gruber, 1994) and long-term (Shriberg, Gruber, & Kwiatkowski, 1994) speech-sound normalization.

KEY WORDS: phonology, disorders, prosody, developmental, causal-correlates

Etiologic research in developmental phonological disorders studies the phonological consequences of biological and environmental constraints at different periods of growth and development. Two principal effects designs are used. The most frequent method is to determine if children with developmental speech disorders have higher base rates of the suspected causal factor compared to incidence and prevalence rates in control groups. Although many speech-hearing mechanism, cognitive-linguistic, and psychosocial factors have been proposed as sufficient cause for a developmental phonological disorder, no study or series of studies to date has provided clear support associating developmental phonological disorders with specific etiologic antecedents (see reviews by Bernthal & Bankson, 1993; Shriberg et al., 1986; Winitz, 1969; Winitz & Darley, 1980). The second and less frequently reported method is to attempt to identify and document unique error patterns in the speech of children with clinical or subclinical involvements of the suspected causal factor. A fundamental question about this approach is whether the putative causes result in only a delay in the *onset* or *rate* of speech acquisition or whether these causal agents may also have differential consequences for the *sequence of target acquisition* and the *error patterns* observed in disordered speech-sound acquisition and eventual normalization. The present profile of the speech, prosody-voice, and causal-correlates characteristics of children with developmental phonological disorders provides baseline information for such questions, as well as other questions with the goals of explanation, prediction, intervention, and ultimately prevention.

Method

Subjects

Recruitment. Potential subjects were obtained through an arrangement with speech-language personnel in the Madison (Wisconsin) Metropolitan School District. Clinicians were asked to refer all 3- to 6-year-old children whose speech errors were

  0022-4685/94/3705-1100

severe enough to interfere with intelligibility and to warrant speech services, provided the origin of the errors was unknown. Thus, the study excluded children whose errors were associated with severe deficits in the structure or function of the speech mechanism, intellectual deficits, or significant psychosocial dysfunction. Each of the caregivers of 66 children identified and contacted by school personnel agreed to participate in the study after follow-up calls explaining the study by the second author. Most of the candidate children had not received speech services at the time of assessment, but some children (reviewed later) were receiving speech-language services in individual programs, small group programs, or early childhood classes. All children were native speakers of American English and had no significant dialectal differences from General American English. Additional description of the final subject group is provided in a later section.

Assessment schedule. Assessment sessions for each of the 66 children were arranged by a telephone call from the examiner who was to assess the child. Preliminary information on the child and caregiver was obtained, with special attention given to information that might be used to increase the child's and caregiver's level of participation in the protocol. The caregiver was given a choice of scheduling one 2-hour assessment session or two 1-hour sessions. Approximately two thirds of the children completed the 2-hour assessment battery in one session, with a 15-minute break after the first hour. Approximately one third of the children were seen for two 1-hour assessment sessions scheduled on different days within a 10-day period. Fifty of the 66 children were seen for assessment during an 8-week summer period; an additional 16 children were assessed during a 6-month period beginning 5 months later (January through June). The final sample consisted of 64 of the 66 children who completed all major elements of the assessment protocol.

Assessment

Two second-year master's students in Communicative Disorders, each with extensive clinical experience with young children, were employed to administer the 2-hour assessment protocol. The examiners were given no prior information about the study other than that they were each to schedule and assess approximately 32 young children with speech delays and to reduce the data from some of the assessment tasks. Examiners were trained for 6 days before administering the assessment protocol to a subject. The three-stage training program included (a) introduction to and demonstration of each assessment task; (b) practice administering each task, including role-playing administrations; and (c) successful administration of the entire protocol to a pilot subject. A successful administration was defined as valid and reliable data collection relative to the directions in each test manual and efficient relative to the authors' experience with each measure. The two training goals were to ensure that all tasks were administered correctly, with minimal individual differences between examiners.

The assessment battery consisted of standardized measures and nonstandardized tasks in six categories: hearing, speech mechanism, speech production, language comprehension, language production, and case history and behaviors. Game-like activities were used to maintain children's interest within the nonstandardized tasks and between all tasks and measures. Following are brief descriptions of each task.

Hearing

1. *Audiologic Evaluation:* Hearing was screened in each ear at 500, 1000, 2000, and 4000 Hz at 15 dB HL using routine audiometric procedures for screening hearing acuity in a quiet room. A Grason-Stadler GSI or a GSAI 28 Auto Tymp meter calibrated according to ANSI (S3.6-1969) specifications was used for all evaluations.

2. *Acoustic Immittance Screening:* The Grason-Stadler GSAI 28 Auto Tymp meter was used to obtain tympanograms and acoustic-reflex thresholds. All activating signals were generated internally by the Auto Tymp meter.

Speech mechanism

1. *Orofacial Screening Examination:* A 57-item orofacial examination to inspect the structure and function of the speech mechanism was adapted from the protocol presented in Nation and Aram (1977). The tasks required the examiner to make both nominal- and ordinal-level judgments of the adequacy of a child's respiratory, laryngeal, velopharyngeal, and articulatory mechanisms.

2. *Isolated and Sequenced Volitional Oral Movements Task:* A task based on the work of Darley, Aronson, and Brown (1975) was used to assess ability to perform nonspeech oral movements (e.g., cough). The examiner made both nominal- and ordinal-level judgments of the child's ability to make isolated movements and a series of two and three sequenced movements in response to verbal directions and imitation.

3. *Diadochokinesis Task:* A modified version of a standard syllable imitation task assessed children's ability to coordinate movement within a single place of articulation and across two and three places of articulation. The single-syllable stimuli (e.g., /pʌ/) were presented for imitation in four-syllable trains, with stress on the first syllable. The two-syllable and three-syllable stimuli were also presented with stress on the first syllable. Responses were scored from audiotape and included information on the number of syllables in a 5-second period, articulatory accuracy, and appropriate rhythm.

Speech production

1. *Conversational Speech Sample:* Spontaneous continuous conversational speech samples were obtained using procedural conventions specified in prior work (Morrison & Shriberg, 1992; Shriberg, 1986; Shriberg & Kwiatkowski, 1980, 1982b, 1983). The examiner's goal was to obtain conversational speech samples of at least 100 utterances by varying topic and materials as described in Shriberg and Kwiatkowski (1985). The conversational samples were the primary source of data for all phonetic and phonologic analyses using enhancements to Programs to Examine Phonetic and Phonologic Evaluation Records (PEPPER) (Shriberg, 1986; Shriberg & Wilson, 1992) and for prosody-voice analyses using the Prosody-Voice Screening Profile (PVSP) (Shriberg, Kwiatkowski, & Rasmussen, 1990; Shriberg, Kwiatkowski, Rasmussen, Lof, & Miller, 1992).

2. *The Photo Articulation Test (PAT)* (Pendergast, Dickey, Selmar, & Soder, 1984): Each pictured stimulus was first named spontaneously, followed immediately by production in imitation of the examiner. The imitative productions were obtained for another study; only the spontaneous utterances were analyzed. Analysis of consonants (singletons and clusters), vowels, and diphthongs in each mode was accomplished using programs in the PEPPER software.

3. *Syllable Sequencing Tasks:* CVCVCV nonsense syllable sequences composed of /m/, /n/, and /b/ with /ʌ/ in C1VC1VC1 and C1VC1VC2V combinations and multisyllabic words were used to assess accuracy of syllable sequencing and speech-motor timing (vowel/consonant ratio). Both tasks were administered by imitation.

Language comprehension

1. *The Peabody Picture Vocabulary Test, Revised Form L* (Dunn & Dunn, 1981).

2. *Miller-Yoder Language Comprehension Test (Clinical Edition)* (Miller & Yoder, 1984).

3. *The Preschool Language Scale* (Zimmerman, Steiner, & Evatt Pond, 1979): Only the Auditory Comprehension subtests were administered to obtain an estimate of the child's general comprehension of language.

Language production

Oral Language Sample: The conversational speech samples were analyzed for syntactic performance using procedures and reference data described in Miller (1981) and Paul and Shriberg (1982) using Systematic Analysis of Language Transcripts (SALT) (Miller & Chapman, 1986). The conversational samples were also analyzed for evidence of difficulty in retrieving words and formulating ideas for expression. Such behaviors as mislabeling, correction of words and phrases, part-word and whole-word fillers, and false starts were coded and analyzed. In addition to any mislabeling coded from the conversational speech sample, mislabeling of words on the articulation test (PAT) were coded to reflect type of labeling error: *within category* (e.g., chair/table), *related item or action* (e.g., cut/scissors), *visually similar* item (e.g., bunny/angel), and *novel* (all other errors) (Shriberg, Kwiatkowski, & Snyder, 1986).

History and behavior

1. *Case History Data Form and Interview:* A comprehensive case history protocol was used, including a follow-up interview with the caregiver, to collect retrospective data on the child's medical, social, and speech-hearing-language history.

2. *Minnesota Child Development Inventory (MCDI)* (Ireton & Twing, 1974): This 320-item paper-pencil inventory was completed by the caregiver(s). The MCDI yielded age equivalent scores on several developmental subscales including general development, gross motor, fine motor, expressive language, conceptual comprehension, situational comprehension, self-help, and personal-social information.

3. *Examiner's Observation Checklist:* Following each assessment session, the examiner used a three-point ordinal rating system (Normal, Questionable, Involved) to code observation about the child's general motor, speech motor, and psychosocial behavior during the assessment session.

Transcription

The conversational speech samples were transcribed by two two-person consensus transcription teams using procedures for narrow phonetic transcription described in several prior reports (Shriberg & Kwiatkowski, 1982a; Shriberg, Kwiatkowski, & Hoffmann, 1984). The transcription teams transcribed a total of 121 articulation tests and conversational speech samples from the 64 children. Intra-team reliability was determined for each transcription team for both consonant and vowel transcription using five randomly selected transcripts yielding a sample of 430 words (763 consonants and 342 vowels). Point-to-point percentages of agreement for narrow phonetic transcription of consonants and vowels were 79% and 82% respectively; reliability for broad transcription of consonants and vowels was 91% and 92% respectively.

Results and Discussion

Results are reported in four sections that are organized to parallel the organization of findings in two prior papers that described children with developmental phonological disorders (Shriberg & Kwiatkowski, 1982a: Study A in the following discussion; Shriberg et al., 1986: Studies B and C in the following discussion): (a) gender, age, and severity data; (b) speech profiles; (c) prosody-voice profiles; and (d) causal-correlates profiles. The goal of each section is to derive one summary descriptive profile from the combined data sets.

Gender, Age, and Severity

Gender. Table 1 compares the demographics of subjects in three prior samples and the current study, including unweighted averages across the 178 subjects in the four studies. As indicated by the percentages in the second column from the right, the ratio of boys to girls in the current study (1.8:1) was considerably lower than ratios obtained in the three prior samples (Study A: 2.9:1, Study B: 2.5:1, and Study C: 2.7:1). Sampling bias is a possible explanation and is a methodological concern when subjects are obtained by referral, rather than by screening (cf. Shaywitz, Shaywitz, Fletcher, & Escobar, 1990). However, because comparable sampling methods (i.e., referral by speech-language pathologists in local schools and clinics) have been used in all four studies, sampling bias is not a likely source of the lowered males-to-females ratio in the present study. Reliable gender data are particularly important in epidemiological and genetics research where such information is used to generate hypotheses about alternative modes of genetic transmission. An epidemiological study by Tomblin (1991) using well-controlled stratified population sampling methods promises the level of reliability needed for prevalence estimates and gender ratios in developmental phonological disorders.

Age. The average age of children in the four studies was 4 years, 8 months. As shown in Table 1, Study C and the current study yielded proportionally more younger children than did the two earlier studies, Studies A and B. Findings from the current study, which are consistent with records in

TABLE 1. Gender and ages of subjects in the current and prior studies.

Variables	Study A[a] (n = 43)	Study B[b] (n = 38)	Study C[b] (n = 33)	Current study (n = 64)	All studies[c] (n = 178)
Gender					
Boys	74%	71%	73%	64%	70.5%
Girls	26%	29%	27%	36%	29.5%
Age at sampling (years:months)					
M	5:9	4:11	4:1	4:3	4:8
SD	1:2	1:6	1:1	0:7	1:1
Range	4:0–8:11	1:10–9:7	1:11–6:8	3:0–6:1	1:11–9:7

[a]Reported in Shriberg and Kwiatkowski (1982a).
[b]Reported in Shriberg, Kwiatkowski, Best, Hengst, and Terselic-Weber (1986).
[c]To adjust for sampling differences across studies, the average for All Studies is not weighted by the number of subjects per study.

our university Phonology Clinic, indicate that the average age of referral for children suspected to have a phonological disorder has stabilized at approximately 4 years, 3 months.

Severity. Three measures have been used in prior studies to index the severity of involvement of children with developmental phonological disorders: the Percentage of Consonants Correct (PCC), the Intelligibility Index, and earlier versions of a procedure currently termed the Prosody-Voice Screening Profile (PVSP) (Shriberg, 1986; Shriberg & Kwiatkowski, 1980, 1982a; Shriberg et al., 1986; Shriberg et al., 1990). Table 2 summarizes the severity of involvement of the current sample compared to prior samples, including the unweighted average values across the four studies. Different methods across the four studies yielded different sample sizes for each of the dependent variables. As assessed by PCC scores, average severity of involvement ranged from approximately 62% to 70% across the four studies, with the younger subjects in the two more recent studies having average PCC scores of approximately 63%. The four-category severity classification based on PCC scores indicates fairly stable percentages of children with *mild* and *severe* involvements in the two most recent studies, with percentages for *mild-moderate* and *moderate-severe* differing by as much as nearly 40% across the four studies. The source of the increased proportion of children in the *moderate-severe* category in the present study is not known. The unweighted average indicates that over half (54%) of children with developmental phonological disorders have *mild-moderate* involvement and nearly one third (32%) have *moderate-severe* involvement, with the remaining 10% to 15% distributed among *mild* and *severe.*

The intelligibility data (percentage of words that could be glossed by the transcribers) for the current study yielded mean Intelligibility Index scores above 90% for each of the three levels of severity (PCC) sampled (see Table 2). Intelligibility Index scores averaged somewhat lower for three of the four PCC levels in Study C. Because all the intelligibility data were obtained in a controlled setting and glossed after repeated audiotape replays by experienced transcribers, they are "best case" estimates of intelligibility. As discussed elsewhere (Weston & Shriberg, 1992), correlations between Intelligibility Index and PCC scores average in the low .40s, sharing only approximately 15% to 20% of common variance.

Finally, the suprasegmental data for the current study in relation to the three other studies shown in Table 2 reflect the upgraded version of the prosody-voice procedure. A later section will review descriptor-level data obtained with the newer procedure. As shown in Table 2, the summative scores for some of the suprasegmentals vary considerably across studies. Because the current sample has the largest and most representative sample of children and uses the most well-developed prosody-voice procedure, the values for this group are proposed as the most reliable estimate of population values in children with developmental phonological disorders.

Speech Profiles

Description. The primary speech analyses in the current study are based on the continuous speech samples; the spontaneous articulation test data are used for some comparisons to other studies. Figures 1 and 2 provide phoneme-level and feature-level speech data in analyses formats called *speech profiles.* The data indicated by the filled circles are from the 64 speech-delayed (D) children referred to as the current or present study. To compare these data with data from children acquiring speech normally, the data points indicated by the open circles are from the 72 speech-normal (N) 3- to 6-year-old children described in Hoffmann (1982), Hoffmann and Shriberg (1982), and Shriberg (1986, 1993). All speech-sampling, transcription, and data reduction procedures for the speech-normal children were accomplished using the same methods as used with the speech-delayed children (Shriberg et al., 1986).

Rationale and validity data for speech profiles are presented in Shriberg (1993). Speech profiles are generated by software that computes descriptive statistics from the speech samples, computes inferential statistics, and produces several types of four-panel displays. The following four paragraphs provide an overview of the numerical and graphic elements of a speech profile.

The four panels in Figure 1 describe the average percentage of consonants correct (Panel A) and error type percentages (remaining panels) for the 64 children with developmental phonological disorders in the current study compared to data for the normative reference group. Each of the four

TABLE 2. Severity of involvement, intelligibility, and prosody-voice status of subjects in the current and prior studies.

Variables		Study A	Study B	Study C	Current study	All studies[a]
Severity of involvement[b]						
n		29	38	14	64	145
M		70.0	68.3	62.2	62.8	65.8
SD		11.0	10.3	12.9	8.2	10.6
Range		48–95	46–89	36–77	39–78	36–95
Mild[c]		10%	5%	0%	0%	4%
Mild-Moderate		55%	71%	57%	33%	54%
Moderate-Severe		31%	16%	29%	53%	32%
Severe		3%	8%	15%	14%	10%
Mean Intelligibility Index[d]						
n		—	—	52	64	—
PCC: Mild		—	—	98%	—	—
PCC: Mild-Moderate		—	—	81%	95%	—
PCC: Moderate-Severe		—	—	78%	91%	—
PCC: Severe		—	—	78%	91%	—
Prosody-Voice Status						
Prosody						
Phrasing	Pass	55%	97%	50%	71%	68%
	Questionable	24%	3%	14%	18%	15%
	Fail	21%	0%	36%	11%	17%
Rate	Pass	74%	87%	57%	92%	78%
	Questionable	13%	3%	21%	2%	10%
	Fail	13%	11%	21%	0%	11%
Stress	Pass	79%	76%	79%	81%	79%
	Questionable	11%	8%	7%	6%	8%
	Fail	11%	16%	14%	13%	14%
Voice						
Loudness	Pass	90%	82%	86%	68%	82%
	Questionable	8%	5%	0%	19%	8%
	Fail	3%	11%	14%	13%	10%
Pitch	Pass	71%	79%	50%	98%	75%
	Questionable	8%	3%	21%	2%	9%
	Fail	21%	18%	29%	0%	17%
Quality	Pass	40%	55%	29%	40%	41%
	Questionable	13%	8%	7%	18%	12%
	Fail	47%	37%	64%	43%	48%

[a]Averages are not weighted by the number of individuals in each group.
[b]Percentage of Consonants Correct (PCC).
[c]Rounded percentages may not equal 100%.
[d]Intelligibility data were not available for Study A. The figures under the Study C heading are combined for Study B and Study C. Notice that the percentages are the mean Intelligibility Index values for each of the four PCC classifications.

panels includes a summary *numeric* section at the top and a larger *graphic* section below. The consonant phonemes in each of the panels in Figure 1 are divided into groups termed *developmental sound classes:* the *Early-8* sounds, the *Middle-8* sounds, and the *Late-8* sounds. Division of the 24 English consonants into these three developmental sound classes was suggested by their clustering on a rank-ordered trend reflecting average percentage correct in speech-delayed children (cf. Shriberg, 1993). Thus, the descending trends in the graphic section of Panel A in Figure 1 reflect the percentages correct for each of the 24 consonants occurring as both singletons and clusters. The numeric section at the top of Panel A provides means and standard deviation data for consonant singletons (S), consonant clusters (C), and all consonants (T) for each of the three eight-sound groups and across all 24 sounds.

The data in the remaining three panels in Figure 1 provide information on the error types observed in the narrow transcription of the conversational speech samples. The trends in the graphic sections are the average *relative* error types for each consonant, with the summary data in the numeric sections of each panel providing information on both *absolute* (A) and *relative* (R) errors. *Absolute* errors (omissions, substitutions, and distortions) are the percentage of each error type in the conversational speech sample. The numerator for each absolute error percentage is the number of incorrect sounds (errors) of that type in the sound class addressed, and the denominator is the total number of *correct* plus *incorrect* sounds for that sound class. As is done for the PCC metric, the data in each of the three 8-sound classes are weighted by the contribution of each sound in the class. Thus, more frequently intended (i.e., target) sounds in a speech sample contribute more heavily than less frequently intended sounds to the subgroup percentages for the Early-8, Middle-8, Late-8 sound groups and the total for all sounds. *Relative* omission, substitution, and distortion errors provide error-pattern information that adjusts for subjects' severity of involvement by basing the percentage on each

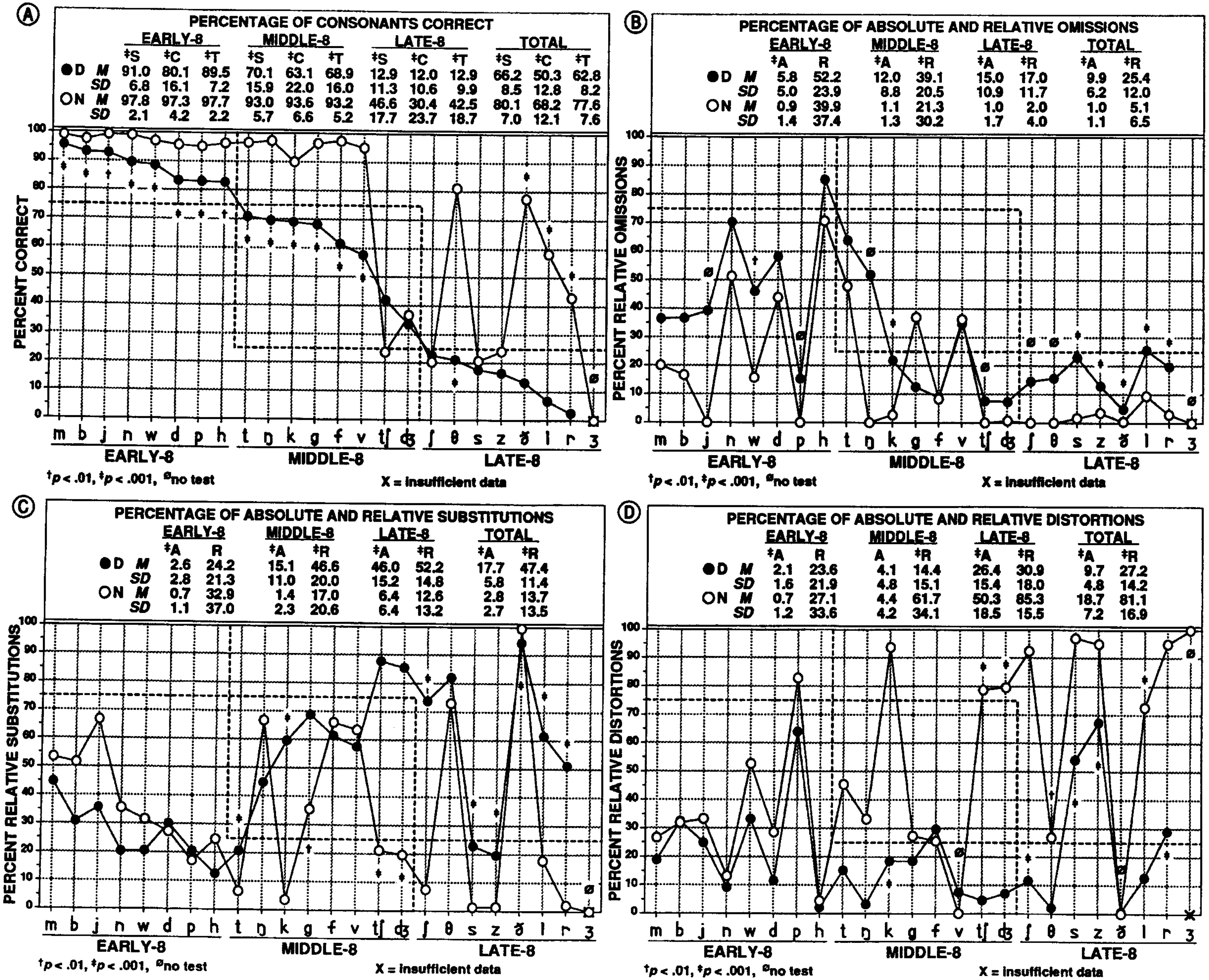

FIGURE 1. ***Speech Profile: Consonants*** comparison of the 64 3- to 6-year-old speech-delayed (D) children in the present study to 72 3- to 6-year-old speech-normal (N) children described in Hoffmann (1982), Hoffmann and Shriberg (1982), and Shriberg (1986, 1993).

subject's total number of errors. In the numeric section of the panel, the relative data are based on all sounds in each of the three developmental sound classes. The numerator for each child is the number of errors of that type, and the denominator is the total number of *incorrect* sounds in the sound class addressed. In the graphic sections, the relative data computed for each phoneme are displayed. Thus, the absolute and relative errors provide alternative metrics for questions about how speakers err in the production of target phonemes.

The four panels in Figure 2 are conceptually similar to those in Figure 1, but aggregated by phonetic features. Feature *Class* data are provided for sonorants (S) and obstruents (O); analysis by *Voice* includes data summed for all voiced (V) and voiceless (VL) sounds; and analysis by *Manner* includes percentages for all target nasals (N), glides (G), stops (S), affricates (A), fricatives (F), and liquids (L). The numeric sections of Panels B, C, and D in Figure 2 include data on the percentage of absolute errors, whereas the graphic sections in these panels display the percentage of relative errors.

The daggers and double daggers in the numeric and graphic sections of all panels in a speech profile indicate significant between-group differences at the .01 and .001 levels, respectively. For the present data the statistic was the nonparametric Mann-Whitney test (MINITAB, 1989; Siegel & Castellan, 1988). Although means and standard deviations provide the most meaningful descriptive statistics for the numeric and graphic displays, nonparametric statistics typically provide the most appropriate inferential tests of differences in the articulatory behaviors of two or more groups. Specifically, nonparametric tests allow for (a) the nonnormality of distributions for each comparison, including high frequencies of 0% and 100% scores that cannot be transformed for parametric analyses; (b) the correlation of means and standard deviations at extremes of measurement; and (c) the typically small and/or disproportionate sample sizes. The two probability levels, .01 and .001, bracket, respectively, liberal and conservative family-wise alpha levels for the number of tests in the numeric and graphic sections of each panel. By presenting the graphic and numeric data in original percentages and using the appropriate nonparametric statistics at two advisory alpha levels, the speech profile analyses (and subsequently, the prosody-voice profile analyses) attempt to balance the goals of exploratory data analysis, advisory inferential statistics, and the avoidance of Type I or Type II errors of inference.

The profiles in Figures 1 and 2 provide information on a number of variables of interest in disordered child phonology. Because of interdependencies, it will be necessary to discuss data in these speech profiles concurrently. Moreover, discussion will move among the numeric and graphic sections of the four panels in each profile.

Consonant profiles. Beginning with the graphic section of Panel A of Figure 1, the speech-delayed children (filled circles) have significantly lower percentage correct scores than the speech-normal children (open circles) on 18 of the 23 sounds (/ʒ/ had insufficient data to test). The two groups had approximately similar percentages correct on the remaining five consonant sounds: /tʃ/, /dʒ/, /ʃ/, /s/, and /z/. As shown in the graphic section of Panel D of Figure 1, approximately 80% to 95% of the errors on these latter five sounds in the speech-normal children were phonetic *distortions*. Subsequent analyses of the specific type of distortion errors using another speech profile format (not shown here) indicated that the speech-normal children's distortions of these two affricates and three fricatives were almost always dentalizations. These data for the speech-normal children are consistent with the data of Smit, Hand, Freilinger, Bernthal, and Bird (1990), indicating that it is not until after 6 years that many children acquiring speech normally have correct articulation of all affricates, fricatives, and liquids. It is important to note that the data for both the normal and the disordered groups in Figures 1 and 2 reflect the same stringent response definitions using a system of narrow phonetic transcription (Shriberg, 1986).

Overall, the numeric and graphic data in Panel A of both Figure 1 and Figure 2 indicate that the speech-delayed children's articulation of nearly all the consonants in conversation differs significantly from the articulation of the speech-normal children. That is, they not only differ significantly on the later-developing sounds, but they also differ in correct articulation of the sounds occurring earliest in speech-sound development. This finding is most readily appreciated in Panel A of Figure 2. Except for the two-member class of affricate consonants, the speech-delayed children differ significantly on each of the other consonants divided by class, voice, and manner features.

Panels B, C, and D in Figures 1 and 2 provide information on the types of errors made by the speech-disordered children compared to the speech-normal children. Recall that the calculations for relative errors adjust for each child's severity of involvement, so that the distributions of omission, substitution, and distortion errors can be compared directly within and between the two groups of children. The percentages of error types between the two groups differ significantly, as indicated in both the numeric sections (which provide summary descriptive and inferential statistics for both absolute and relative percentages) and the graphic sections (which provide sound- or feature-level descriptive and inferential statistics for the relative percentages). The speech-normal children's errors were distributed as 5.1% omissions, 13.7% substitutions, and 81.1% distortions (see relative totals [R] in the numeric sections of Panels B, C, and D, respectively, of Figure 1). In comparison, the speech-delayed children's errors were distributed as 25.4% omissions, 47.4% substitutions, and 27.2% distortions. Statistically significant between-group differences in error type are apparent in the numeric sections of each panel for the three 8-sound subgroups, especially for phonemes in the Late-8 group. As shown by the trends in the graphic sections in both Figure 1 and Figure 2, the errors of the speech-delayed children were primarily omissions and substitutions, whereas the errors of the speech-normal children were primarily distortions.

Vowels and diphthongs. Figure 3 provides summary information on the vowel and diphthong articulation of the two groups (for clarity, only Panel A of the speech profile format is shown). The graphic section of Figure 3 shows that the speech-delayed children's articulation was significantly lower on 9 of the 17 vowel-diphthong comparisons testable with

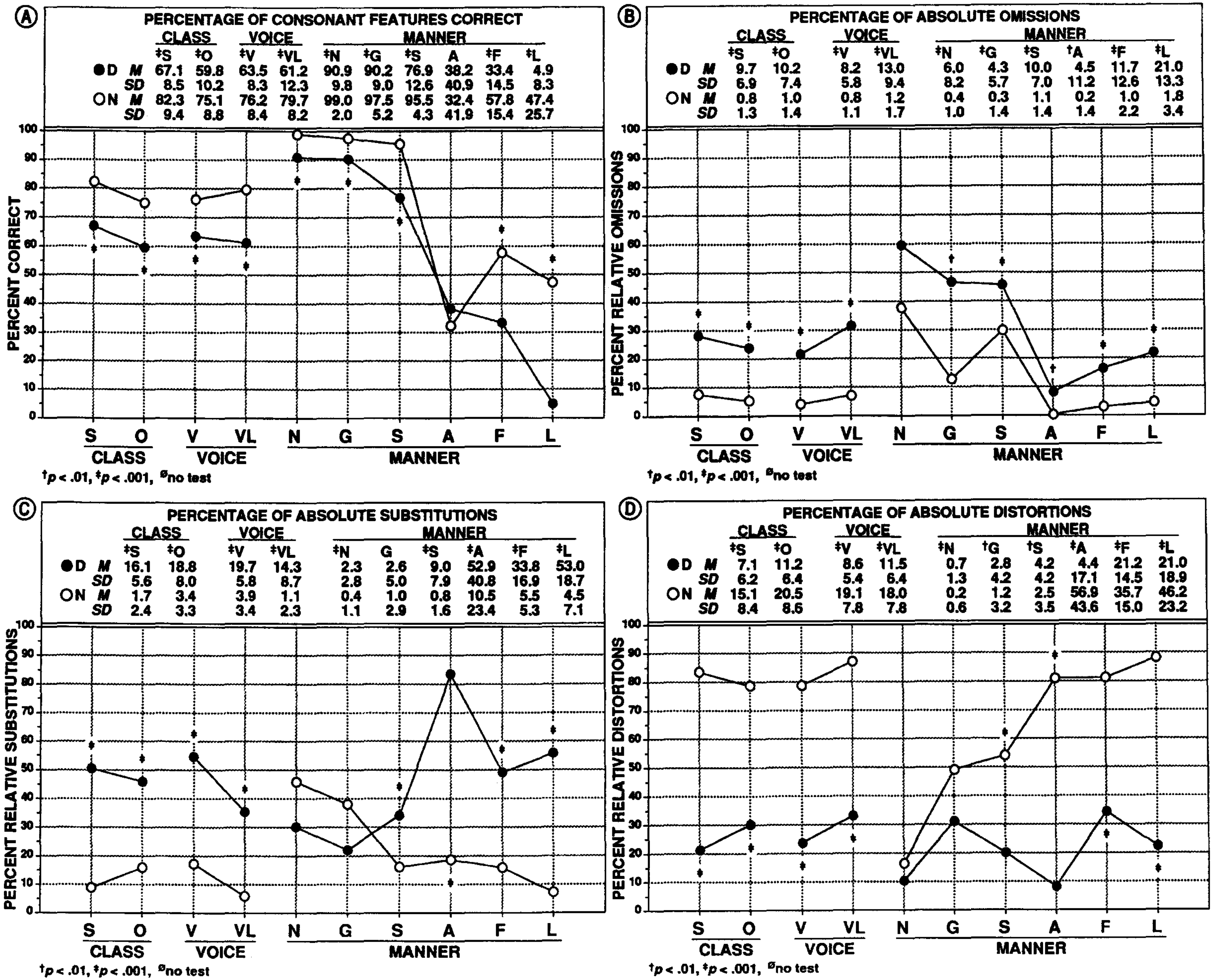

FIGURE 2. ***Speech Profile: Consonant Features*** **comparison of the 64 3- to 6-year-old speech-delayed (D) children in the present study to 72 3- to 6-year-old speech-normal (N) children described in Hoffmann (1982), Hoffmann and Shriberg (1982), and Shriberg (1986, 1993).**

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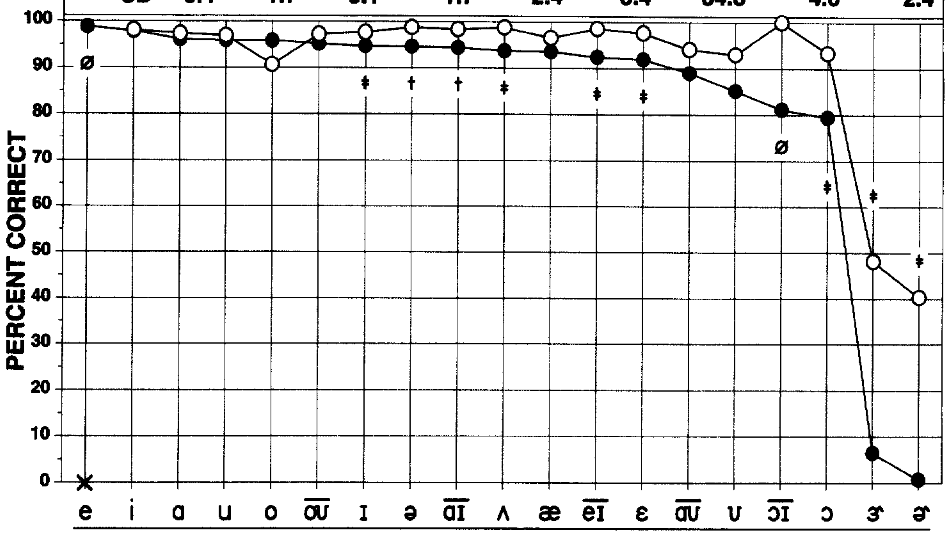
(A)

PERCENTAGE OF VOWELS CORRECT

		HEIGHT			PLACE				NONPH	
		HIGH	‡MID	LOW	‡FRNT	‡CNTRL	‡BACK	‡RHOT	‡DIPH	‡ALL
● D	*M*	97.0	93.7	95.1	95.0	94.7	93.0	2.6	92.8	91.3
	SD	4.4	4.6	6.3	3.7	6.8	5.5	8.2	9.8	3.6
○ N	*M*	97.5	97.8	96.7	97.6	98.7	96.6	46.3	97.8	95.3
	SD	3.4	1.7	5.1	1.7	2.4	3.4	34.8	4.0	2.4



†$p < .01$, ‡$p < .001$, ⌀no test X = insufficient data

FIGURE 3. ***Speech Profile: Vowels and Diphthongs*** **comparison of the 64 3- to 6-year-old speech-delayed (D) children in the present study to 72 3- to 6-year-old speech-normal (N) children described in Hoffmann (1982), Hoffmann and Shriberg (1982), and Shriberg (1986, 1993).**

Mann-Whitney statistics. Differences occurred primarily for sounds that were more difficult for both groups; notably, they did not differ on the cardinal vowels /i/, /ɑ/, and /u/. In the numeric section of this speech profile, which tests differences at the feature class level of vowels-diphthongs, most of the comparisons between the speech-normal and speech-delayed children were statistically significant. Specifically, statistically significant comparisons were obtained for MID, front (FRNT), central (CNTRL), and BACK vowels; for the rhotic (RHOT) vowels (/ɚ/, /ɝ/); for the two nonphonemic diphthongs (NONPH DIPH) (/o͞ʊ/, /e͞ɪ/); as well as across all (ALL) vowels-diphthongs. Thus, as with the percentage of consonants correct data in Figures 1 and 2, the vowel-diphthong profiles for this sample of speech-delayed children in Figure 3 may be characterized as "across-the-board" involvement—that is, parallel to the profile for speech-normal children, but significantly lower in percentages correct.

Summary: Delay or disorder? All literature reviews to date conclude that the speech patterns of children with speech involvement are essentially similar to patterns described for younger children acquiring speech normally (e.g., Bernthal & Bankson, 1993; Stoel-Gammon & Dunn, 1985). Thus, although the term *speech disorder* provides the most useful cover term for a variety of service delivery issues, the term *speech delay* more appropriately reflects a presumed shift in only the temporal *onset* and/or *rate* of speech-sound development. That is, support for the alternative concept of a disorder requires evidence for a notable shift in the *sequence* of acquisition of phoneme targets and/or in the *error patterns* associated with disordered compared to normal acquisition. Although the cross-sectional data for both groups of children in Figures 1, 2, and 3 do not allow a direct test of similarities in the ontogenetic sequence of speech-sound mastery, they do allow statistical comparisons of mastery and error patterns for each sound. Interpretation is generally guided by the overall pattern of descriptive and inferential data, rather than by the statistical findings for any particular data point. These profile comparisons are interpreted as providing mixed support for the concept of a speech delay.

In support of the notion of delay is the overall between-group similarity in the shapes of the consonant (Panel A in Figures 1 and 2) and vowel-diphthong (Figure 3) percentage-correct trends. Overall, the percentages between the Early-8, Middle-8, and Late-8 consonant phonemes follow similar decreasing trends, with the notable departures for the speech-normal group involving distortions of /tʃ/, /dʒ/, /s/, and /z/. Thus, although by definition the two samples of children differ in the absolute magnitude of errors, the pattern of mastery across the Early-8, Middle-8, and Late-8 consonant sounds is interpreted as considerably more similar than dissimilar.

Lack of support for the notion of speech delay is based on analyses comparing the error patterns of the two groups of children. Notice in the numeric sections of Panels B, C, and D of Figures 1 and 2 that the number and types of statistically significant comparisons of the Relative (R) consonant error types indicate a dissimilarity in error patterns. The Relative error types are appropriate for this comparison because they adjust for each subject's severity of involvement (i.e., the per-child denominators are the total number of each child's errors). As reviewed previously, the children acquiring consonants normally averaged 5.1% Relative omission errors, 13.7% Relative substitution errors, and 81.1% Relative distortion errors, whereas the children with disordered speech averaged 25.4% Relative omissions, 47.4% Relative substitutions, and 27.2% Relative distortions.

To summarize, the descriptive profiles and advisory statistical findings in Figures 1, 2, and 3 provide mixed support for an *across-the-board* developmental delay in the acquisition of phoneme targets. The delay is characterized by omission and substitution errors across all consonant sounds, including those that normally are mastered earliest. However, these data also indicate that, when adjusted for absolute differences in error magnitude, the averaged error patterns of children with developmental phonological disorders deviate significantly from the error patterns of children acquiring speech normally.

Prosody-Voice Profiles

A second set of descriptive profiles for the most recently assessed group of 64 speech-delayed children describe their prosody and voice characteristics in conversational speech. Using a preliminary version of the assessment procedure to be described below, prior reports indicate that from approximately 25% to 50% of speech-delayed children also have questionable or notable involvement in prosody and/or voice (Shriberg et al., 1986). Using different methodologies from those used in the Shriberg et al. (1986) studies, St. Louis, Hansen, Buch, and Oliver (1992) and Ruscello, St. Louis, and Mason (1991) have reported comparable rates of the coexistence of speech and voice disorders in school-age children.

For the current study, prosody-voice data were obtained on two samples of children using an enhanced version of the prosody-voice assessment procedure (Shriberg et al., 1990, 1992) reported in prior work (Shriberg & Kwiatkowski, 1982a; Shriberg et al., 1986; Shriberg & Widder, 1990). Prosody-voice assessment was technically feasible for 62 of the 64 speech-delayed children described above. Prosody-voice assessment was also accomplished on a normative reference sample available in the SALT database (Miller, 1990). The latter sample of 71 normally developing 3- to 5-year-old children, approximately balanced in number by age and gender, were drawn from the same demographic groups as the speech-delayed children. Data reduction for the prosody-voice procedure was accomplished using similar procedures by the same personnel for both samples. Detailed analyses of these data with reference to age and gender issues in speech genetics will be reported elsewhere. For the current descriptive-comparative purposes, the data are collapsed across age and gender. The question is whether speech-delayed children differ significantly from speech-normal children in any aspects of prosody and/or voice.

Group data. The four panels in Figure 4, collectively termed a *prosody-voice profile,* provide information on six suprasegmentals: *Phrasing, Rate, Stress, Loudness, Pitch,* and *Voice Quality* (with Voice Quality divided into Laryngeal and Resonance). Figure 5, which is taken from the scoring form for the prosody-voice assessment procedure (Shriberg et al., 1990), is the key for the numbered codes in Figure 4. Included in Figure 5 is the key for the 31 Exclusion Codes (Figure 4, Panel B) and the 32 numbered inappropriate prosody-voice codes (Figure 4, Panels C and D). The structural elements of a prosody-voice profile are similar to those described for a speech profile. The numeric and graphic sections in each panel provide descriptive and inferential statistics for each between-group contrast. The inferential statistic used in this prosody-voice profile is the nonparametric Mann-Whitney statistic with *p* values indicated for the .01 and .001 levels of significance. As with the speech profile data, preliminary analyses indicated that means data generally provide the better central tendency descriptors for the questions pursued in these studies, with nonparametrics typically most appropriate for inferential statistical tests. Parametric descriptive statistics in the numeric and graphic sections sometimes appear to differ from the more conservative results of the nonparametric inferential statistics.

Beginning with the rightmost column in the numeric section of Figure 4, Panel B (%Exclusion Codes: Total), there was a statistical difference in the number of utterances that were excluded from prosody-voice coding for each group. The relative frequencies of each code can identify group- or individual-level differences in behavioral, discourse, and sociolinguistic functions and processes (e.g., Shriberg, 1993; Shriberg & Widder, 1990). As shown, more than one half (55.4%) of the utterances of the speech-delayed subjects had to be excluded from prosody-voice coding because one or more of four classes were termed Exclusion Codes. In comparison, only somewhat more than one third (36.9%) of the utterances of the speech-normal children were excluded from prosody-voice coding. At the summary level in the numeric panel, significantly greater percentages of the speech-delayed children's utterances were excluded on the basis of the exclusion codes subsumed under Content/Context (CONT), Environment (ENVIR), and Register (RGSTR). At the level of individual codes shown in the graphic section of Figure 4, Panel B, the speech-delayed children had significantly more utterances excluded because of Too Many Unintelligibles (C12), Too Far From Microphone (E4), and Narrative Register (R2). The speech-normal children had significantly more utterances excluded because of Interruption/Overtalk (C5).

As indicated by the dashed horizontal lines in Figure 4, Panel A, the prosody-voice analysis procedure—designed as a perceptual screening instrument—considers 90% and above on each suprasegmental as a Pass, 80% to 89.9% as Questionable, and fewer than 80% appropriate utterances as a Fail (Shriberg et al., 1990, 1992). Based on these clinical criteria, the averaged speech-normal children's values in the numeric section of Panel A and the data points in the graphic section fall into the Questionable range for Phrasing and Laryngeal Quality. Mean values for the speech-delayed children fall into the Fail range for Laryngeal Quality. Statistically significant differences were obtained for four of the suprasegmental contrasts, as well as the combined Quality contrast. The speech-normal group had significantly more

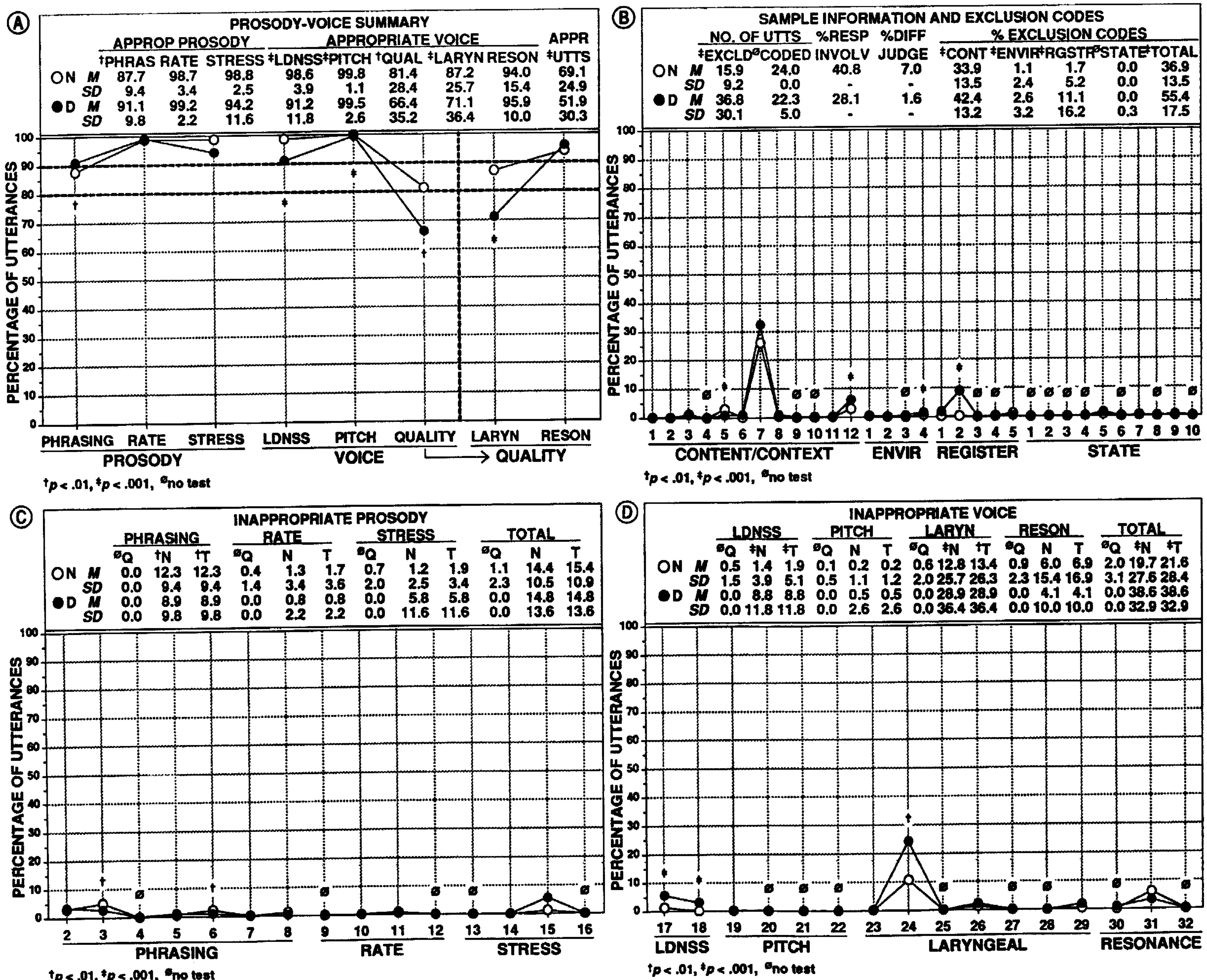


FIGURE 4. *Prosody-Voice Profile* comparison of the 64 3- to 6-year-old speech-delayed (D) children in the present study to 71 3- to 5-year-old speech-normal (N) children described in Miller (1990).

Exclusion Codes

Content/Context	Environment	Register	States
C1 Automatic Sequential ___	E1 Interfering Noise ___	R1 Character Register ___	S1 Belch ___
C2 Back Channel/Aside ___	E2 Recorder Wow/ Flutter ___	R2 Narrative Register ___	S2 Cough/Throat Clear ___
C3 I Don't Know ___	E3 Too Close to Microphone ___	R3 Negative Register ___	S3 Food in Mouth ___
C4 Imitation ___	E4 Too Far from Microphone ___	R4 Sound Effects ___	S4 Hiccup ___
C5 Interruption/ Overtalk ___		R5 Whisper ___	S5 Laugh ___
C6 Not 4 (+) Words ___			S6 Lip Smack ___
C7 Only One Word ___			S7 Body Movement ___
C8 Only Person's Name ___			S8 Sneeze ___
C9 Reading ___			S9 Telegraphic ___
C10 Singing ___			S10 Yawn ___
C11 Second Repetition ___			
C12 Too Many Unintelligibles ___			

Prosody-Voice Codes

Prosody

Phrasing	Rate	Stress
1 Appropriate ___	1 Appropriate ___	1 Appropriate ___
2 Sound/Syllable Repetition ___	9 Slow Articulation/Pause Time ___	13 Multisyllabic Word Stress ___
3 Word Repetition ___	10 Slow/Pause Time ___	14 Reduced/Equal Stress ___
4 Sound/Syllable and Word Repetition ___	11 Fast ___	15 Excessive/Equal/ Misplaced Stress ___
5 More than One Word Repetition ___	12 Fast/Acceleration ___	16 Multiple Stress Features ___
6 One Word Revision ___		
7 More than One Word Revision ___		
8 Repetition and Revision ___		

Voice

Loudness	Pitch	Quality	
		Laryngeal Features	Resonance Features
1 Appropriate ___	1 Appropriate ___	1 Appropriate ___	1 Appropriate ___
17 Soft ___	19 Low Pitch/Glottal Fry ___	23 Breathy ___	30 Nasal ___
18 Loud ___	20 Low Pitch ___	24 Rough ___	31 Denasal ___
	21 High Pitch/Falsetto ___	25 Strained ___	32 Nasopharyngeal ___
	22 High Pitch ___	26 Break/Shift/ Tremulous ___	
		27 Register Break ___	
		28 Diplophonia ___	
		29 Multiple Laryngeal Features ___	

FIGURE 5. Prosody-Voice Profile key for the elements and codes shown in Figure 4.

utterances with inappropriate Phrasing; the speech-delayed group had significantly more utterances scored inappropriate in Loudness, Pitch, and Laryngeal Quality.

Information on the 15 specific Inappropriate Prosody codes and the 16 Inappropriate Voice codes underlying the summative scores in Panel A of Figure 4 is available in Panels C and D, respectively. The numeric sections of each panel provide coding-level information on the percentage of utterances in which the coding decision was questionable (Q) (i.e., borderline behaviors meeting response-definition criteria), nonquestionable (N), and the totals (T) for Q plus N. As shown in the numeric sections of Panels C and D, almost all of the inappropriate codes assigned to utterances in both groups were considered reliable (i.e., not questionable) by the scorer. The speech-normal children had significantly more utterances that were inappropriate in Word Repetition (Phrasing 3) and One-Word Revisions (Phrasing 6). The speech-delayed children had significantly more utterances that were inappropriately Soft (Loudness 17), Loud (Loudness 18), and Rough (Laryngeal Quality 24).

Individual data. Table 3 and Table 4 provide subject-level percentages on the prevalence of prosody-voice involvement in the two samples of children described in Figure 4. For the present purposes, inferential statistics are not reported for all statistically significant differences among cell frequencies. Rather, the emphasis is on patterns of prosody-voice outcomes between and within the two sample groups. Whereas the previous data in Table 2 and Figure 4 provide grouped averages, the data in Table 3 and Table 4 provide two types of comparative information on the

TABLE 3. Prosody-voice data for 71 3- to 5-year-old speech-normal children (Miller, 1990) and 62 of the 3- to 6-year-old speech-delayed children in the present study. All table entries are percentages.

	Speech-Normal			Speech-Delayed		
Suprasegmental	Pass[a]	Questionable[b]	Fail[a]	Pass	Questionable	Fail
Prosody						
Phrasing	52.1	29.6	18.3	71.0	17.7	11.3
Rate	97.2	1.4	1.4	100.0	0	0
Stress	98.6	1.4	0	82.3	6.5	11.3
Voice						
Loudness	97.2	0	2.8	69.4	19.4	11.3
Pitch	100.0	0	0	98.4	1.6	0
Quality						
Laryngeal	76.1	7.0	16.9	51.6	12.9	35.5
Resonance	85.9	4.2	9.9	88.7	4.8	6.5

[a]Following criteria in Shriberg, Kwiatkowski, and Rasmussen (1990): *Pass* = ≥90%, *Questionable* = 80–89.99%, and *Fail* = <80%.

speech-delayed children's prosody-voice characteristics in continuous speech.

The column entries in Table 3 are the percentages of speech-normal and speech-delayed children whose status on the prosody-voice procedure meet criteria for Pass (>90%), Questionable (80% to 89.9%), and Fail (<80%). The descriptive percentages for the seven suprasegmentals in Table 3 can be summarized as follows: (a) The speech-normal and speech-delayed groups have generally similar classification outcomes for Rate, Pitch, and Resonance Quality. (b) Proportionally more speech-normal than speech-delayed children have Questionable or Fail outcomes on Phrasing. (c) Proportionally more speech-delayed than speech-normal children have Questionable or Fail outcomes on Stress, Loudness, and Laryngeal Resonance. As described in the technical report for the prosody-voice assessment instrument, the findings for Phrasing are not unexpected given the age of both the speech-normal and speech-delayed children (Shriberg et al., 1992). The Phrasing codes are sensitive to whole-word repetitions and revisions, behaviors that appear to be more frequent in children acquiring speech normally than in children with delayed speech acquisition (Shriberg et al., 1992). These Phrasing data support a number of theoretical perspectives on the interaction of speech and language processing variables in children's conversational speech. The findings for Loudness and especially Laryngeal Quality are also of interest in relation to potential genetic issues underlying the co-occurrence of speech, voice, and language disorders (e.g., Ruscello et al., 1991).

Table 4 provides prosody-voice classification data for each child in the speech-normal and speech-delayed groups. The table is divided into two sets of percentages reflecting the four possible Pass-Fail outcomes for the three prosody and the four voice suprasegmentals. The Pass/Nonpass data use all outcomes, whereas the Fail/Nonfail outcomes discard scores for children who had a Questionable on any one of the seven suprasegmentals. The primary purpose of the descriptive data in Table 4 is to provide baseline information at the level of individual subject profiles. The following are among the findings that warrant additional study: (a) Approximately 30% of speech-normal children, compared to approximately 18% of speech-delayed children, had scores at 90% or greater (Pass) for all seven suprasegmentals. (b) Approximately 4% of speech-normal children, compared to approximately 16% of speech-delayed children, had scores below 80% (Fail) on at least one suprasegmental in both prosody and voice. (c) Nonpass and Fail scores for the speech-normal children were more often associated with one or more of the prosody suprasegmentals, whereas the Nonpass and

TABLE 4. Summary of pass-fail status for the 71 speech-normal and 62 speech-delayed children described in Table 3.

	Status		Percentage of children	
Criteria	Prosody	Voice	Speech-Normal	Speech-Delayed
Pass vs. Nonpass	+ (≥ 90%)	+ (≥ 90%)	29.6	17.7
	+ (≥ 90%)	− (< 90%)	21.1	41.9
	− (< 90%)	+ (≥ 90%)	32.4	9.7
	− (< 90%)	− (< 90%)	16.9	30.7
Fail vs. Nonfail[a]	+ (≥ 90%)	+ (≥ 90%)	29.6	17.7
	+ (≥ 90%)	− (≤ 80%)	15.5	24.2
	− (≤ 80%)	+ (≥ 90%)	15.5	4.8
	− (≤ 80%)	− (≤ 80%)	4.2	16.1

[a]For the fail versus nonfail criteria there were 25 speech-normal children with intermediate values and 23 speech-delayed children with intermediate values.

Fail scores for the speech-delayed children were more frequently involved with one or more of the voice suprasegmentals.

Causal-Correlates Profile

The term *causal-correlates* refers to all assessment and case history data that may be relevant to an eventual understanding of the origin of developmental phonological disorders (Shriberg & Kwiatkowski, 1982a). Prior papers have reported the percentage of subjects coded *normal (0), questionable (1),* and *involved (2)* for each of the causal-correlate variables described in the Method section (Shriberg & Kwiatkowski, 1982a; Shriberg et al., 1986). Table A in the Appendix includes a summary of findings tabulated separately for the three prior data sets (combined), the current study, and the totals for all study groups. Coding criteria for each of the descriptors are provided in the Appendix, together with specific counts and percentages for each descriptor in the prior and current studies. Figure 6 is a graphic summary of the primary findings. The bars in each of the panels in Figure 6, which are sorted left-to-right in descending order of magnitude, are the percentages of speech-delayed children rated *1* or *2* on the abbreviated descriptive label for each bar. The percentages are based on the totals for children in all four study groups and thus are weighted by the number of children in each group. To allow comparison with the data in Shriberg et al. (1986), percentages are shown only for descriptors that were rated for 39 or more children (see Appendix for descriptive data for each percentage). For the I. B. Speech Mechanism panel (upper right), data are shown only for the 32 descriptors with the highest percentages; there were 40 additional descriptors for which 0% to 9% of rated subjects received either a *1* or a *2*. In the absence of normative reference data for normally speaking children of comparable demographics, it is not directly possible to interpret the significance of any one percentage or cluster of percentages in Figure 6. However, as suggested in the following brief summaries, these data should be useful as baseline information for many associated research issues in developmental phonological disorders. To be consistent with prior reports, the organization and format of these summaries closely follows the exposition in Shriberg et al. (1986). A companion paper in this series (Shriberg, Kwiatkowski, & Gruber, 1994) will be concerned specifically with the data in Figure 6 and the Appendix as predictors of short-term speech-sound normalization.

Hearing. As shown in the top left panel in Figure 6, over 30% of the rated children had a *1* or a *2* on one or more of six descriptors associated with reduced hearing levels. Within these first six variables (a) 26% of children had PE tubes in place and an additional 21% had been considered for PE tubes, (b) 41% had four or more episodes of otitis media before 18 months as well as more episodes after 18 months, (c) 42% had documented mild conductive loss in one or both ears on one or more occasions, and (d) over 30% had tympanometry and/or acoustic reflex findings implicating middle ear problems in one or both ears on one or more occasions. As shown in Figure 6, percentages for the remaining eight descriptors indicated hearing-related conditions, behavioral observations by parents, and audiological assessment findings for from 4% to 32% of children.

In the absence of well-matched control data, it is difficult to interpret the significance of these prevalence findings on hearing-related variables for explanatory models of the onset and maintenance of clinically delayed speech. The case history findings that have the most face validity and highest reliability relative to hearing loss may not differ from distributions found in a group of children with comparable demographics. And those percentages that do differ significantly might be biased by concern for children's intelligibility problems. Specifically, these children's overt speech problems could prompt caregivers and physicians to take more aggressive approaches to assessment and management. As discussed in the prior report (Shriberg et al., 1986), complex clinical issues underlie referrals for suspected middle-ear involvements and medical-surgical recommendations. Findings from large, well-controlled prospective studies (e.g., Friel-Patti & Finitzo, 1990) have not yielded a definitive explanatory-predictive model relating early otologic-audiologic-tympanometric status to short-term and long-term communicative function. Using models developed in prior work (Shriberg, 1982, 1987; Shriberg & Smith, 1983; Thielke & Shriberg, 1990), a series of forthcoming database studies will describe the speech and prosody-voice characteristics of children with differing hearing histories.

Speech mechanism. The speech mechanism data are divided into 86 descriptors representing diverse history and status variables on orofacial and speech-motor function (see Appendix). Ratings of *1* or *2* were obtained for from 2% to 96% of children on 66 of the 86 descriptors. Figure 6 includes data for 32 of these 66 variables. The data for three variables assessing children's ability to sustain sounds (Variables 64–66 in Table A of Appendix) were excluded because of questions about the reliability of this measure. Also excluded were data for the remaining variables that had 2% to 9% of the rated children obtaining ratings of *1* or *2*. The most prevalent descriptor was Familial, with 39% of children having one member of the family with the same speech problem and an additional 17% (total = 56%) having more than one family member with the same speech problem. A total of 40% of the children had questionable or nonquestionable involvement of the palatine tonsils. The data for the remaining 30 speech-mechanism descriptors in Figure 6 included ratings of *1* or *2* for from 7% to 30% of the children.

These data are generally consistent with findings from the classical causal-correlates studies of children with articulation disorders (cf. Bernthal & Bankson, 1993; Winitz, 1969). They suggest that clinical findings implicating the speech mechanism may be found in a significant number of children referred for speech delays of unknown origin. However, as no one descriptor variable (or group of descriptors; see the subscale summative scores in the Appendix) is clearly prevalent across children, these findings fail to implicate specific speech-mechanism deficits as sufficient causes of speech delay. It is important to underscore the relatively gross levels of these measures. Although the magnitudes of structural and speech-motor control deficits affecting speech production might be expected to be manifest at

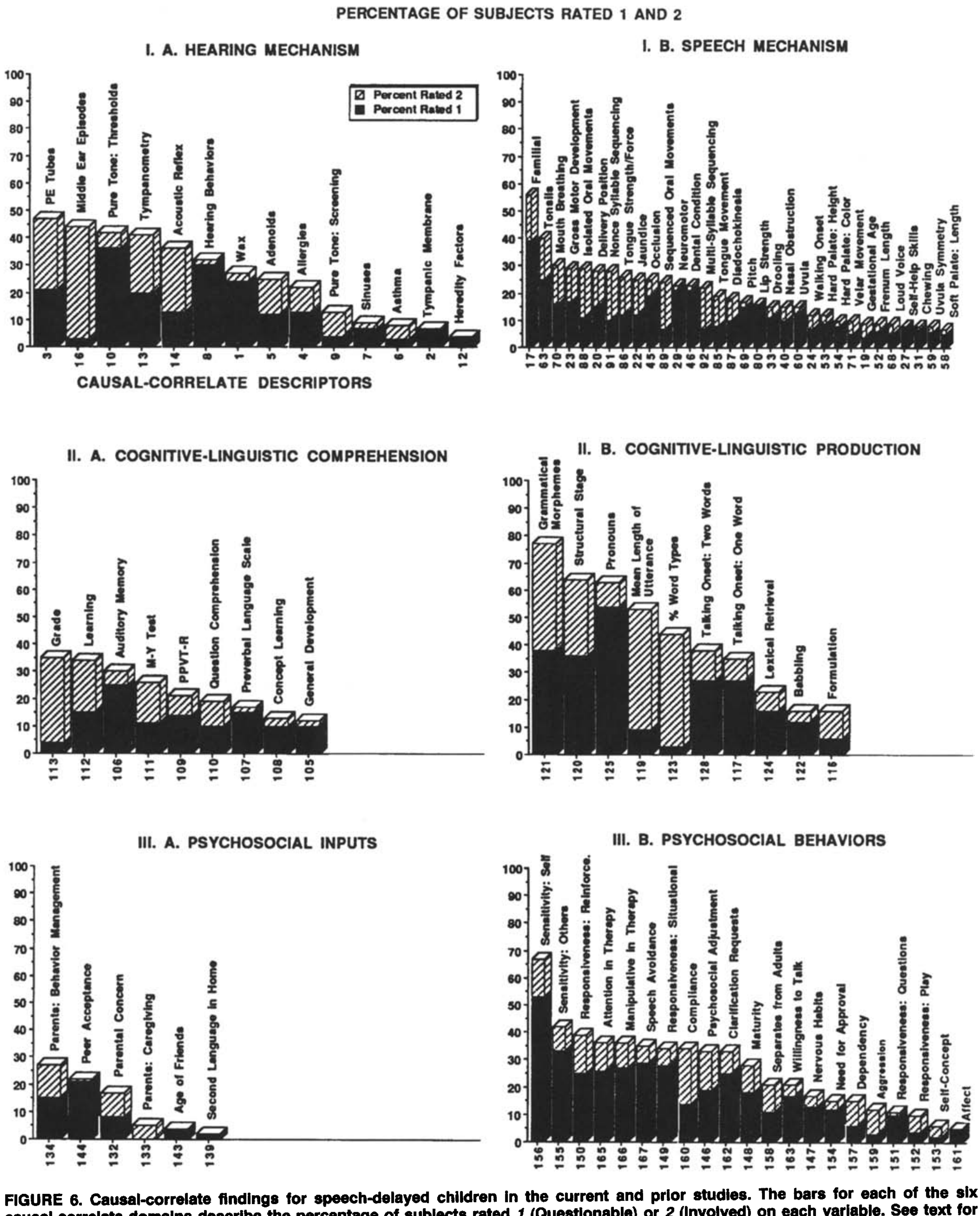


FIGURE 6. Causal-correlate findings for speech-delayed children in the current and prior studies. The bars for each of the six causal-correlate domains describe the percentage of subjects rated *1* (Questionable) or *2* (Involved) on each variable. See text for explanation of the numbers below each bar and additional selection criteria.

clinically obvious levels, relevant causal factors may be accessible only at the level of fine-grained instrumental measurement. The most provoking speech-mechanism finding in Figure 6 relative to an eventual understanding of the origins of speech-sound disorders are the data for heredity factors. As in most other clinical sciences, genetic transmission models have recently emerged as strong candidates to explain at least one form of communicative disorders of heretofore unknown origin.

Cognitive-linguistic: comprehension. Of the 13 cognitive-linguistic comprehension descriptors listed in the Appendix, Figure 6 includes data for 9 that were rated for a minimum of 39 children. The two most prevalent descriptors (34% and 35%) reflect a child's potential for learning as questioned by parents or teachers or as confirmed in older children by repetition of a grade or special class placement. Percentages for the remaining seven descriptors (12% to 30%) reflect scores on tasks and measures of cognitive-linguistic comprehension. Among these latter variables, six of the seven indicated proportionally more children having scores in the questionable or up to 1-year delay range, with proportionally fewer children having scores indicating greater than 1-year delay. These data indicate that cognitive-linguistic comprehension is a concern for at least one third of children with speech delays of currently unknown origin. As previously suggested, such information about language comprehension involvement is crucial for eventual phenotyping of speech-language disorders. Moreover, as discussed in the two companion articles in this series, a child's cognitive-linguistic comprehension status is of central significance to short-term and long-term speech-sound normalization.

Cognitive-linguistic: production. From 10% to 77% of children rated on the 10 cognitive-linguistic production variables were rated involved or questionable. Most frequent were children who had a one-stage gap (38% of the children) or a two or more stage gap (39% of the children) between emerging and expected grammatical morphemes. The remaining 9 variables in Figure 6, which were rated *1* or *2* for from 10% to 64% of children, included three case history variables and six developmental indices of language content and form. Based on typical clinical criteria, language production is of at least questionable concern for 75% to 80% of children whose speech errors qualify them to be classified as having a developmental phonological disorder. As considered in the companion articles in this series, a child's cognitive-language status appears to be a central factor associated with both short-term and long-term speech-sound normalization.

Psychosocial inputs. The six descriptors reflecting ratings of *1* or *2* for psychosocial inputs included from 2% to 27% of children. Among the three most frequent findings, two reflected clinical judgments that parent's behavioral management strategies were somewhat (15%) or considerably (12%) ineffective and that they were somewhat (8%) or considerably (9%) overconcerned about their child's problem. The third variable reflected parent's perception that their child had difficulty with initial acceptance by peers.

Parent reports and clinical judgments of parenting strategies suggest that significant external pressures are not prevalent in approximately 75% of children with developmental phonological disorders. No study to date has demonstrated that such variables are associated with the normal acquisition of speech. Rather, as indicated next, these children are judged to experience internal pressures affecting their psychosocial adjustment.

Psychosocial behaviors. The data in Figure 6 indicate that 21 psychosocial behavior variables were of questionable or nonquestionable concern for from 5% to 67% of the children. Over half the children (53%) were described as somewhat too sensitive (easily hurt feelings), and an additional 14% were described as overly sensitive (very easily hurt feelings). The other 20 variables reflect an array of observations, including both general social responsiveness and responses to speech-related social contexts.

These descriptive data indicate that a significant number of children with developmental phonological disorders experience psychosocial difficulties. As with most of the other descriptors, it is not known whether sampling biases inflate the magnitudes of these findings or whether they would differ significantly from data in a non-speech-delayed group. For intervention questions, however, such information clearly confirms the need to account for psychosocial variables in the overall plan of treatment.

Prevalence Profile of Developmental Phonological Disorders

Figure 7 is the fourth and final descriptive profile of children with developmental phonological disorders of currently unknown origin. These prevalence estimates were assembled primarily from the databases used in this research series. Prevalence rates for the independence and co-occurrence of speech and language disorders in children are central to studies exploring the hypothesis of genetic transmission modes. Specifically, prevalence data are used for liability estimates (the expected percentage of affected subjects in a population) in genetic analyses and for hypothesis generation about the number of genes that might be involved. In the present context the following summary of the data in Figure 7 is presented in an effort to gain the broadest perspective on the major descriptive characteristics of developmental phonological disorders.

Approximately 7.5% of 3- to 11-year-old children have clinically significant sound changes termed *developmental phonological disorders.* Within this group, 2.5% have *delayed speech,* defined as deletion and substitution errors that persist beyond approximately 4 years of age. Follow-up studies of speech-delayed children identified during preschool years indicate that some children normalize, some children retain delayed speech or only residual articulation errors, and many children experience problems in reading, writing, and spelling, or show evidence of a general learning disability. The remaining 5% of children with developmental phonological disorders have distortions of /s/, /l/, and /r, ɝ, ɚ/, termed *residual articulation errors,* that may persist into adulthood. There has been considerably less research recently in residual articulation errors compared to speech delay, because of, among other factors, an increas-

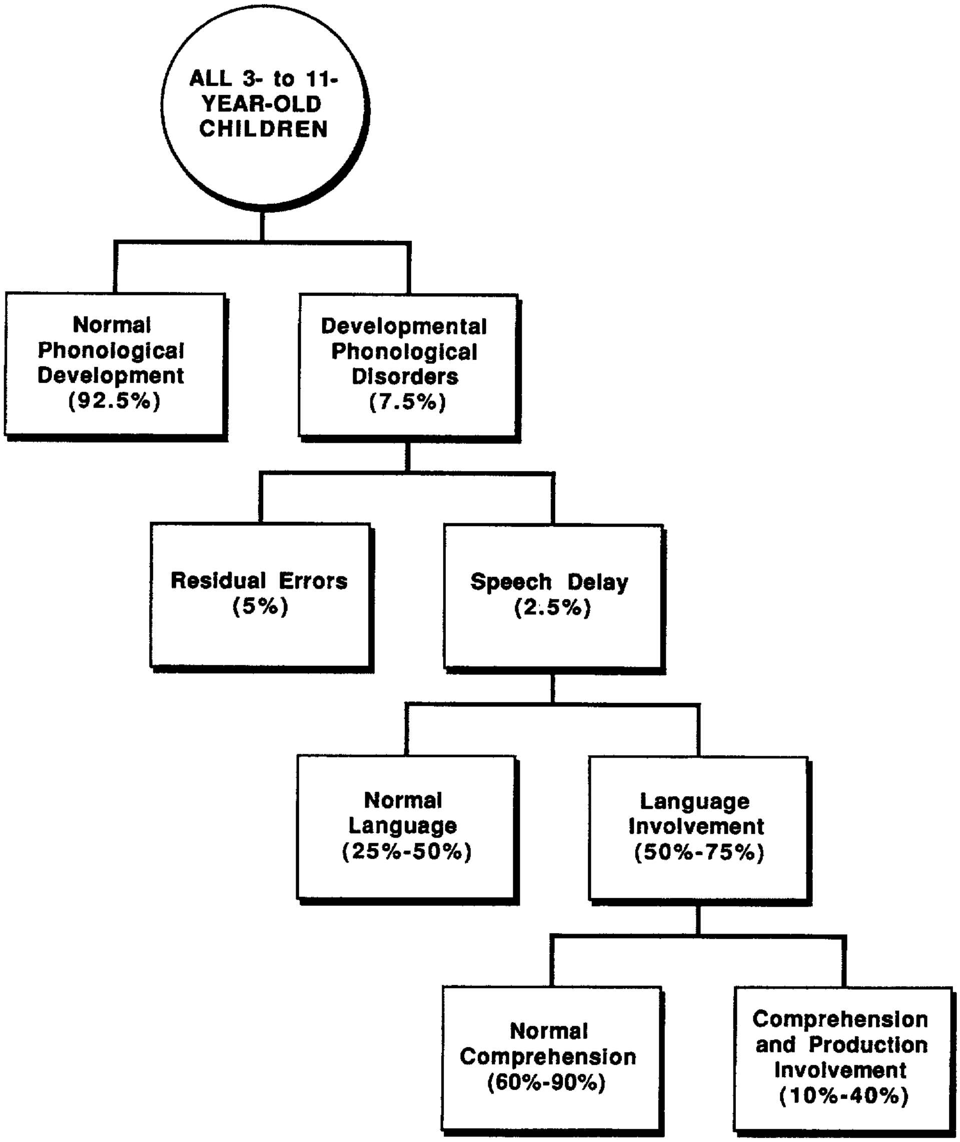


FIGURE 7. Prevalence estimates for children with developmental phonological disorders.

ing cultural pluralism in contemporary definitions of a communicative disorder. From a theoretical perspective, however, the origin and persistence of a residual articulation error may play an important role in an eventual explanation of developmental phonological disorders (cf. Shriberg, 1994). Finally, in Figure 6, as evidenced in the descriptive studies reported here, 50% to 75% of young children with delayed speech have a productive language involvement, with 10% to 40% also having a delay in language comprehension.

Conclusion

The profiles developed in this paper reflect over a decade of research to develop ways to characterize the salient features of developmental phonological disorders. Findings attempt to enhance the information base required for significant advances in five areas: description, explanation, prediction, intervention, and prevention. With the notable exception of descriptive research, progress in these areas since the earliest work in the 1930s might be characterized as distressingly slow. A major impetus for continued research is provided by the wealth of research documenting the social handicap of unintelligible speech and the central role of phonology in the development of language, reading, and other academic skills. The challenge is to use an increasing array of theories and technologies to eventually understand a puzzling childhood disorder of currently unknown origin.

Acknowledgments

We extend sincere thanks to the many colleagues who have contributed their time and expertise to the collection, analysis, and reporting of these data: Diane Austin, Maria Cavicchio, Rebecca Hinke, Patti Engebose Hovel, Frederic Gruber, Maureen McGowan Jepsen, Patrice Kearney, Doris Kistler, Sarah Hoffman, Kit Hoffmann, Gregory Lof, Jane Loncke, Jane McSweeny, Dennis Olson, Amparo Ortez, Carmen Rasmussen, Dorothy Rorick Ross, Catherine Trost-Steffen, Audrey Weston, Carol Widder, and David Wilson. We also wish to express our profound gratitude to speech-language pathologists and administrative personnel in the Madison Metropolitan School District, whose continuous and varied contributions for over a decade have been central to the accomplishment of this work. The manuscript was substantially improved by editorial suggestions provided by Carol Stoel-Gammon, Paul Deputy, and by an awesomely astute (but anonymous) JSHR reviewer. This work was supported by grants from the U.S. Department of Education (G008400633) and the U.S. Public Health Service, NIDCD No. DC00496.

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Received April 6, 1993
Accepted March 16, 1994

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Appendix

Table A, which follows, is a summary of the causal-correlates data for each of the three studies. Data are not available for all descriptors in all studies because of deletions, additions, and relabeling of the descriptors in successive studies. So that the classification system used in Study B and Study C (1986) could be compared with that of Study A, additional assessment and management data were added and some descriptors were deleted because they were more appropriately included in the speech data. For the current study, the following categories of descriptors were deleted for the indicated reasons: (a) management data—because data were not available for most subjects who were assessed before management, (b) prosody-voice, intelligibility, and other speech production data—because these data are more appropriately included in the speech data, and (c) performance on specific assessment measures—because these measures are no longer routinely administered. Descriptors added to the classification system used in the current study include (a) hearing descriptors for reporting pure tone screening results, sensorineural hearing loss, and episodes of otitis media, (b) speech descriptors for providing detailed information on structure-function of the oral-peripheral speech mechanism, (c) cognitive-linguistic descriptors for additional information on cognitive and language comprehension, and (d) language production descriptors for semantic and syntactic detail. Finally, descriptors that were relabeled for the current study include those originally titled *Infections* (presently included in PE Tubes), *Clumsiness* (relabeled Gross Motor Development), *Lip Movement* (relabeled Lip Movement During Continuous Speech), and *Mandible Movement* (relabeled Mandible Movement During Continuous Speech). These descriptor changes yielded totals of 90 for Study A, 127 for Study B and Study C, and 146 for the present study.

TABLE A. Causal-correlates descriptor ratings for speech-delayed children in Studies A–C, the current study, and percentaged across all studies.

	Rating definitions			Studies A–C				Current study				All studies			
Item	0	1	2	*n*	0	1	2	*n*	0	1	2	*n*	%0	%1	%2
I. MECHANISM															
A. Hearing															
1. Wax buildup	None	Periodic wax buildup warrants medical attention	Frequent; excessive wax buildup warrants medical attention	44	29	13	2	63	49	13	1	107	73	24	3
2. Tympanic membrane	Normal	Scarring in one ear	Scarring bilaterally	12	9	3	0	32	32	0	0	44	93	7	0
3. P.E. tubes	None	P.E. tubes considered by physician	P.E. tube(s) placed in ear(s)	69	22	27	20	64	48	1	15	133	53	21	26
4. Allergies	None	Mild; controlled with mild medication	Severe; persistent; strong medication	48	35	12	1	64	53	2	9	112	79	13	9
5. Adenoids; size	Normal	Slightly enlarged	Significantly large or removed	14	3	9	2	64	56	0	8	78	76	12	13
6. Asthma	Not present	Mild	Severe	31	28	3	0	64	59	0	5	95	92	3	5
7. Sinuses	Normal	Intermittent sinus condition; warrants medication	Chronic sinus condition; treated with medication	19	14	5	0	64	61	1	2	83	90	7	2
8. Hearing; observationally	Normal	"Does not always seem to hear; is sometimes indifferent to sound."	"Seems to always have trouble hearing."	67	41	25	1	61	45	14	2	128	67	30	2
9. Pure tone screening	Passed	Failed at one frequency	Failed at more than one frequency	—	—	—	—	54	47	2	5	54	87	4	9
10. Pure tone thresholds	Normal	Mild conductive loss in one or both ears on at least one occasion	Mild-moderate conductive loss on repeated occasions in one or both ears	91	52	36	3	28	17	7	4	119	58	36	6
11. Sensorineural	None	Mild loss	Moderate to severe loss	—	—	—	—	25	25	0	0	25	100	0	0
12. Heredity factor	No family history	One parent has congenital malformation or sensorineural loss since childhood	Both parents have congenital malformation or sensorineural loss since childhood	8	7	1	0	46	45	1	0	54	96	4	0
13. Tympanometry	Normal	Negative pressure of at least −200 in one ear on at least one occasion	Negative pressure of at least −200 in both ears on at least one occasion	62	31	17	14	52	36	6	10	114	59	20	21

(Continued)

TABLE A. Continued.

Item	Rating definitions 0	1	2	Studies A–C *n*	0	1	2	Current study *n*	0	1	2	All studies *n*	%0	%1	%2
14. Acoustic reflex	Present in both ears	Absent in one ear on at least one occasion	Absent in both ears on at least one occasion	46	31	4	11	45	27	8	10	91	64	13	23
15. Eustachian tube function	Normal	Suspected or confirmed dysfunction in one ear	Confirmed dysfunction in both ears	11	1	7	3	12	8	3	1	23	39	43	17
16. Middle ear problems	Fewer than four episodes 0–18 months	Four-plus episodes between 0–18 months but none later	Four-plus episodes between 0–18 months and later episodes	—	—	—	—	63	35	2	26	63	56	3	41
B. Speech															
17. Heredity factor	Not present	Single family member with same speech problem	More than one family member with same speech problem	20	5	12	3	64	32	21	11	84	44	39	17
18. Pregnancy	Normal	Threat of miscarriage late in pregnancy	Frequent threat of miscarriage throughout pregnancy	54	52	1	1	62	60	2	0	116	97	3	1
19. Gestational age	Full term	One month premature	Greater than one month premature	13	10	3	0	62	58	0	4	75	91	4	5
20. Delivery position	Normal	Complications, such as breech position, but normal delivery	Complications requiring a C-section	27	17	9	1	62	47	4	11	89	72	15	13
21. "Blue"	Not present	Blue at birth; oxygen not required	Blue at birth; oxygen required	55	52	2	1	63	60	1	2	118	95	3	3
22. Jaundice	Not present	Jaundice at birth lasting no more than 3 days	Jaundice at birth lasting 4 days or more	39	25	7	7	62	51	5	6	101	75	12	13
23. Gross motor development	Within age level	20%–30% below age level (MCDI) or delayed up to 1 year	Greater than 30% below age level (MCDI) or greater than 1-year delay	7	4	2	1	34	25	5	4	41	71	17	12
24. Walking; onset	15 months or earlier	16–19 months	20 months or later	64	56	7	1	61	54	2	5	125	88	7	5
25. Fine motor development	Within age level	20%–30% below age level (MCDI) or delayed up to 1 year	Greater than 30% below age level (MCDI) or greater than 1-year delay	—	—	—	—	49	47	1	1	49	96	2	2
26. Gross/fine motor skills; quality	Normally coordinated	Somewhat uncoordinated	Very uncoordinated	—	—	—	—	50	47	2	1	50	94	4	2
27. Self-help skills	Within age level	20%–30% below age level (MCDI) or delayed up to 1 year	Greater than 30% below age level (MCDI) or greater than 1-year delay	—	—	—	—	61	56	5	0	61	92	8	0
28. Neurological	Normal	Medically affiliated person suspects minimal brain damage	Medically confirmed minimal brain damage	6	4	2	0	9	6	2	1	15	67	27	7
29. Neuromotor	Normal	Medically affiliated person suspects dysarthria or dyspraxia	Confirmed dysarthria or dyspraxia	28	11	16	1	54	52	1	1	82	77	21	2
30. Seizures	Not present	Periodically; effectively controlled with medication or occur only with fevers	Periodically/frequently; not effectively controlled with medication or grand mal seizure pattern	33	32	1	0	64	62	2	0	97	97	3	0
31. Chewing	Normal	Noticeably slow, but coordinated	Significant difficulty coordinating movements	41	36	4	1	64	61	3	0	105	92	7	1
32. Choking after infancy	None	Periodically chokes on food	Frequently chokes on food	37	34	3	0	64	62	2	0	101	95	5	0

Continued

TABLE A. Continued.

Item	Rating definitions			Studies A–C				Current study				All studies			
	0	1	2	*n*	0	1	2	*n*	0	1	2	*n*	%0	%1	%2
33. Drooling after infancy	None	Drools when concentrates on tasks	Chronic drooling	44	35	8	1	64	57	4	3	108	85	11	4
34. Pooling of saliva after infancy	None	Periodic	Frequent	34	32	2	0	63	59	3	1	97	94	5	1
35. Facial symmetry	Normal	Questionable	Involved	—	—	—	—	64	62	2	0	64	97	3	0
36. Vertical facial dimension	Normal	Questionable	Involved	—	—	—	—	64	64	0	0	64	100	0	0
37. Adenoidal facies	Normal	Questionable	Involved	—	—	—	—	63	63	0	0	63	100	0	0
38. Eye spacing	Normal	Questionable	Involved	—	—	—	—	64	61	3	0	64	95	5	0
39. Nasal septum	Normal	Questionable	Involved	—	—	—	—	64	64	0	0	64	100	0	0
40. Nasal obstruction	Normal	Questionable	Involved	—	—	—	—	63	54	6	3	63	86	10	5
41. Lips; symmetry	Normal	Questionable	Involved	—	—	—	—	64	63	1	0	64	98	2	0
42. Lips; scarring or cleft	Normal	Questionable	Involved	—	—	—	—	64	64	0	0	64	100	0	0
43. Lips; length	Normal	Questionable	Involved	—	—	—	—	64	63	1	0	64	98	2	0
44. Lips; position at rest	Normal	Questionable	Involved	—	—	—	—	63	60	3	0	63	95	5	0
45. Teeth; occlusion	Normal	Questionable	Involved	57	47	8	2	61	42	14	5	118	75	19	6
46. Teeth; condition	Normal	Questionable	Involved	28	25	2	1	64	46	17	1	92	77	21	2
47. Teeth; condition of gingiva	Normal	Questionable	Involved	—	—	—	—	62	61	1	0	62	98	2	0
48. Teeth; prosthetics	Normal	Questionable	Involved	—	—	—	—	63	63	0	0	63	100	0	0
49. Tongue; size	Normal	Questionable	Involved	51	50	1	0	64	63	1	0	115	98	2	0
50. Tongue; appearance at rest	Normal	Questionable	Involved	—	—	—	—	64	62	2	0	64	97	3	0
51. Tongue; appearance of surface	Normal	Questionable	Involved	—	—	—	—	64	62	2	0	64	97	3	0
52. Tongue; length of frenum	Normal	Questionable	Involved	—	—	—	—	64	58	4	2	64	91	6	3
53. Hard palate; height	Normal	Questionable	Involved	56	48	5	3	63	56	6	1	119	87	9	3
54. Hard palate; coloration	Normal	Questionable	Involved	—	—	—	—	63	57	5	1	63	90	8	2
55. Hard palate; bony framework	Normal	Questionable	Involved	58	57	1	0	63	59	3	1	121	96	3	1
56. Soft palate; symmetry at rest	Normal	Questionable	Involved	—	—	—	—	61	60	1	0	61	98	2	0
57. Soft palate; intactness	Normal	Questionable	Involved	—	—	—	—	62	60	0	2	62	97	0	3
58. Soft palate; length	Normal	Questionable	Involved	53	46	6	1	62	61	0	1	115	93	5	2
59. Uvula; symmetry at rest	Normal	Questionable	Involved	—	—	—	—	62	57	4	1	62	92	6	2
60. Uvula; description	Normal	Questionable	Involved	22	19	2	1	62	52	9	1	84	85	13	2
61. Pharynx; anterior faucial pillars	Normal	Questionable	Involved	—	—	—	—	56	55	0	1	56	98	0	2
62. Pharynx; posterior faucial pillars	Normal	Questionable	Involved	—	—	—	—	54	54	0	0	54	100	0	0
63. Pharynx; palatine tonsils	Normal	Questionable	Involved	37	19	13	5	51	34	9	8	88	60	25	15
64. Respiration and phonation; sustain /ɑ/	Normal	Questionable	Involved	—	—	—	—	54	9	22	23	54	17	41	43

(Continued)

TABLE A. Continued.

Item	Rating definitions			Studies A–C				Current study				All studies			
	0	1	2	*n*	0	1	2	*n*	0	1	2	*n*	%0	%1	%2
65. Respiration and phonation; sustain /s/	Normal	Questionable	Involved	—	—	—	—	53	2	16	35	53	4	30	66
66. Respiration and phonation; sustain /z/	Normal	Questionable	Involved	—	—	—	—	50	6	18	26	50	12	36	52
67. Respiration and phonation; soft voice	Normal	Questionable	Involved	—	—	—	—	57	55	0	2	57	96	0	4
68. Respiration and phonation; loud voice	Normal	Questionable	Involved	—	—	—	—	56	51	3	2	56	91	5	4
69. Respiration and phonation; pitch	Normal	Questionable	Involved	—	—	—	—	54	45	8	1	54	83	15	2
70. Respiratory; mouth breathing	Not present	Intermittent	Habitual	51	31	9	11	63	49	9	5	114	70	16	14
71. Velopharyngeal function; velar movement	Normal	Questionable	Involved	52	47	3	2	57	52	2	3	109	91	5	5
72. Velopharyngeal function; position of velar dimple	Normal	Questionable	Involved	—	—	—	—	32	32	0	0	32	100	0	0
73. Velopharyngeal function; lateral wall movement	Normal	Questionable	Involved	—	—	—	—	32	29	1	2	32	91	3	6
74. Velopharyngeal function; nasality /u/	Normal	Questionable	Involved	—	—	—	—	57	54	2	1	57	95	4	2
75. Articulation; non-speech lip protrusion	Normal	Questionable	Involved	—	—	—	—	61	57	3	1	61	93	5	2
76. Articulation; lip protrusion /u/	Normal	Questionable	Involved	—	—	—	—	61	59	2	0	61	97	3	0
77. Articulation; non-speech lip retraction	Normal	Questionable	Involved	—	—	—	—	63	59	4	0	63	94	6	0
78. Articulation; lip retraction /i/	Normal	Questionable	Involved	—	—	—	—	63	61	2	0	63	97	3	0
79. Articulation; lip movement during continuous speech	Normal	Slightly limited during speech	Significantly limited during speech	92	89	2	1	—	—	—	—	92	97	2	1
80. Articulation; lip strength	Normal	Questionable	Involved	—	—	—	—	57	48	9	0	57	84	16	0
81. Articulation; mandible range of movement	Normal	Questionable	Involved	—	—	—	—	62	61	0	1	62	98	0	2
82. Articulation; mandible movement during continuous speech	Normal	Slight extraneous movement relative to tongue movement	Considerable extraneous movement relative to tongue movement	70	67	3	0	—	—	—	—	70	96	4	0
83. Articulation; tongue position at rest	Normal	Slight deviation from midline	Significant deviation from midline	53	50	3	0	63	61	2	0	116	97	3	0
84. Articulation; tongue protrusion	Normal	Questionable	Involved	—	—	—	—	61	59	1	1	61	97	2	2
85. Articulation; tongue movements (highest score)	Normal	Questionable	Involved	82	75	7	0	60	41	4	15	142	82	8	11

(Continued)

TABLE A. Continued.

Item	Rating definitions			Studies A–C				Current study				All studies			
	0	1	2	*n*	0	1	2	*n*	0	1	2	*n*	%0	%1	%2
86. Articulation; Normal tongue strength/force (highest score)	Normal	Questionable	Involved	—	—	—	—	51	38	6	7	51	75	12	14
87. Diadochokinesis	Normal	Accurate, but slow and/or arrhythmic	Significantly slow and/or arrhythmic	46	33	11	2	60	53	0	7	106	81	10	8
88. Volitional oral movements; isolated	Normal	Between 15th and 30th percentile	Below one standard deviation	—	—	—	—	61	43	7	11	61	70	11	18
89. Volitional oral movements; sequenced	Normal	Between 15th and 30th percentile	Below one standard deviation	—	—	—	—	60	46	4	10	60	77	7	17
90. Dyspraxia test	Normal	Mild involvement	Moderate-severe involvement	9	4	2	3	—	—	—	—	9	44	22	33
91. Syllable sequencing; nonsense syllables	Normal	Between 15th and 30th percentile	Below one standard deviation	—	—	—	—	62	45	6	11	62	73	10	18
92. Syllable sequencing; multisyllabic words	Normal	Between 15th and 30th percentile	Below one standard deviation	24	18	5	1	62	49	1	12	86	78	7	15
93. Facial structure scales	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	63	51	9	3	63	81	14	5
94. Lip structure scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	63	58	5	0	63	92	8	0
95. Teeth and mandible structure scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	61	32	22	7	61	52	36	11
96. Tongue structure scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	64	55	7	2	64	86	11	3
97. Hard palate structure scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	63	51	10	2	63	81	16	3
98. Soft palate structure scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	61	49	9	3	61	80	15	5
99. Pharnyx structure scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	51	34	9	8	51	67	18	16
100. Respiration and phonation function scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	57	1	14	42	57	2	25	74
101. Velopharyngeal function scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	35	28	3	4	35	80	9	11
102. Articulation function scale	All zero scores	Highest scale score = "1"	Highest scale score = "2"	—	—	—	—	55	24	13	18	55	44	24	33
II. COGNITIVE-LINGUISTIC															
A. Comprehension															
103. Situational comprehension	Within age limits	20%–30% below age level (MCDI) or up to 1-year delay	Greater than 30% below age level (MCDI) or greater than 1-year delay	—	—	—	—	30	27	1	2	30	90	3	7
104. Intelligence quotient or test	Within normal range	Marginal (between 15th and 30th percentile)	Below one standard deviation	—	—	—	—	2	2	0	0	2	100	0	0
105. General development	Within age limits	20%–30% below age level (MCDI) or up to 1-year delay	Greater than 30% below age level (MCDI) or greater than 1-year delay	—	—	—	—	62	55	6	1	62	89	10	2
106. Auditory memory	Normal	Questionable	Confirmed deficits	44	31	11	2	—	—	—	—	44	70	25	5
107. Preschool Language Scale; Auditory Comprehension	Age appropriate	Up to 1-year delay	Beyond 1-year delay	—	—	—	—	55	46	8	1	55	84	15	2

(Continued)

TABLE A. Continued.

Item	Rating definitions 0	1	2	Studies A–C n	0	1	2	Current study n	0	1	2	All studies n	%0	%1	%2
108. Concept learning	Within age limits	20%–30% below age level (MCDI) or up to 1-year delay	Greater than 30% below age level (MCDI) or greater than 1-year delay	—	—	—	—	60	52	6	2	60	87	10	3
109. PPVT-R	Standard score 75 or more	Standard score <75, age equivalent 1 year or less below actual age	Standard score <75, age equivalent greater than 1 year below age	85	58	19	8	61	58	1	2	146	79	14	7
110. Question comprehension	Age appropriate	Up to 1 year delay in comprehension of question forms	Beyond 1 year delay in comprehension of question forms	64	51	7	6	3	3	0	0	67	81	10	9
111. Miller-Yoder Test of grammatical comprehension	Age appropriate	Passed 80% of age level items	Passed less than 80% of age level items	53	39	6	8	1	1	0	0	54	74	11	15
112. Learning	Normal	Parent/teacher question learning ability	Special class placement, confirmed learning problem	48	30	8	10	6	6	0	0	54	67	15	19
113. Grade	Age appropriate	Repeated grade	Special class placement	42	27	3	12	35	23	0	12	77	65	4	31
114. Directions	Grade level	Up to 1-year delay in ability to follow directions	Beyond 1-year delay in ability to follow directions	30	19	9	2	—	—	—	—	30	63	30	7
115. Reading	Grade level	Up to 1-year delay	Beyond 1-year delay	6	3	3	0	—	—	—	—	6	50	50	0
B. Production															
116. Amount of babbling	Normal	Limited	None/very little	25	22	1	2	63	52	4	7	88	84	6	10
117. Talking onset; first word	14 months or earlier	15–18 months	Later than 18 months	57	32	21	4	52	39	8	5	109	65	27	8
118. Echolalia	None	Occasionally	Frequently	—	—	—	—	1	1	0	0	1	100	0	0
119. Mean length of utterance (MLU)	Within expected range for chronological age	Marginal (between 15th and 30th percentile)	Predicted chronological age equivalent below one standard deviation of expected age	—	—	—	—	64	30	6	28	64	47	9	44
120. Structural stage	Emerging stage consistent with expected stage	One stage gap between emerging and expected stage	Two or more stage gaps between emerging and expected stage	105	35	44	26	64	26	16	22	169	36	36	28
121. Grammatical morpheme use stage	Consistent with expected stage	One stage gap between overall grammatical morpheme stage and expected stage	Two or more stage gaps between emerging and expected stage	—	—	—	—	64	15	24	25	64	23	38	39
122. Formulation	Within normal range	Marginal (15th–30th percentile)	Below one standard deviation	42	32	9	1	64	57	4	3	106	84	12	4
123. Percentage of word types	46% or greater	45%–46%	Less than 45%	—	—	—	—	64	36	2	26	64	56	3	41
124. Lexical retrieval	Within normal range	Marginal (15th–30th percentile)	Below one standard deviation	43	30	9	4	64	53	8	3	107	78	16	7
125. Pronoun production	Normal	Only one error type	Two or more error types	40	9	24	7	64	30	32	2	104	38	54	9
126. Preschool Language Scale; Verbal Ability	Age appropriate	Up to 1-year delay	Beyond 1-year delay	18	11	4	3	3	2	1	0	21	62	24	14
127. Test of Early Language Development	Above 30th percentile	Between 30th and 15th percentile	Below the 15th percentile	—	—	—	—	1	1	0	0	1	100	0	0

(Continued)

TABLE A. Continued.

Item	Rating definitions			Studies A–C				Current study				All studies			
	0	1	2	*n*	0	1	2	*n*	0	1	2	*n*	%0	%1	%2
128. Talking onset; two-word combinations	22 months or earlier	23–31 months	Later than 31 months	—	—	—	—	45	28	12	5	45	62	27	11
III. PSYCHOSOCIAL															
A. Inputs															
129. Martial stability	Normal	Unsettled; some separation threats and disputes	Considerably unstable; disputes	—	—	—	—	5	0	3	2	5	0	60	40
130. Parental expectation	Normal age appropriate ability level expectations	Slightly high or low expectations; somewhat inconsistent with age/ability level	Considerably high or low expectations; significantly inconsistent with age/ability level	36	32	3	1	—	—	—	—	36	89	8	3
131. Parenting responsibility	Normal	Slightly overwhelmed by parenting responsibility	Considerably overwhelmed by parenting responsibility	35	29	4	2	—	—	—	—	35	83	11	6
132. Parental concern	Appropriate	Somewhat over-concerned with child's problems	Considerably over-concerned with child's problems	53	44	4	5	—	—	—	—	53	83	8	9
133. Parents; caregiving	Supportive	Somewhat nonsupportive	Considerably nonsupportive	43	41	0	2	—	—	—	—	43	95	0	5
134. Parents; behavior management	Normal	Somewhat ineffective	Considerably ineffective	41	30	6	5	—	—	—	—	41	73	15	12
135. Parenting effectiveness	Effective	Need some parenting training	Need extensive parenting training	34	23	7	4	—	—	—	—	34	68	21	12
136. Parents; abuse	No reports	Suspected child abuse	Confirmed child abuse	22	20	0	2	—	—	—	—	22	91	0	9
137. Sibling comparison	Normal	Somewhat unfavorable comparison of child to sibling(s)	Considerably unfavorable comparison of child to sibling(s)	29	25	3	1	—	—	—	—	29	86	10	3
138. Independence training	Normal	Somewhat reluctant to train child to be independent	Considerably reluctant to train child to be independent	33	30	3	0	—	—	—	—	33	91	9	0
139. Second language spoken at home	None	Limited input in second language	Extensive input in second language	1	0	1	0	63	63	0	0	64	98	2	0
140. Language stimulation	Normal	Somewhat limited	Significantly limited	18	11	4	3	—	—	—	—	18	61	22	17
141. Parents' understanding of treatment	Normal	Question their understanding of treatment and what they are to do when practicing with their child	Parents do not understand treatment or what they are to do when practicing with their child; they need explicit directions	34	30	2	2	—	—	—	—	34	88	6	6
142. Treatment support	Positive	Parent somewhat indifferent to child's speech progress	Parent does not make effort to see or support child's speech treatment	38	32	5	1	—	—	—	—	38	84	13	3
143. Age of friends	Appropriate	Somewhat limited to younger children	Plays only with younger children	47	45	2	0	—	—	—	—	47	96	4	0
144. Acceptance by peers	Readily accepted	Accepted after initial period of nonacceptance	Never fully accepted	32	30	1	1	63	44	19	0	95	78	21	1
B. Psychosocial Behaviors															
145. Social responsiveness; first year	Normal	Somewhat nonresponsive to social contacts	Significantly nonresponsive to social contacts	32	31	0	1	—	—	—	—	32	97	0	3
146. Psychosocial adjustment	Within age limits	20%–30% below age level	Greater than 30% below age level	23	15	5	3	34	23	6	5	57	67	19	14

(Continued)

TABLE A. Continued.

Item	Rating definitions 0	1	2	Studies A–C n	0	1	2	Current study n	0	1	2	All studies n	%0	%1	%2
147. Nervous habits	None	Limited to some situations	Consistently in many situations	40	36	4	0	64	50	10	4	104	83	13	4
148. Maturity	Within age limits	20%–30% below age level (MCDI) or somewhat immature behavior	Greater than 30% below age level or considerably immature behavior	52	28	16	8	63	55	5	3	115	72	18	10
149. Social responsiveness; new situations	Normal	Somewhat shy, quiet, fearful	Considerably shy, quiet, fearful	51	24	26	1	63	51	6	6	114	66	28	6
150. Social responsiveness; reinforcement	Normal	Needs somewhat more external reinforcers	Needs considerably more external reinforcers	43	25	11	7	63	39	16	8	106	60	25	14
151. Social responsiveness; questions	Normal	Somewhat unresponsive to direct questions	Generally unresponsive to direct questions	39	35	3	1	60	53	7	0	99	89	10	1
152. Social responsiveness; play	Normal	Often chooses to play alone	Consistently chooses to play alone	48	40	5	3	64	60	0	4	112	89	4	6
153. Self-concept	Positive	Somewhat poor	Significantly poor	41	37	2	2	64	62	0	2	105	94	2	4
154. Need for approval	Normal	Somewhat high	Considerably high	38	30	6	2	64	57	6	1	102	85	12	3
155. Sensitivity to others	Normal	Somewhat over-concerned about others' feelings	Considerably over-concerned about others' feelings	36	33	3	0	61	23	29	9	97	58	33	9
156. Sensitivity to self	Normal	Somewhat too sensitive; feelings easily hurt	Overly sensitive; feelings very easily hurt	39	23	15	1	64	11	40	13	103	33	53	14
157. Dependence on adults	Normal	Somewhat too dependent	Overly dependent	44	38	4	2	64	54	2	8	128	85	6	9
158. Separates from adults	Normal	Separates from parents only after encouragement	Cannot be encouraged to separate from parents	57	46	10	1	64	50	3	11	121	79	11	10
159. Aggression	Normal	Periodically over-aggressive	Consistently over-aggressive	64	61	2	1	64	52	2	10	128	88	3	9
160. Compliance	Normal	Compliant when expectations are made clear	Compliant only in highly structured situations	73	52	15	6	64	39	4	21	137	66	14	20
161. Affect	Appropriate	Limited	Significantly limited	65	61	4	0	60	58	2	0	125	95	5	0
162. Requests for clarification	Normal	Often unwilling to repeat an utterance	Consistently unwilling to repeat an utterance	40	24	15	1	64	46	11	7	104	67	25	8
163. Willingness to talk	Normal	Hesitant in many situations	Hesitant in most situations	55	41	12	2	64	53	8	3	119	79	17	4
164. Response to speech treatment	Normal	Often frustrated; needs encouragement	Consistently frustrated	36	23	13	0	—	—	—	—	36	64	36	0
165. Attention in treatment	Normal	Somewhat distractible; can attend for short periods	Highly distractible	48	31	13	4	57	36	14	7	105	64	26	10
166. Manipulative behavior in treatment	Not over-manipulative	Periodically over-manipulative	Constantly over-manipulative	39	26	9	4	62	39	18	5	101	64	27	9
167. Speech-related avoidance	Normal	Some avoidance of difficult speech tasks	Frequent avoidance of difficult speech tasks	40	19	18	3	61	47	11	3	101	65	29	6
168. Willingness to work on targets in treatment	Very willing	Somewhat unwilling during speech tasks at times	Unwilling	36	17	15	4	—	—	—	—	36	47	42	11
169. Rate of change	Making steady progress	Moderately slow	Significantly slow	32	14	12	6	—	—	—	—	32	44	38	19