COEXISTENCE OF COMMUNICATION DISORDERS IN SCHOOLCHILDREN

ASHA MONOGRAPHS

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Chapter 1

The National Speech and Hearing Survey: Database

1.1 BACKGROUND AND PURPOSE

In the mid-1960s, demand for speech and hearing clinicians in the schools increased dramatically. To meet this demand, university training programs in speech pathology and audiology expanded rapidly and aggressively sought federal funds to support students in training. As more money was requested and disbursed, it became clear that there was no agreement on estimates of the prevalence of speech and hearing disorders in the public schools. Thus, the idea of a national survey was borne (M. Marge, personal communication, April 1985), and in 1964, the U.S. Office of Education sought to determine the prevalence of speech and hearing problems in the U.S. public schools.

Marge, who was then a program specialist in the Office of Education, contacted a number of universities around the country to carry out a speech and hearing survey; Colorado State University in Fort Collins, Colorado, was eventually given the contract. During 1965 and 1966, a group of 19 distinguished consultants assembled to make recommendations about design, methodology, and statistical analysis to a research group at Colorado State University, headed by Forrest M. Hull, Project Director (Hull & Timmons, 1966). Two pilot studies, one with approximately 900 subjects and another with 6,290 public schoolchildren, were carried out in the Rocky Mountain region to formulate reliable procedures for selection of subjects and data collection (Hull, Mielke, Timmons, & Willeford, 1971). Aside from an interim report submitted to the Office of Education (Hull, 1969), the results of these pilot studies were not published.

> The primary purpose of the National Speech and Hearing Survey was to reliably estimate the prevalence of speech and hearing disorders among public school children. But the survey offered a unique opportunity to obtain updated normative speech and hearing data for a large group of randomly selected school-age subjects. (Hull et al., 1971, p. 502)

1.2 DESIGN CONSIDERATIONS

1.2.1 Content of Examinations

Speech Examinations. Each speech examination required about 10 minutes. Students named items on a picture articulation test, repeated erred sounds in a syllable stimulability task, produced a spontaneous language sample elicited by pictures and questions, repeated sentences, and sustained production of several vowels. The evaluators scored the subjects' single word articulatory responses as either correct or incorrect. They also provided numerical summary rating judgments of the subjects' articulation, rate, fluency, voice, dialect, and overall communicative adequacy. The entire speech sample was audio recorded.

Hearing Examination. Pure-tone air conduction thresholds were obtained for each subject in a sound-treated environment. The time allotted for each hearing test was approximately 5 minutes.

Historical Perspective. As noted, a panel of authorities in speech, language, and hearing assembled to make recommendations about what should be—and should not be—included in the National Speech and Hearing Survey (NSHS). Despite the fact that the survey was intended to include the best current thinking and technology at the time (circa 1965–1966), looking at the data more than 2 decades later reveals how much the content and methodology of speech and language evaluation has changed.

Perhaps the most glaring "omission" from the test protocol was any specific measure of language. Nevertheless, it must be remembered that courses in language disorders were generally not offered in speech pathology curricula in the mid-1960s. Following Chomsky's (1957) seminal work, psycholinguists were only beginning to publish the early results of studies in children's acquisition of syntax (e.g., Brown & Fraser, 1963). The Northwestern Syntax Screening Test, the first widely used language test to sample linguistic aspects other than vocabulary, was not published until 1969 (Lee, 1969). Fortunately, the NSHS designers included spontaneous and imitative language samples that were audio recorded. As a result, a wide variety of language analyses could be performed from the tapes.

By and large, the NSHS design reflected the best information available at the time. It certainly sampled the disorders that were of concern to professionals and attempted to do so as efficiently, objectively, and reliably as possible.

1.2.2 Geographic Scope

A stratified random sampling plan was developed to select students from grades 1–12 who were enrolled in school districts with populations of at least 300 students. Potential districts were located in the 48 contiguous states and the District of Columbia (excluding Hawaii and Alaska). The population figure of 300 enabled adequate sampling of all grades at a locale. In addition, the lower bound limit excluded only a small number of potential students (2.3%) (Hull, Mielke, Willeford, & Timmons, 1976).

School districts meeting the population criteria were categorized into one of nine census divisions established by the U.S. Bureau of Census and then further divided by student population into one of five district size groups. The division by student size was based on school population data provided by the U.S. Office of Education. By employing the specific sampling criteria, the investigators were able to ensure that the sample was representative of those students enrolled in the public schools of the United States and the District of Columbia.

A total of 100 sampling points were selected for study purposes so that approximately 400 students could be evaluated from grades 1–12 with 33–34 students screened at each grade. If a school district did not contain a total of 400 students, it was combined with a district in the immediate locale. Figure 1 shows the census regions and sampling sites that were selected for study purposes. Appendix A provides a listing of specific cities and towns that were included.

1.2.3 Test Environment

Mobile Units. Early on, the NSHS planners determined that the evaluations should take place in comfortable, quiet, controlled, and similar environments nationwide. They decided that using custom-built mobile units would be the best way to ensure adequate and uniform test environments. For these reasons, NSHS commissioned the Gerstenslager Company in Wooster, Ohio, to design a testing van to be used in the Rocky Mountain region pilot study. On the basis of this experience, the design was modified to provide optimal size, sound attenuation characteristics, and use of space. Figure 2 provides a sketch of the layout of the mobile units utilized in data collection. Each of the six vans was equipped with an IAC (Model 401) chamber in the center for hearing testing and two speech testing rooms, one at the front and one at the back. Electricity was provided by a connection line that could be rolled out and attached to the school's main power supply. Vans had central heating and air conditioning capability and carefully designed equipment to maintain even voltage and current levels and to protect the test equipment from damage.

Test Equipment. Hearing tests were carried out in the IAC Model 401 sound chambers utilizing Maico MA 11 audiometers and TDH-39/102 earphones in MX-41/AR cushions. Audiometers were modified by the addition of trim potentiometers to facilitate calibration. Speech samples were recorded on Uher (4000 L Report) reel-to-reel tape recorders using 5-inch Scotch audio tape reels.
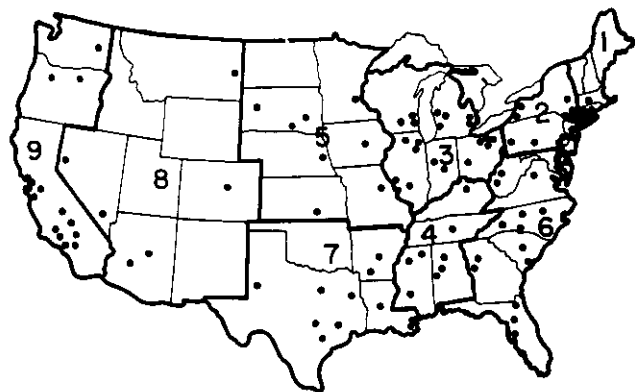
FIGURE 1. Map of the contiguous 48 states and 100 NSHS sampling sites located in nine U.S. census regions (adapted from Hull et al., 1971).
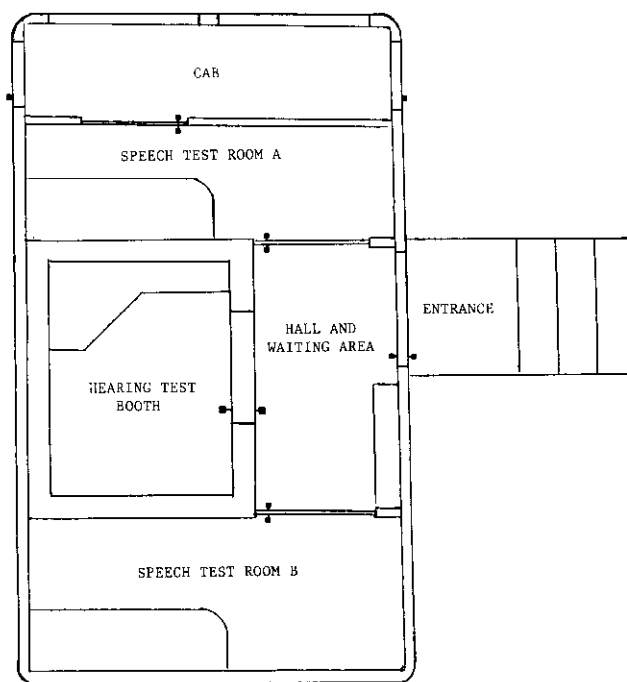
FIGURE 2. Floor plan sketch of an NSHS test van.

1.2.4 Examiners

Survey Teams. The 24 individuals hired to carry out the actual testing formed six teams. Each team had one coordinator who made contact with each school district and visited each school. After obtaining lists of students, the coordinators randomly selected 33–34 students per grade and placed identifying information at the top of individual data sheets: each subject's number, name, city, state, grade, sex, age (in months), school district number, census district number, and team number. Coordinators generally worked on the next survey site while the remainder of the team members carried out testing at any given location. The three examiners rotated assignments each day so that two would test speech and one would test hearing; each assignment lasted a half or full day. In this way, all three examiners performed equal shares of speech and hearing testing.

Training. All of the examiners and coordinators who participated in the NSHS possessed bachelor's or master's degrees in speech pathology. Some were new graduates of training programs; others had been employed as clinicians for a number of years.

Prior to testing, which occurred throughout the 1968–1969 school year, the 24 examiners and coordinators spent approximately 1 month at Colorado State University in a specialized training course. Essentially, the training involved detailed briefings on testing and scoring guidelines and group listening and scoring practice. All the examiners were required to meet minimum interjudge and intrajudge reliability criteria for the speech and hearing measures. Additionally, considerable time was necessary to prepare the teams to operate the vans, calibrate and maintain

equipment, collect and mail data, and carry out other related activities necessary to the project.

At various times throughout the school year, project staff from Colorado State University visited each team on site and provided any necessary follow-up training and information. These visits and the frequent telephone contacts also provided necessary psychological support and incidental troubleshooting.

Reliability. NSHS project officers considered reliability of judgments critical in conducting a national survey. Examiners were trained using specially prepared tapes with the purpose of improving and maintaining both intrajudge and interjudge agreement. For spontaneous speech judgments, examiners listened to tapes on seven occasions so intra- and interjudge comparisons were possible. These were carried out before (twice), during (four times), and after the testing (once). Hearing threshold reliability was assessed by requiring all three examiners to test one first grader on 2 successive days at each test site.

1.3 METHOD

1.3.1 Subjects

In all, 38,884 students underwent the testing process. Subjects represented 37 states and the District of Columbia and were distributed across all nine census regions. Of the 38,884 subjects, 51.4% were male and 48.6% were female. The hearing data from 316 students were deemed unreliable for various reasons, and the speech data collected from 82 subjects were not included for analysis. Consequently, hearing threshold data are available for 38,568 students, and speech data are available for 38,802 subjects.

1.3.2 Testing Procedures

Speech. The parameters studied during the speech evaluation included articulation, fluency, and voice. Four types of speech responses from each subject were evaluated: single word responses elicited from a standard picture articulation test, repetition of four vowel sounds, connected speech samples elicited by stimulus pictures or questions, and sentence repetitions. The order of presentation was constant for all subjects. Each subject was tape recorded.

After entering the speech testing room, the subject's name and number were tape recorded, and he/she was first given the Sound-in-Words subtest of the Goldman-Fristoe Test of Articulation, Experimental Edition (Goldman & Fristoe, 1968). The combined criteria of adult normal speech and General American Dialect were the standards against which examiners were trained to determine deviations of articulation. As the subject named each picture, the examiner scored a 0 on the data sheet if the sound in question was correct. If incorrect, the space was marked for later identification. After the completion of the last plate, a stimulability test was administered for all the misarticu-

lated sounds. Initial, medial, or final word position errors were modeled using the neutral vowel /ʌ/. For example, an error of initial /l/ would be modeled as /lʌ/; an error on medial /r/ would be presented for imitation was /ʌrʌ/. If the stimulated sound was still produced incorrectly, a 1 was scored in the space for a nonstimulable error. On the other hand, if upon stimulation, it was correct, a 2 was scored for a stimulable error.

Next, each subject was asked to sustain the vowels /i/, /a/, /u/, and /æ/. (The design protocol called for at least five second productions for each vowel, but some examiners did not insist on a full five seconds.)

Stimulus materials to evoke spontaneous speech varied slightly among age groups, but the format remained constant. The task was to obtain a minimum of 30 seconds of connected speech. There were two questions for grades 1–6—one of the two picture stories from the Sounds-in-Sentences Goldman-Fristoe Articulation Test for grades 1–3, and two other pictures for grades 4–6. The subjects were expected to tell a story about the pictures. Junior high subjects (grades 7–9) were asked three questions and shown two pictures for storytelling. High school subjects (grades 10–12) were simply asked four questions. When necessary, examiners encouraged students to respond by such prompts as "Tell me more." Finally, all subjects were asked to repeat the same four 10-syllable sentences. For example, a fifth grader would be asked to tell about his family and a television program, to make up a story about two pictures, and to repeat four sentences. A senior high subject would be asked to discuss four questions and to repeat four sentences. Appendix B provides a complete list of stimulus materials.

After listening to the entire speech sample, the evaluator made a number of judgments regarding the quality of performance based on deviations from a predetermined standard of speech behavior. These judgments are described in the following paragraphs.

A judgment of articulation was made from the articulation test and connected speech sample according to the following criteria: 0 = no deviation, 1 = mild-to-moderate deviation, and 2 = severe articulation deviancy. Dialectical variations such as /dɪs/ for /ðɪs/ were typically considered to be errors and often resulted in a rating of 1. In cases of any dialect that deviated from Adult General American (AGA) dialect, a 1 was scored. AGA speakers were scored 0 for dialect.

Deviation in voice was rated on a similar 3-point scale with the standard being a clear laryngeal tone appropriate in pitch level for age and sex of the subject. Thus, a subject received a 0, 1, or 2 rating for voice. When a 1 or 2 were scored, the examiner was obliged to score at least one additional deviancy in three descriptive categories. The first judgment was made regarding the type of resonance/quality deviation: none (0), hypernasal or hyponasal (1), breathiness (2), and hoarseness (3). The second judgment referred to pitch, i.e., normal (0) versus too high or too low (1). The third assessed loudness, i.e., normal (1) versus too loud or too soft (1).

Fluency and stuttering were scored separately. According to the NSHS *Operations Manual*, "fluency" was scored normal (0) or abnormal (1) if the subject's speech had "dis-

fluencies to the degree that they [were] disrupting to the overall speech pattern." "Stuttering" was scored either as absent (0) or present (1) if the subject had "secondary mannerisms, tricks, or 'apparent emotional reactions' to disfluencies." Subjects could be scored abnormal for fluency (1) but not stuttering (0), but the converse was not true; all stuttering subjects were required to be scored abnormal (1) for fluency.

The subject's speaking rate also was evaluated dichotomously. Zero was scored for normal rates; 1 represented a rate that was either too fast or too slow.

Finally, a 4-point scale was used to rate the overall adequacy speech sample, referring to intelligibility and taking into account the subject's articulation, voice, and fluency as contributors to the total speech pattern. Zero indicated no deviation from the standard pattern; 1 indicated mild impairment in communication; 2, a moderate impairment; and 3, a severe impairment. A subject was required to be scored 1, 2, or 3 for overall adequacy if any other abnormal judgments of articulation, voice, or fluency were noted. (In spite of this, a few cases in the survey received 0 ratings for overall adequacy even when other deviancies were scored.)

Both forms of the data sheet are provided in Appendix C. They illustrate that the only other ratings for speech included the examiner's individual number (1, 2, or 3) and a slot to score a 1 if the speech test was for any reason judged not to be a reliable (or valid) estimate of the student's speech. As noted above, each speech test required approximately 10 minutes.

Hearing. Obtaining bilateral, pure-tone, air conduction thresholds for each child required about 5 minutes. Each subject was seated so that he could not see the evaluator. The following procedure was used to determine thresholds.

An initial 1000-Hz tone was presented at 40 dB HL (re: ISO, 1964) to orient the child to the test stimulus. Following his/her response at this level, the tone intensity was decreased in successive 10-dB steps until the child failed to respond. The stimulus was then increased in 5-dB increments until a response was once again obtained. This procedure was repeated until a hearing level was established at which the child responded at least 50% of the time. A minimum of three ascents were made to determine threshold. This phase of testing was intended solely to familiarize the child with the threshold measurement task, and the value obtained was not recorded.

For threshold measurements after orientation, the initial presentation level was lowered from 40 dB to 20 dB HL. If a child failed to respond to 20 dB, the stimulus was increased in 20 dB steps until a response was elicited. Threshold was then obtained using the "down 10 dB up 5 dB" procedure described previously. If a child responded at 0 dB HL, three stimulus presentations were made to confirm this hearing level, but no effort was made to obtain responses at lower intensities.

For one-half of the children, order of frequency presentation was 4000, 500, 2000, 3000, and 1000 Hz; the left ear was tested first. For the other half, the order of presenta-

tion was 3000, 1000, 2000, 500, and 4000 Hz, and the right ear was tested first.

At all frequencies where hearing levels in the child's two ears differed by 40 dB or more, 86 dB (SPL) of white noise was supplied to the child's better ear while his poorer ear was retested. Both masked and unmasked thresholds were recorded.

Appendix D includes a list of variables scored on the data sheets and numerical possibilities for each. In addition, the location on the current computer file for each variable is provided.

1.3.3 Calibration

Tape Recorders. Twice each day, the Uher tape recorders were calibrated by adjusting a potentiometer that modified the tape speed. The procedure was as follows: A prerecorded tape of a 1000 Hz tone was placed on the tape recorder and played. Next, the examiner set into vibration a 1000-Hz tuning fork and adjusted the tape speech until beats became slow and, eventually, nonexistent. Basically, this was a "zeroing-in" technique of going above and below the correct match, a procedure nearly identical to tuning a guitar string to a piano note.

Audiometer. Before testing was initiated at each site, an artificial ear (Rudmose, Model RA 106) was used to perform an electroacoustic calibration (re: ISO, 1964 standards) of audiometer output level at each frequency. At the beginning and end of each testing day, audiometer calibration was verified by measuring output levels with a voltmeter (Simpson, Model 715).

As an added precaution, each team had backup equipment that could be used in the event of a malfunction. This allowed testing to continue while damaged equipment was sent for repair.

1.3.4 Data Reduction

Data sheets and tapes were carefully checked at the end of each day. After each site was finished, the team sorted and boxed all of the tapes and data sheets and mailed them to Colorado State University. There, trained key punch specialists coded the data sheets on computer cards. Later, the data were stored on computer tape, and the cards were discarded.

1.3.5 Current Status of the NSHS Data

In 1983, Project Director Forrest M. Hull contacted Kenneth O. St Louis, who had been one of the NSHS examiners, about obtaining the NSHS data. They made arrangements to transfer all of the data to West Virginia University, where it is currently stored. A number of studies have been carried out with these data and are summarized in Chapter 4.

Our archives contain computer files, data sheets, and tapes for each subject. In addition, written protocols for those subject groups that have been studied can be made available under special arrangement.

Chapter 2

The National Speech and Hearing Survey: Results

2.1 RELIABILITY

As noted in Chapter 1, NSHS examiners listened to and scored reliability tapes on seven occasions; each of these seven occasions involved two different ratings for the purpose of assessing intrajudge agreement. The time interval between the two intrajudge ratings was 1 day for the two assessments prior to testing and the one assessment after the survey; the interval was 1 week for the four reliability checks during the survey proper. Mean percentages of agreement for interjudge and intrajudge comparisons were calculated at each time period for articulation, voice, stuttering, and overall adequacy. The highest levels of reliability were observed for stuttering, but these high figures (98%–100%) certainly were influenced by the fact that a majority of listeners agreed that most of the subjects were *not* stutterers. The next highest ratings were for articulation (75%–90%), followed by overall adequacy (58%–83%) and voice (66%–84%). Mean intrajudge reliability was 79%, and mean interjudge reliability was 86%. Both inter- and intrajudge reliability improved over the course of the survey.

Reliability for audiological measures was assessed throughout the survey by having all three examiners at each site test one first grader on 2 successive days. For 63 of the 100 sites for which completed data were available, at least 90% of all five thresholds in both ears (ten thresholds) made on 2 successive days were within plus or minus 5 dB. Inter- and intrajudge percentages were nearly equal. Threshold differences greater than 10 dB at any frequency were obtained in no more than 3% of interjudge and 1% of intrajudge comparisons, and no discrepancy was greater than 20 dB. Considering the variability inherent in threshold measurement and the fact that all reliability subjects were first graders (in whom test-retest inconsistencies were assumed to be most likely), this rigorous test supports the conclusion that the reported NSHS hearing thresholds were reliable.
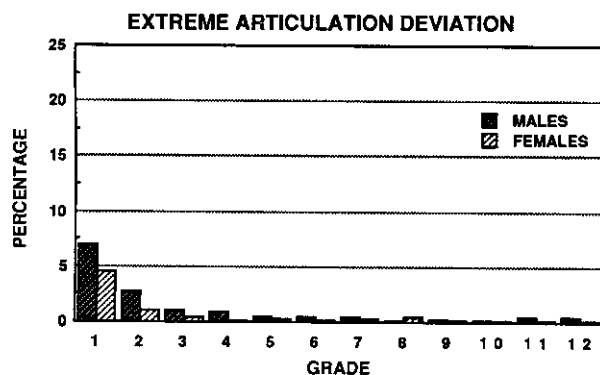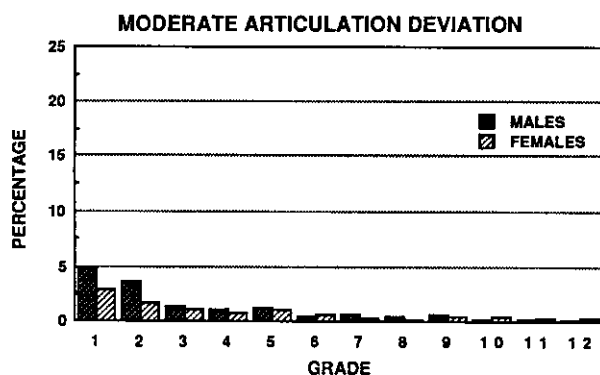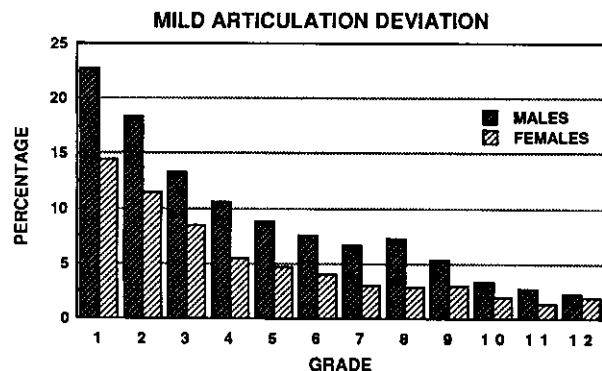
2.2 PREVALENCE RESULTS

2.2.1 Speech

Articulation. In the final Grant Report (Hull et al., 1976), figures were provided for each disorder, and a composite estimate of prevalence of speech disorders was reported. Figures 3a-3c show the percentage of subjects in each grade determined to have what were termed *mild, moderate,* or *extreme* articulation deviations. The data are plotted on the same ordinate on these and a number of subsequent figures so that the graphs can be compared directly for a visual impression of prevalence. Two patterns can be seen easily. First, there is a strong developmental effect, i.e.,

many more articulatory deviations in the early elementary grades compared to later grades. Second, males received lower ratings than females at nearly every level. Overall, the male-to-female ratio was 1.8:1. The project investigators reported the prevalence of articulation disorders to be sum of the means of the latter two categories: *moderate* and *extreme* deviations, 1.0 and 0.9% respectively, for a total of 1.9%. This figure is extremely conservative because the categories for articulation deviance were derived from various combinations of the original ratings of articulation and overall adequacy. Only those with original articulation ratings of severe and overall ratings of moderate or severe were included. If the *mild* articulation deviation group, which includes mild-moderate articulation and moderate and severe overall adequacy ratings, were added, the prevalence figures would jump to 9.0%. This figure is higher than most estimates (Leske, 1981b). If the survey had required examiners to estimate articulation according to mild, moderate, or severe instead of mild-to-moderate or severe, and if moderate articulation deviances were added, it is likely that a higher prevalence of articulation disorders would have emerged. It would have included the relatively mild articulation disorders often observed clinically but *not* those who ordinarily are not considered to warrant treatment.

From the Goldman-Fristoe Test Articulation results, the sounds most frequently misarticulated by all males and females in the moderate and extreme groups are shown in Table 1. The /hw/ was excluded from analysis because about 50% of the total sample said /wil/ for /hwil/ ("wheel"). Common errors included: initial /z/, /s/, /ð/, /v/, and /tʃ/; medial /θ/ and /ð/; and final /r/, /s/, /ʃ/, /tʃ/, /j/, /l/, and /g/.

Voice. The results for voice are shown in Figures 4a–c. Again, males received more severe ratings than females at every level; the sex ratio was 1.8:1, males to females. As with articulation, too, a strong developmental effect emerged. Results were collapsed for the *moderate* and *extreme* voice deviation groups to derive a total prevalence estimate of 3.0%. As was the case for articulation, these categories were derived by combining the original voice and overall ratings. If the *mild* voice deviation category were added, the prevalence would increase to 10.2%, again, a figure that is higher than most estimates (D. K. Wilson, 1987).

Vocal deviations in loudness, pitch, resonance, and quality were also scored by examiners. Figure 5 displays percentages of males and females who were scored either too loud or too soft and too high or too low. These two categories are nearly identical. For loudness and pitch, respectively, the percentages for deviance were 2.5% and 2.6% for males, 4.0% and 4.1% for females, and 3.3% overall. For both loudness and pitch deviations, females *exceeded* males by a ratio of 1.5:1. A total of 15.1% of all subjects (16.6% of the males and 13.5% of the females) were scored

MILD ARTICULATION DEVIATION

MODERATE ARTICULATION DEVIATION

EXTREME ARTICULATION DEVIATION

FIGURES 3a, 3b, and 3c. Percentage of subjects by grade level and sex for the NSHS sample with (a) "mild articulation deviations," (b) "moderate articulation deviations," and (c) "extreme articulation deviations."

for resonance deviations (hypernasality or hyponasality). The sex ratio was 1.3:1, males to females. Breathiness was scored for 7.5% of males and 14.6% of females for a total of 11.0%. Again, females predominated by a 1.9:1 ratio. Hoarseness was observed for 28.6% of the males, 17.4% of the females, and 23.1% of the total group. For hoarseness, males were more likely to be scored by 1.8:1. No doubt, these percentages were influenced by the presence of shyness, producing soft, breathy voices as well as colds, allergies, and the 1968–1969 Asian flu epidemic, resulting in hoarseness. For voice, it is interesting also that females were more likely than males to be deviant for the variables of loudness, pitch, and breathiness.

Stuttering, Fluency, and Rate. Subjects were rated for the presence of abnormal fluency and stuttering. Both judg-

ments were necessary for stuttering. Figure 6 shows the results for stuttering. The uneven decline from 1st through 12th grades suggests that although the prevalence of stuttering declines, there are small reversals in the trend at grades 5 and 7–9. The male-to-female sex ratio was 3.1:1, very close to the often reported 3:1 ratio (Bloodstein, 1987). The total prevalence was 0.8% (1.2% of the males and 0.4% of the females).

Figure 7 shows the results for abnormal fluency that was not stuttering. Prevalence results were 4.9% for males, 2.5% for females, and 3.7% for all subjects. The sex ratio here was 2.1:1. These individuals are quite likely to manifest other speech and language problems as will be seen in Chapter 4. Rate of speech, i.e., too fast or two slow, was scored as well. Of the males tested, 1.3%, of females, 0.8%, and, of the total sample, 1.1% were considered deviant for rate. The sex ratio was 1.6:1, males to females.

MILD VOICE DEVIATION

MODERATE VOICE DEVIATION

EXTREME VOICE DEVIATION
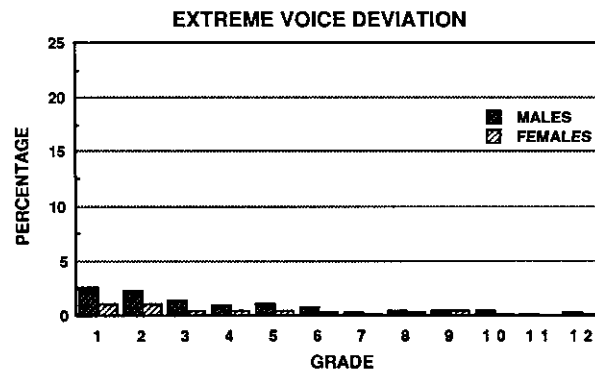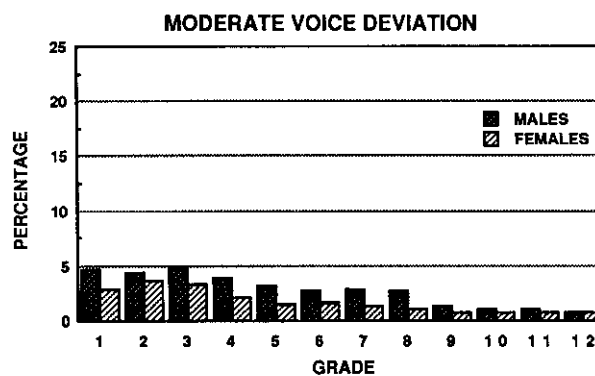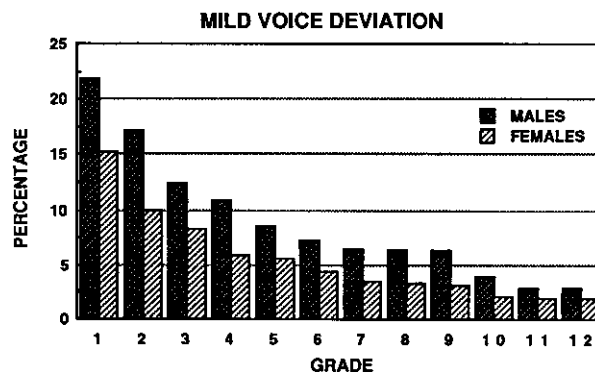

FIGURES 4a, 4b, and 4c. Percentage of subjects by grade level and sex for the NSHS sample with (a) "mild voice deviations," (b) "moderate voice deviations," and (c) "extreme voice deviations."

TABLE 1. Most common single articulation errors in moderate and extreme articulation deviation groups.

| | Moderate | | Severe | |
Rank	Male	Female	Male	Female
1	z-	z-	-θ-	z-
2	s-	-r	z-	-θ-
3	-θ-	s-	-r	-tʃ
4	-tʃ	-θ-	-ʃ	-ʃ
5	-r	-tʃ	-tʃ	-r
6	-ʃ-	-ʃ-	-ð-	-s
7	v-	v-	s-	v-
8	-ð-	ð-	v-	-ð-
9	-j	-j	-j	-j
10	-g	-g	-l	-l

FIGURE 6. Percentage of subjects with stuttering by grade level and sex for the NSHS sample.

Dialect. Any dialect that deviated from the Adult General American dialect was identified. Forty-eight percent of the sample was rated as having a dialect, split almost equally between males and females. There were no surprises in the regional distribution of the percentage of subjects not using the Adult General American dialect. In the Rocky Mountain and Pacific areas, the prevalences were 3%–5%, in the Midwest, 14%–29%, in the Northeast and New England areas, 49%–62%, in the South and Southeast areas, 82%–91%. The figures correspond to the common assumptions about the prevalence of the distribution of various dialects around the United States.

2.2.2 Hearing

A total of 38,568 students provided hearing test results judged as "reliable" by NSHS evaluators. In the following analysis, an ear was designated as hearing impaired when the average of pure-tone thresholds at 500, 1000, and 2000 Hz exceeded 25 dB HL.

Figure 8a presents the sum of unilateral and bilateral hearing-loss prevalence statistics for each grade level and for all students in the NSHS sample. First graders showed the highest prevalence of hearing impairment. Prevalence was sharply lower in the second grade and showed a gradually progressive decline through the elementary school

years. In the seventh grade, hearing-loss prevalence again showed a relatively large drop but then remained fairly stable throughout the higher grade levels. Overall, 2.63% of the schoolchildren tested in the NSHS had PTA's greater than 25 dB HL in one or both ears.

The percentage of children with bilateral hearing impairment is shown in Figure 8b. The prevalence of bilateral losses ranged from 1.8% (first grade) to 0.22% (ninth grade). In total, 0.73% of schoolchildren in the NSHS sample had PTA's greater than 25 dB HL in their better ear.

Unilateral losses were more common than bilateral impairments at all grade levels of the NSHS sample. Figure 8c presents a detailed breakdown of these prevalence statistics. It shows that the hearing of 3.71% of first graders was impaired in one ear. Over the remaining elementary school years, the prevalence of unilateral losses declined to around 2% by the sixth grade. In grades 7–12, the prevalence of unilateral impairments ranged from 0.9% (grade 11) to 1.63% (grade 9). For grades 1 through 12 combined, the overall prevalence of unilateral impairment was 1.9%.

2.2.3 Summary

Overall, the NSHS investigators reported a 5.7% prevalence for speech disorders (including articulation, voice, and stuttering) and 2.6% for hearing impairments. A sub-

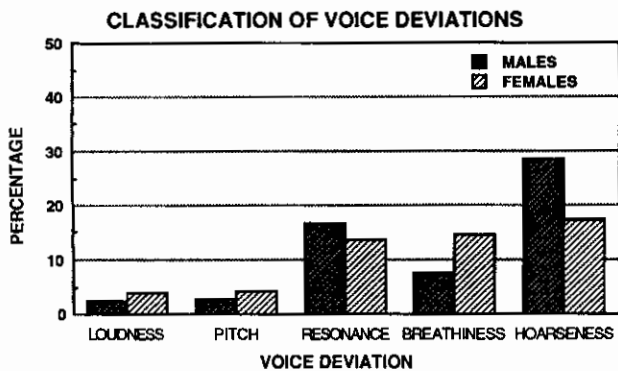
FIGURE 5. Percentage of subjects with specific voice deviations by sex for the NSHS sample.

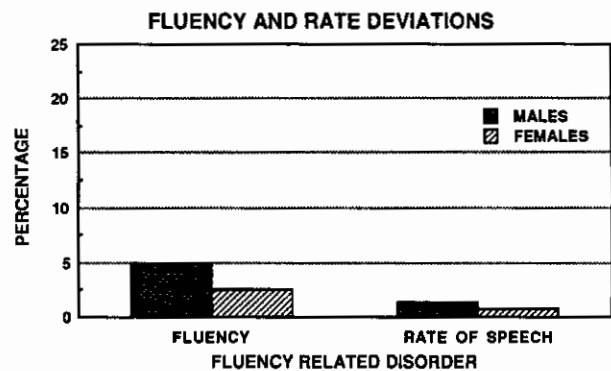FIGURE 7. Percentage of subjects with abnormal fluency and rate by sex for the NSHS sample.

PTA'S >25dB HL IN ONE OR BOTH EARS

PTA'S >25 dB HL IN BOTH EARS

PTA'S >25 dB HL IN ONE EAR ONLY
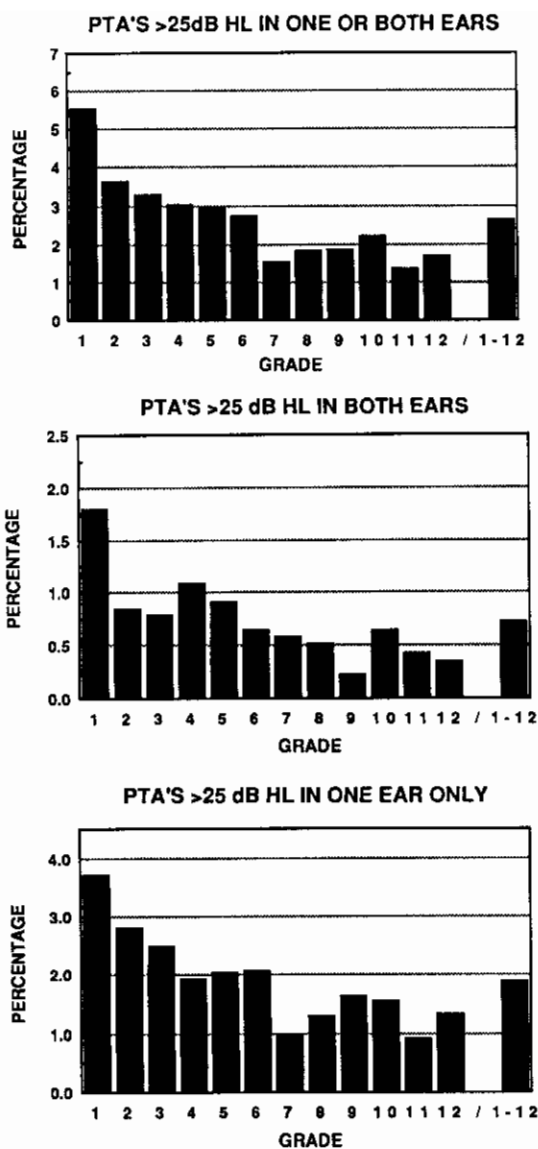
FIGURE 8a, 8b, and 8c. Percentage of subjects by grade level and for the entire NSHS sample with (a) hearing loss in one or both ears, (b) hearing loss in both ears, and (c) hearing loss in one ear.

stantial sex effect, from $1\frac{1}{2}$ to 3 times as many males as females, characterized most of the results. This suggests that boys are generally more at risk for the entire range of speech and hearing disorders than girls. Most disorders also showed a developmental pattern, with the greatest degree of impairment at grade 1 and the least at grade 12. In some cases, such as the drop between first, second, and third grades for articulation, the decline is precipitous, suggesting the role of maturation.

2.3 COEXISTENCE RESULTS

2.3.1 Speech

Articulation. Previously unreported computer printouts of the NSHS data were inspected to determine the degree to which examiners scored subjects with multiple deviations. Printouts were available for all combinations of ratings for articulation, voice, stuttering and overall for the 38,802 usable subjects. (A detailed table showing these results are provided in Appendix E.) One-third (33.6%) of the sample was rated as having deviancy in articulation. (Obviously, only a fraction of these was judged to be disordered.) As seen in Figure 9, of these 13,038 individuals, 41.7% were "pure," that is, without coexisting deviance of voice and stuttering. Nearly 57% had coexisting voice deviations, 10 times more with mild-moderate voice deviations than severe deviations. Less than 1% of the articulation deviant group had associated stuttering of stuttering and voice deviations, 0.6% and 0.9%, respectively.

As noted earlier (see Figures 3a–3c), there were developmental factors involved in the prevalence of articulation disorders. Those subjects with "pure" articulation deviancies are shown in Figure 10a as a function of grade; those with coexisting voice and/or stuttering deviancies are displayed in Figure 10b. Percentages reflect the proportion of total children in each grade scored. Regression lines are included for these two distributions to further illustrate that the two groups reflect different developmental patterns. The regression lines are linear and visibly provide a better fit for the "pure" group than the coexisting group. In fact, the data in Figure 10b are better fit with a logrithmic function ($R = 0.97$); however, the regression lines provided were used solely to illustrate the difference between the groups. There are approximately twice as many articulation deviations with coexisting stuttering or voice involvement as "pure" misarticulators in grade 1, 20.5% versus 42.0%. The prevalence of the coexistence group declines much more dramatically than that for the "pure" group such that by grades 9 and 10 the prevalences are approximately equal. By grade 12, there are fewer coexistence subjects (by about 20%). In fact, the two traces in Figures 10a and 10b suggest that the two groups are quite similar in grades 5–12 but markedly dissimilar in grades 1–4. This suggests that those factors responsible for articulation deviance accompanied by other communicative disorders in the early grades become *less* potent throughout the school years at a faster rate developmentally than factors that re-
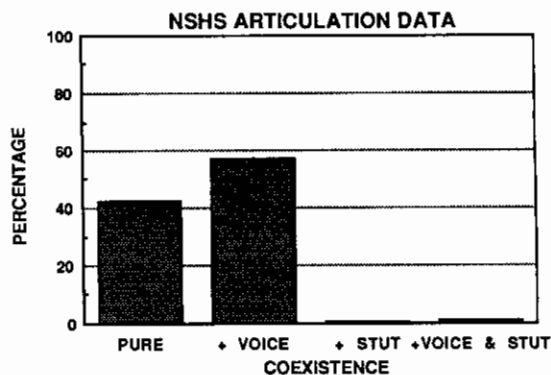
FIGURE 9. Percentage of subjects with pure articulation deviations versus those with coexisting deviations of voice and stuttering in the NSHS sample.

NSHS ARTICULATION DATA: PURE

$$y = 18.4018 - 0.673x \quad R = 0.90$$

NSHS VOICE DATA: PURE

$$y = 27.7476 + 0.3826x \quad R = 0.40$$

NSHS ARTICULATION DATA: COEXISTENCE

$$y = 36.2111 - 2.5616x \quad R = 0.93$$

NSHS VOICE DATA: COEXISTENCE

$$y = 36.2465 - 2.5597x \quad R = 0.93$$
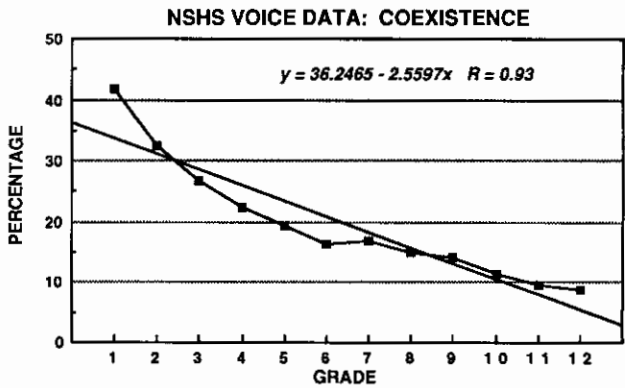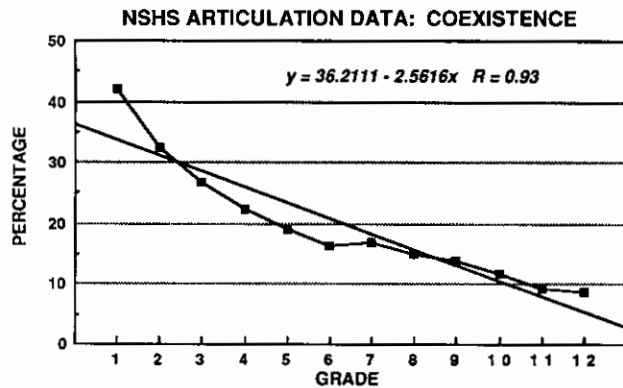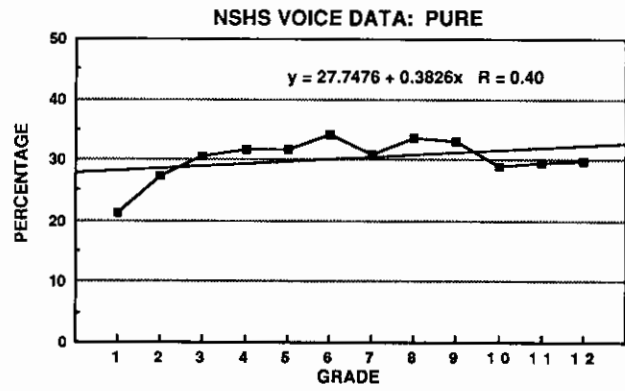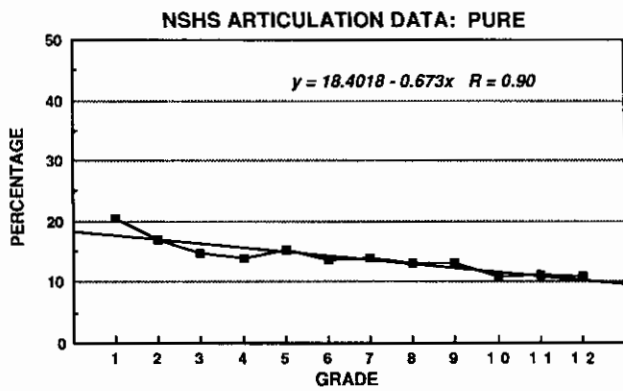
FIGURES 10a and 10b. Percentage of subjects by grade level in the NSHS sample with a line of best fit with (a) pure articulation disorders and (b) coexisting articulation disorders.

FIGURES 12a and 12b. Percentage of subjects by grade level in the NSHS sample with a line of best fit with (a) pure voice disorders and (b) coexisting voice disorders.

duce the prevalence of articulation deviance as the sole disorder.

Voice. Half (49.9%) of the total NSHS sample was scored deviant for voice in some way (see Figure 11). Of these 19,376 subjects, 60.5% were "pure," and 38.1% had coexisting articulation problems, with nearly 14 times as many with mild-moderate as severe, and less than 1% with associated problems with stuttering (0.5%) or articulation and stuttering (0.6%).

Developmentally, voice deviant subjects with and with-

NSHS VOICE DATA

FIGURE 11. Percentage of subjects with pure voice deviations versus those with coexisting deviations of articulation and stuttering in the NSHS sample.

out coexisting articulation and stuttering deviancies are quite different as seen in Figures 12a and 12b. The "pure" voice group increases from about 20% in the 1st grade up to about 30% by the 3rd grade and remains at that level through the 12th grade. By contrast, the coexistence group shows a decline throughout the school years. In fact, this curve is practically identical to the parallel curve for articulation because, by far, the greatest number of subjects with coexisting deviancies were those scored with mild-moderate articulation and mild-moderate voice. This combination, alone, accounts for 16.3% of the total NSHS sample. It should be noted that most of these subjects would be so mild as not to be considered disordered in a clinical sense. Still, the degree of overlap between articulation and voice in these subjects is striking.

Stuttering. Only 0.8%, or 320, of the total sample were stutterers. Figure 13 reveals that only 14.1% of these were "pure," 21.6% with articulation only, 27.5% with voice only, and 36.6% with articulation and voice. In all cases, there were more associated mild-moderate articulation or voice ratings than severe ratings, 3 times more than when either one was rated severe and 14 times more than when both received severe ratings.

Developmentally, the "pure" stutterers versus those with coexisting articulation or voice profiles are different (Figures 14a and 14b). Increasing from zero in grade 1 to 0.12% in grade 2, the "pure" group remains quite stable throughout the school years. This pattern contrasts to an

NSHS STUTTERING DATA

FIGURE 13. Percentage of subjects with pure stuttering versus those with coexisting deviations of articulation and voice in the NSHS sample.

uneven but fairly steady decline throughout in the coexisting group, from over 1% in the early elementary years down to 0.31% in grade 12.

Summary. "Pure" disorders comprised approximately 40% of the total articulation deviant group, 60% of the voice deviant group, and 15% of the stutterers. This leads to the conclusion that many, if not most, of the NSHS subjects with deviant speech production had more than one clinical category involved. Moreover, we can conclude, tentatively, that stutterers are most likely to have coexisting

NSHS STUTTERING DATA: PURE

$y = 0.1226 - 0.0013x$ $R = 0.08$

NSHS STUTTERING DATA: COEXISTENCE

$y = 1.1855 - 0.0735x$ $R = 0.90$
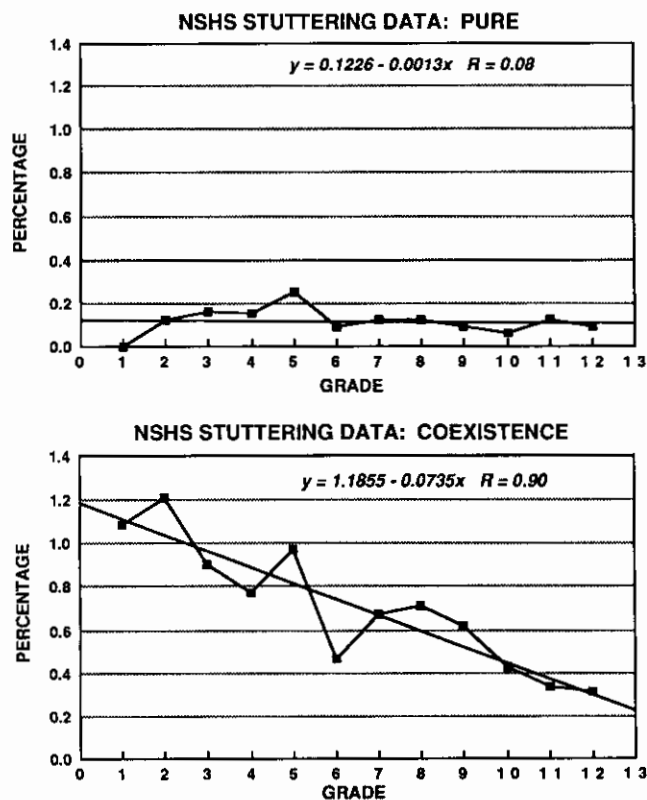
FIGURES 14a and 14b. Percentage of subjects by grade level in the NSHS sample with a line of best fit with (a) pure stuttering disorders and (b) coexisting stuttering disorders.

disorders, followed by those with articulation disorders, and finally by individuals with voice disorders.

2.3.2 Hearing

Data collected in the NSHS (Hull et al., 1976) provide a wealth of raw, unpublished information on the speech of schoolchildren with a wide range of hearing abilities. The preliminary analyses presented herein were conducted by partitioning the NSHS sample into three categories of hearing sensitivity and computing the prevalence of other communicative problems for each hearing category. The significance of differences among categories was then tested using chi-square.

Subjects were assigned to a hearing level category according to their best ear pure-tone average (PTA), computed by averaging thresholds at 500, 1000, and 2000 Hz. Significant hearing impairment was indicated by PTAs greater than 25 dB HL in the better ear; 16–25 dB HL was defined as the region of slight hearing impairment. This stratification placed 855 and 367 children in the slight and significant hearing impairment categories, respectively. A total of 37,275 children in the NSHS sample had good hearing, with PTAs in the range from 0–15 dB HL.

Articulation. Figure 15 shows the percentage of children in the entire NSHS sample (ALL) and in each hearing level category who were rated as having mild-to-moderate or severe articulation deviance. Both the prevalence and severity of deviant articulation increased as degree of hearing impairment increased. It is important to note that even among children with only slightly decreased hearing, articulation problems were far more common than in the NSHS sample as a whole. According to the chi-square analysis, these differences are significant (χ^2 (4) = 286.24; $p < .001$).

Voice. The percentage of children whose voice deviance was rated as mild-to-moderate or severe is presented in Figure 16. Over 60% of children with slight or significant hearing impairment had some degree of voice deviance, compared with 50% prevalence in the NSHS sample as a whole. Interestingly, the prevalence of voice deviance

ARTICULATION DEVIANCE

FIGURE 15. Percentage of subjects in the NSHS sample (ALL) and in each hearing level category with mild-to-moderate or severe articulation deviance.

VOICE DEVIANCE

FIGURE 16. Percentage of subjects in the NSHS sample (ALL) and in each hearing level category with mild-to-moderate or severe voice deviance.

among children with slight hearing impairment was virtually the same as in the significant hearing loss group. However, the proportion of children with severe voice deviance increased progressively as hearing sensitivity declined. Again, these differences are significant (x^2 (4) = 184.66; $p < .001$).

Stuttering. Figure 17 shows the prevalence of stutterers in each hearing category and for the NSHS sample as a whole. For children with good hearing or slightly decreased thresholds, stuttering was no more or less common than it was for the entire NSHS sample, of whom 0.82% were stutterers. In contrast, the stuttering prevalence was substantially higher in the significant hearing loss category. However, these prevalences are based on a very small number of cases. Of 38,497 subjects in the NSHS, complete hearing data were available on 315 of 320 total stutterers, and only six of these stutterers had significant hearing impairment. Because of these small numbers, the chi-square analysis indicates that the prevalence of stuttering is not significantly different among hearing categories, and no further analysis of stuttering among children with hearing impairment was pursued (x^2 (2) = 3.68; $p > .05$).

Coexistence of Deviant Voice and Articulation. Treating articulation or voice as singular, independent variables ig-

STUTTERING PREVALENCE

FIGURE 17. Percentage of subjects with stuttering in the NSHS sample (ALL) and in each hearing level category.

PTA'S 0-15 dB HL

PTA'S 16-25 dB HL

PTA'S >25 dB HL
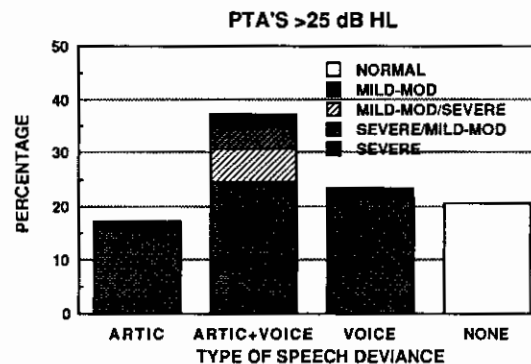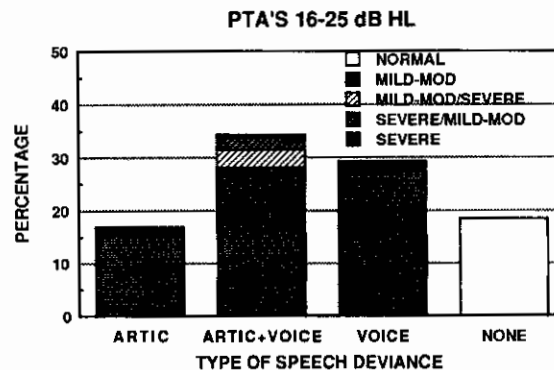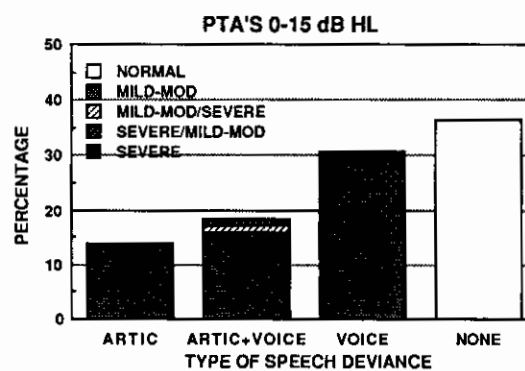
FIGURES 18a, 18b, and 18c. Percentage of subjects with (a) good hearing, (b) slight hearing impairment, and (c) significant hearing impairment, who showed no speech deviance (NONE), pure articulation deviations (ARTIC), pure voice deviations (VOICE), and coexisting articulation-voice deviance. Severity of the deviation is indicated in the legend. Where coexisting disorders differed in severity, the degree of deviance (mild-moderate or severe) is indicated first for articulation, then for voice.

nores the fact that the speech of the children in the NSHS sample with decreased hearing most commonly showed coexisting voice and articulation problems, as noted earlier. This is illustrated in the following three figures, which contrast the prevalence of pure articulation, pure voice, and coexisting articulation-voice deviance for children with good hearing (Figure 18a), slight hearing impairment (Figure 18b), and significant hearing loss (Figure 18c). More than one-third of children with slight or significant hearing loss had speech problems characterized by a combination of articulation and voice anomalies, whereas the prevalence among children with good hearing was only

18%. In contrast, the prevalence of pure articulation deviance showed little change across the three categories of hearing level. Pure voice deviance actually had a higher overall prevalence among children with good hearing (30.6%) than in groups with slight or significant hearing loss (29.3% and 23.4%, respectively).

Overall Adequacy of Speech. Although speech intelligibility may not be seriously affected by isolated articulation or voice errors, intelligibility is likely to be degraded when articulation and voice parameters are both deviant. This hypothesis finds general support in NSHS examiners' summary judgments of the overall adequacy of each child's speech. The percentage of children with mild, moderate, and severe impairment of overall speech adequacy is enumerated in Figure 19. Fewer than 20% of children with slight or significant hearing impairment had speech judged to be adequately intelligible, compared with 35% in the NSHS sample as a whole. The proportion of children with
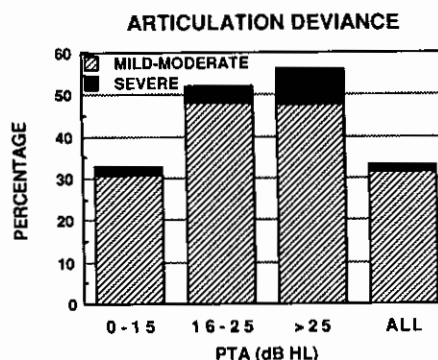

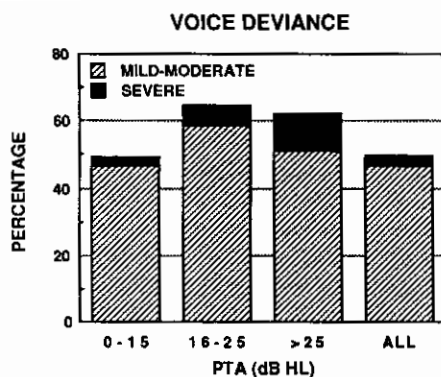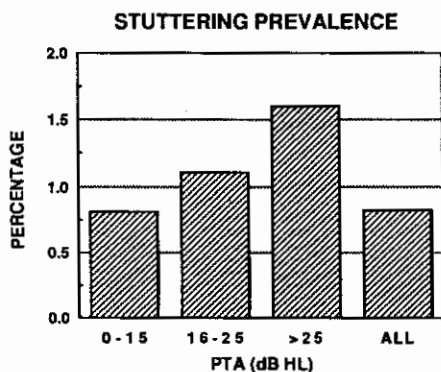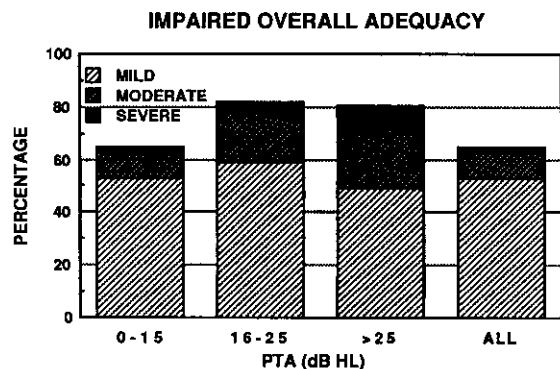FIGURE 19. Percentage of subjects in the NSHS sample (ALL) and in each hearing level category with mild, moderate, or severe impairment of overall speech adequacy.

moderate or severe speech problems increased progressively with degree of hearing loss. Differences among categories are significant (χ^2 (6) = 400.16, $p < .001$).

Implications. Because it is well known that children with even mild hearing losses are more likely to demonstrate articulation disorders (e.g., Markides, 1970; Oller & Kelley, 1974; C. R. Smith, 1975; West & Weber, 1974), the high prevalence of articulation deviance shown in Figure 15 is not unexpected. However, disordered voice characteristics are ordinarily associated only with deaf speakers, and not those with less severe hearing impairment (J. M. Davis & Hardick, 1981; Jensema, Karchmer, & Trybus, 1978; Seyfried, Hutchinson, & L. L. Smith, 1989). A major finding of the preceding analysis is that children in the NSHS sample with decreased hearing were most likely to show a combination of both articulation and voice problems. The relatively high prevalence of these disorders cannot be attributed to the inclusion of deaf speakers among students with hearing impairment in the NSHS sample. Of the 368 children with significant hearing impairment, only 31 had pure-tone averages poorer than 70 dB HL in the better ear, while the degree of loss was mild (40 dB HL or better) in the great majority of cases. Furthermore, the communication skills of all subjects in the NSHS sample were sufficient to permit their attendance at a regular school.

The fact that children with hearing thresholds in the 16–25 dB HL range also show a relatively high prevalence of coexisting articulation and voice problems is particularly noteworthy. In recent years, researchers have investigated the possible relationship between delayed speech and language development and slight hearing impairment associated with chronic otitis media (for reviews, see Rapin, 1979; Hasenstab, 1989). The NSHS results presented here indicate that aspects of speech production may indeed be affected by slightly depressed hearing sensitivity.

Chapter 3

Coexistence of Communication Disorders: Review of the Literature

3.1 PURPOSE AND OVERVIEW

The issue of coexistence of communication disorders is not new, as the review presented in this chapter illustrates. Before reviewing the West Virginia University studies utilizing the NSHS database, we believed it necessary to summarize research that has documented coexistence of communication disorders within various primary disorder groups or the population in general. The chapter is extensive and includes information that might be considered tangentially related to the issue of coexistence, such as speech and language of children with otitis media. Nevertheless, we concluded that it was important to summarize the available research in one place.

3.2 COEXISTENCE IN ARTICULATION AND LANGUAGE DISORDERS

This review will summarize those studies that have examined coexistence in subjects with articulation disorders[1] and language impairment of unknown etiology (Aram & Kamhi, 1982; Bernthal & Bankson, 1988; Winitz, 1969). There are two different perspectives from which this type of information is available. In one instance, investigators have selected subjects with articulation disorders and studied them to identify any potential coexisting problems. Articulation disorder was the primary diagnostic entity with the other disorders secondary to it. On the other hand, some investigators have examined individuals with language impairment and identified articulation disorders as a secondary category in their scheme. The material to be reviewed will include both perspectives; however, primary emphasis will be directed to the former.

3.2.1 Articulation and Language Disorders

Winitz (1969) conducted a critical review of investigations that studied the coexistence of articulation disorders and other language impairment. The results of the investigations varied as to the association between communication dimensions. Some of the investigations showed relationships between articulation disorders and various language parameters (E. A. Davis, 1937; House & Johnson, 1937); others found none (Yedinack, 1949). Winitz felt that future research should develop hypotheses regarding the interrelationships between phonology and the other

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[1] It should be noted that the term *phonological disorder* is the term currently used, and there is justification for its use in contemporary discussions (Locke, 1983). However, the majority of studies reviewed herein used the term *articulation disorder*; that nomenclature will be maintained in this section.

components of language. That is, there was no hypothetical direction in which investigators could formulate study methodology and interpret their results.

An early study conducted by Schneiderman (1955) provided data to indicate that schoolchildren with articulation disorders also showed decrements in language skills. She studied the articulation and language skills of 70 first-grade children and found that as articulation errors increased, language performance scores decreased for her study group. In another experiment, Vandemark and Mann (1965) examined the expressive language skills of 50 children with articulation disorders and 50 matched controls. The children with articulation disorders ranged in age from 8:4 (years: months) to 13:6. All scored at or below the cutoff score for 8-year-old children on the Screening Test of the Templin Darley Tests of Articulation (Templin & Darley, 1960). An expressive language sample was elicited, and measures of length, complexity, and vocabulary diversity were obtained. The results indicated that the subjects with articulation disorders had significantly lower structural complexity scores than matched normals.

Morley (1965) reported the results of a large study wherein she studied the speech development of children from approximately 1,000 families in England. In summarizing the data, Morley indicated that some of the children with articulation disorders presented a coexisting language disorder. The actual number of subjects showing such coexisting deficits was not available from the report. The presence of a language disorder was said to interfere with the evaluation of expressive phonology.

Shriner, Holloway, and Daniloff (1969) examined the language skills of 30 children who were described as having severe articulation disorders. Enrolled in grades 1–3, the children were matched with an equal number of controls. A language sample was collected from each subject and a number of structural analyses undertaken. Results indicated that significant differences existed with respect to length of utterance, grammatical completeness, and complexity.

Whitaker, Luper, and Pollio (1970) identified a group of children with articulation disorders and compared them with normal controls on a number of different tasks, including word association, metalinguistic awareness, and sentence imitation. The subjects ranged in age from 6:1 to 7:7. The articulation-disordered group showed poorer group performance on all measures that were used.

Although most investigations have focused on one or more aspects of expressive language, Marquardt and Saxman (1972) studied the receptive language skills of a group of children with articulation deficits and compared them to normal subjects. Thirty children with articulation disorders and 30 normal speakers who ranged in age from 5:6 to 6:7 were administered the Carrow Auditory Test for Language Comprehension (Carrow, 1969). The articulation-disordered group exhibited significantly lower scores on the test

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than the normal speaking group. In a separate investigation, Saxman and Miller (1973) used the same study population and evaluated short-term memory and imitative language skills. The groups did not differ with respect to digit and random word recall tasks, but significant differences in terms of sentence recall were found. The differential performance across tasks was interpreted by the authors as support for the position that the poorer performance of the articulation group could be attributed to deficiencies in linguistic ability rather than short-term memory.

In a large longitudinal investigation, Templin (1973) tracked 435 children's acquisition of articulation and language. She reported parallel development of the acquisition of various grammatical morphemes, using Berko's (1958) test, and consonants, measured by a standardized articulation test. This was true for children from preschool through the fourth grade who were inferior to (i.e., 7th percentile), or superior to (i.e., 98th percentile) children who manifested average performance (i.e., 50th percentile). In other words, children who were behind, or precocious, compared to average performance on articulation measures during preschool maintained their relative position with respect to their peers through $5\frac{1}{2}$ years. Those starting the lowest were also the lowest during the fourth grade; those who were most advanced during preschool continued to excel at grade four. Significantly, the same pattern was true for morphological development and a number of other measures, including intelligence, spelling, and reading. Children selected for stimulability and specific misarticulation of /r/, /l/, or /s/ had morphological scores similar to the 50$^{\text{th}}$ percentile group.

Panagos and his associates (Panagos & Prelock, 1982; Panagos, Quine, & Klich, 1979; Schmauch, Panagos, & Klich, 1978) carried out a number of studies that examined relationships between phonology and language structure. The experimenters used a series of imitative production tasks that included differing levels of phonological and grammatical complexity.

For example, Schmauch et al. (1978) had nine preschool children with articulation disorders imitate phrases and different sentence types. The results indicated that the children made significantly more errors in the sentence contexts, suggesting that syntactic complexity may influence articulatory production. Panagos et al. (1979) used a similar experimental format and devised production tasks that varied with respect to grammatical structure, syllabic structure, and word position. A total of 17 youngsters between the ages of 4:8 and 6:8 participated in the investigation. Subjects were required to imitate words and sentences across 14 target consonants. The authors found significant effects for grammatical structure and syllable structure, but not for word position. Their data suggest that both grammatical and articulatory factors may affect the production capabilities of children with articulation disorders.

The final study in this series was conducted by Panagos and Prelock (1982), and syllabic structure and grammatical structure were again varied. Subjects were required to imitate a series of sentence stimuli. Their 10 subjects showed decrements in performance that varied as a function of both phonological composition and grammatical structure. The authors concluded that both "top-down and bottom-up" processing strategies were employed, suggesting that both are important to speech production. Moreover, the data demonstrate the bi-directional relationship that exists between language and articulation. The synergism alluded to by Panagos and his associates is similar to positions that have been articulated by others (Shriner et al., 1969).

The series of studies just reviewed by Panagos and his group represent an effort to study particular subsystems of language and phonology rather than to compare subjects on global measures. This shift, which began during the past 15 years, has continued with other investigators exploring various subsystems in order to describe the population of children with articulation disorders and focus on specific interactions between phonology and other language subsystems.

For example, Paul and Shriberg (1982) examined the articulation and expressive syntax of 30 children with articulation disorders ranging in age from 4:1 to 8:6. Continuous speech samples were analyzed to quantify articulation processes and patterns of syntactic development. The results indicated patterns of differential performance for the articulation and syntactic measures. Approximately 66% of the subjects exhibited some form of syntactic delay, and over 50% had problems in the productive use of some grammatical morphemes due to articulation disorders.

Shriberg and his associates (Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986) carried out a retrospective study that included 114 children with articulation disorders. The subjects, who ranged in age from 2:10 to 9:7, underwent comprehensive assessment utilizing the diagnostic schema developed by Shriberg and Kwiatkowski (1982). Their descriptive classification included subsets of causal correlate categories such as speech mechanism, cognitive-linguistic performance and psychosocial variables. Ratings in the cognitive-linguistic category indicated that over 50% of subjects were rated as exhibiting some language involvement, although their primary referral was delayed articulation development.

Shriberg and Kwiatkowski (1988) examined the educational histories of 36 schoolchildren who had received therapy during their preschool years for articulation disorders. A number of the children required special educational services upon entering school. Speech and language profiles of the children indicated that approximately 70% of the subjects presented initial articulation and language disorders.

Lewis, Ekelman, and Aram (1989) conducted a familial study of children with severe articulation disorders. Twenty children with severe impairment and their siblings were compared to 20 controls and their siblings on a battery of articulation, language, and motor measures. The experimental subjects and their siblings demonstrated poorer performance on the battery of measures employed, generally exhibiting deficits in both receptive and expressive language measures.

In a similar vein, Lewis (1990) presented the case histories of four children who had severe articulation disorders and had participated in the previous study. Family histories

revealed speech and language manifestations in the parents and siblings of the four subjects. The subjects' communication profiles were characterized by a severe phonological deficit and concomitant language disorder. The familial association suggested a genetic basis to the communication deficits observed.

An additional methodologic procedure, which has been used to study children with articulation disorders, involved the utilization of cluster (Arndt, Shelton, Johnson, & Furr, 1977) and factor analysis procedures (McNutt & Hamayan, 1984) to identify specific subgroups. Subgroups of subjects can then be identified within the larger population of children with articulation disorders. Arndt et al. (1977) evaluated a total of 98 subjects between the ages of 8:0 and 9:6 who showed mild articulation impairment in the production of /s/, /r/, or both. The subjects were given a battery of 40 tests, which included measures of language, oral structure, oral form recognition, auditory processing, school achievement, and other relevant measures. One of the subgroups, which contained 26 subjects, showed overall deficits on the language measures that were administered. Even though these participants were mildly involved, a subgroup with coexisting language impairment was identified.

McNutt and Hamayan (1984) also utilized multivariate analysis with groups of 60 articulation-disordered children, representing a wide range of severity, and 39 control subjects, ages 8 to 12 years. The subjects were given a battery of measures that sampled articulation, language, auditory processing and memory, and oral sensory behaviors. A factor analysis was carried out, and 12 subgroups of subjects were identified. Two of the subgroups showed deficiencies in language performance as assessed by the various tests that were administered.

A number of investigations have identified children with articulation disorders and studied them with respect to a number of different language variables. In some cases a number of nonarticulatory variables also have been used so that the population of children with articulation disorders might be specified more clearly. In most studies reviewed, an association between articulation deficits and language deficits has been identified. Shelton and McReynolds (1979) have suggested that younger children with severe articulation disorders are likely to display concomitant language problems; however, the studies reviewed suggest that older children also may show coexisting articulation and language disorders. The relationship is not on a one-to-one basis, but the reported coexistence is substantial.

3.2.2 Language and Articulation Disorders

Investigators who have studied language disorders in children and other related variables have reported coexistence (Panagos, 1974); however, the nature of the articulation disorder is generally not clearly specified. Undoubtedly, this is because of the research direction. Leonard (1979) carried out a critical review of the literature in which he discussed a number of abiding issues that have been examined in language-disorders research. One of those issues, articulation and language impairment, was presented along with relevant research investigations. In summary, Leonard indicated that research to date was generally in the form of case study reports and that the data indicate that many children with language impairments experience problems in articulation development. He further stated that the articulation problems identified to date suggest that the deficit is quantitative in nature. That is, the articulation processes are similar to those observed in the productions of younger children who do not exhibit language impairment (Leonard, 1982; Leonard, Newhoff, & Mesalam, 1980).

A comparative study conducted by Menyuk (1964) employed a generative transformational model of grammar to identify the expressive language structures of 10 children with articulation disorders and 10 matched, normal controls. The children were preschool age, and they were each engaged in three different language-elicitation tasks. The author found that the children with articulation disorders used fewer transformations and exhibited more restricted grammatical forms than the normal subjects. The articulation abilities of the disordered group were not specified, but the author suggested a pattern of omission and substitution errors for phonemes in the fricative, stop, and liquid categories.

Menyuk and Looney (1972) used the same imitation paradigm described previously, and they had their subjects produce active-declarative, imperative, negative, and question sentences. Subjects also were required to repeat a second set that was constructed to evaluate the articulatory sequences of words in sentences. Study groups included 13 language-impaired children, 6:2 years of age, and 13 matched younger children in a control group, 4:2 years old. Prior to carrying out the repetition tasks, the language-impaired subjects were administered a 76-item articulation test. The number of articulatory errors ranged from 6 to 40. The results favored the younger controls on both of the sentence repetition tasks. Moreover, experimental subjects who experienced the most problems with the sentence repetition tasks, also had the most problems with repetitions of the various articulatory sequences.

Aram and Nation (1980) conducted a retrospective study whereby they identified 63 school children who had been diagnosed with language impairment as preschoolers. Two speech-language pathologists examined their records and rated seven speech-language dimensions along a 5-point rating scale. A survey was also sent to the parents and teachers of the children to determine if communication problems continued. Their findings indicated that articulation impairment received one of the highest negative ratings by the speech-language pathologists. Moreover, approximately 50% of the parents and teachers indicated that the articulation impairment continued.

A case study report by Samples and Lane (1985) detailed the speech and language histories of six siblings between the ages of 5 and 11 years and suggested the possibility of a genetic basis contributing to the deficits noted. The subjects in question were all receiving services for their communication disorders, and all had concomitant speech and language disorders. Phonological process analysis was

carried out with each during a 5-year study period. The number of processes identified ranged from 7 to 10; the investigators noted little improvement in the articulation of the siblings at the termination of the investigation.

Schery (1985) reported data on 718 children who had been diagnosed as having a language impairment and received treatment. The children included preschool, primary, and middle-school participants. Performance data were collected on cognitive functioning, language production and comprehension, auditory processing, oral motor integrity, speech production, and academic level. The overall performance data show that approximately 75% of the subjects had some type of articulation disorder, and 8.4% exhibited stuttering or voice problems. These data are consistent with that reported from other investigations, and further extend the coexistence of language and articulation deficits to older children not generally included in such investigations. In addition, the inclusion of other speech disorders in the study group provides further evidence of the coexistence of speech and language disorders.

A familial study of children with language impairment was undertaken by Neils and Aram (1986) to determine if speech and language disorders showed a higher incidence in the population. Seventy-four language-impaired children and 36 controls were identified. Subjects ranged in age from 4:0 to 5:11. Questionnaires were prepared and completed by the families of both groups. The results indicated that the families of the language-impaired had a higher incidence of speech and language disorders than the controls. Some of the respondents reported affected relatives with coexisting deficits that included articulation and language.

A longitudinal investigation conducted by Bishop and Edmundson (1987) examined the language status of children at ages 4, 4.5, and 5.5 years. The investigators identified 88 children who had some form of language impairment and compared their performance to a group of normal controls. Inspection of their test data indicated that a large number of their language-impaired subjects had an articulation disorder. Group percentages of articulation involvement at each sampling time were, in order, 74%, 55%, and 34% of the language-impaired subjects.

Preliminary data from the San Diego Longitudinal Study of specific developmental language impairment were reported by Tallal, Ross, and Curtiss (1989). The authors found that families with children with language impairment reported a higher incidence of affected relatives than matched children in the control group. In their subject test performance data, over 60% of the 76 language-impaired subjects had a concomitant articulation disorder.

Some investigations of children with language impairment have used large groups and then used multivariate statistical methods to identify subgroups (Aram & Nation, 1975; Wolfus, Moscovitch, & Kinsbourne, 1980), just as had been summarized previously in the articulation disorders literature (Arndt et al., 1977; McNutt & Hamayan, 1984).

Aram and Nation (1975) used such a procedure and conducted a factor analysis with 47 language-impaired children who ranged in age from 3:2 to 6:11. Each subject was given a battery of 14 language tests that were selected to provide information in regard to comprehension, production, and sematics. The investigators identified 6 subgroups of children who differed on the dimensions examined. Although all subjects did not exhibit articulation disorders, 4 of the 6 subgroups or a total of 28 subjects did.

Wolfus et al., (1980) also investigated the hypothesis of subgroups within the general population of language-impaired children. Their subjects consisted of 19 children with language impairment between the ages of 4:4 and 7:6. Each child was evaluated on measures that examined syntactic skills, semantic knowledge, articulation, syllable sequencing ability, and digit span. Through the use of discriminant analysis statistical procedures, the authors identified two groups of subjects. One group consisted of those subjects who were characterized by deficits in expressive syntax and articulation with satisfactory comprehension skills. The other group exhibited deficiencies in the areas of expressive and receptive syntax, semantics, articulation discrimination, and digit span reproduction. The second group had expressive articulation deficits, but not to the extent of the first group.

Rapin and Allen (cited in Aram & Nation, 1982) carried out an unpublished investigation; the methodology allowed for the identification of subgroups of language-impaired children. The investigators found four distinct groups with a number of subtypes. As with the previous studies cited, Rapin and Allen found a number of children in the groups and subtypes that had articulation deficits. Although articulation deficits were not characteristic of all subjects, many did have such impairment.

The language-based studies reviewed suggest rather convincingly that coexistence among articulation and language is substantial. If both research perspectives are examined, one finds that the two systems are intertwined, but the exact nature of the relationship still has not been specified at this time. Aram and Kamhi (1982) conducted a critical review of the existing literature and concluded that current theoretical perspectives and research to date are inadequate to explain the interaction between articulation and language. They feel that one should examine present theoretical positions very carefully because the two might be separate domains and the interaction more of a surface-level productive phenomena rather than a reflection of underlying linguistic processes. Other investigators (R. Schwartz, Leonard, Folger, & Wilcox, 1980) also have speculated that articulation and other aspects of language are related but separate entities. Assessment must attend to concomitant disorders, and remediation should consist of an integrated approach for those who exhibit involvement in both domains (Leonard, Miller, & Brown, 1980).

3.3 COEXISTENCE IN VOICE DISORDERS

The literature bearing directly on the coexistence of other disorders with voice disorders is sparse. In a study of teacher referral abilities, James and E. B. Cooper (1966)

reported the results of a speech clinician's screening of 718 third graders in 30 classrooms. One-third (242) were diagnosed with various speech problems. Slightly more than half of the 45 youngsters who were judged to have voice disorders (51%) also had coexisting articulation disorders. It is interesting to note that teachers were 52% accurate in identifying this group as compared to 10% for children with voice disorders alone. It is tempting to speculate that this is because voice disorders are frequently overlooked (e.g., Boone & McFarlane, 1988), and teachers, in fact, were noticing the articulatory irregularities of these children's speech.

Warr-Leeper, McShea, and Leeper (1979) studied a middle-school population to determine the incidence of various disorders: 51% had vocal disorders, and an additional 6% manifested combined voice and articulation disorders. In a study referred to in the previous section, Shriberg et al. (1986) found "moderate to severe" coexisting voice involvement in 53% of 90 "speech-delayed children" with "intelligibility problems." An additional 23% were considered to have a "questionable or mild" coexisting voice component.

There is widespread speculation that voice disorders, particularly hoarseness, could be related to mild hearing loss. Of course, the reason is that upper respiratory infections often are related to acute or chronic laryngitis as well as middle-ear infections (Miller & Madison, 1984; Senturia & F. B. Wilson, 1968; Warr-Leeper et al., 1979).

3.4 COEXISTENCE IN STUTTERING AND DISFLUENCY

In this section, we consider prevalence figures among stutterers for coexisting communicative disorders. Reviews of the relevant data are numerous (e.g., Andrews, Craig, Feyer, Hoddinott, Howie, & Neilson, 1983; Bloodstein, 1987; Conture, 1990b; Homzie & Lindsay, 1984; Nippold, 1990; Starkweather, 1987; Wall & Myers, 1982, 1984). Not surprisingly, studies are difficult to compare because of differences in populations sampled, criteria for disorders, and survey methodologies. Nevertheless, the evidence is quite clear that stutterers are likely to manifest higher than normal prevalences for coexisting communicative disorders, which range from modest to dramatic. The following review considers the available research first from the perspective of reports from memory and then from actual testing by an observer.

3.4.1 Studies Based on Recall or Case Files

Berry (1938) analyzed medical records of approximately 250 stutterers and nonstutterers revealing marked differences in the age of first words, with stutterers delayed by 7 months. Data obtained from about 60% of these subjects indicated that the ages at which individuals outside the family could understand the children again showed marked retardation of the stutterers (36 months) compared to controls (24 months).

In a series of three monumental investigations at the University of Iowa on the onset of stuttering (Darley, 1955; Johnson, 1955; Johnson and Associates, 1959), stuttering children and their parents were compared to nonstuttering controls and their parents. Study I contained 46 pairs of triads (i.e., child, mother, and father); Study II, 50 pairs; and Study III, 150 pairs. The studies consisted primarily of standardized and nonstandardized tests and interviews with the parents, but there were a few tests of the children (i.e., intelligence and handedness measures). The data reported here were from parental interviews. In Study I (Johnson, 1955), the reported age of first words and first sentences were identical for the stutterers and nonstutterers, medians of 12 and 20 months, respectively. In Study II (Darley, 1955), stutterers were 1–2 months behind the nonstutterers on the ages of first words and first sentences. Moreover, in Study II, average ages for both stutterers and nonstutterers were somewhat lower for age of first word (by 1–2 months) and higher for first sentences (by 5–7 months) than in Study I, most likely because parents in Study II were reporting ages of children who were an average of 5 years older than those in the previous investigation. This highlights the difficulty in obtaining valid developmental age data from interviews. According to the mothers in Study III (Johnson and Associates, 1959), stutterers' mean ages for first words were 10.9 months compared to 10.8 months for nonstutterers. Analogous means for first sentences were 22 and 21 months, respectively.

These studies suggest that stutterers and nonstutterers are very similar in terms of the onset of spoken language. By contrast there were marked differences in the reported prevalence of "speech defects" in Studies II and III. Using the mean of mothers' and fathers' reports, the percentages of stutterers in the two studies who were said to manifest "lisping," "other articulatory defects," and "stuttering and articulatory defect" were 14.0% and 12.3%, respectively (Johnson and Associates, 1959, Appendix A, p. 56). Control subjects' totals for these defects were 4.0% and 3.0%.[2]

Bloodstein (1958) analyzed case files for 108 young stutterers who entered the Brooklyn College Speech and Hearing Center between 1950 and 1955. One-third of these subjects were described as "late talkers" by their parents. "Many" of the children had defective articulation; in fact, "several" had been referred to the clinic for misarticulation, and a "few" had been evaluated prior to the stuttering onset for infantile articulation (Bloodstein, 1958, p. 24). Five children began to stutter while being treated for misarticulations. Kent and Williams (1963) reported a similar finding in which former stutterers in the second grade were more likely than nonstutterers to have a history of articulation disorders. From the opposite perspective, Horowitz (1965) reported that 44% of a sample of articulation disordered children had symptoms of stuttering.

In a large longitudinal study in Newcastle Upon Tyne,

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[2] The figures for study III differ from those reported by Bloodstein (1987, p. 220), which were 15.3% and 7.3%, respectively, for stutterers and nonstutterers.

England, stutterers were identified by speech-language therapists and social workers ("health visitors"). As part of that study, Morley (1965) compared 29 stutterers with 114 nonstutterers. In sharp contrast to the aforementioned Iowa studies, the ages of first words, as reported by mothers, were 15 versus 12 months for the stutterers and nonstutterers, respectively. The same pattern emerged for age of first 2–3 word phrases, with means of 24 months versus 19 months.

Morley highlighted the coexistence of stuttering and articulation disorders. In 37 stutterers, including 21 who had stuttered longer than 6 months. She pointed out that 18 (49%) of the children were articulatory defective at age 3:9 and that half of these (24%) were unintelligible. This 50% [sic] coexistence figure for stutterers compared to 31% for the controls. At age 6 years, nearly 25% of the stutterers still had articulatory defects.

Data from parents of 80 young stutterers and 80 nonstutterers from the same city in England indicated that the former group was approximately 4 months behind the latter in the average age of first phrase (Andrews & Harris, 1964). Twenty-three percent of the stutterers, compared to 8% of those in the control group also had a history of abnormal articulation. Both of these differences were statistically significant. In Egypt, Okasha, Bishry, Kamel, and Hassan (1974) queried mothers regarding the age of first sentences of 79 stutterers and 80 controls. Stutterers were reportedly delayed compared to the nonstutterers.

Van Riper (1971, 1982) proposed a typology of stuttering development consisting of four different "tracks" of development. He identified 14% of the case files he examined as examples of "Track II" stutterers. This group had delayed speech and language, articulatory difficulties, and other evidence of organic involvement. Van Riper suggested strong similarities between this group and clutterers (Weiss, 1964). At least two attempts have been made to classify stutterers according to Track II, and both utilized coexisting articulation and language disorders to do so. Daly (1981) reported that 24% of a sample of 138 stutterers, ages 8–20 years, could be placed into Track II. Ninety-seven percent of this subgroup of stutterers were reported to have language delay and 85% had a history of articulation impairment (58% at the time of testing). In Norway, Preus (1981) carried out detailed analyses of 100 16- to 21-year-old stutterers and reported that 18% of his subjects could be classified as Track II stutterers. The same percentage (18%) was reported by parents to have been delayed in language development (age of first word after 2 years, age of talking in sentences after 3 years, or having articulation problems after 6 years).

M. Cooper (1979) reported that approximately one-third of the 300 stutterers whom he had treated also had coexisting voice disorders. He expressed the belief that these were typically secondary to the clients' stuttering.

Two related studies of elementary school-age children (Cullinan & Springer, 1980; McKnight & Cullinan, 1987) reported that 55% and 41% of stuttering subjects, respectively, had other clinically significant speech, language, and/or learning disorders. Data on the presence of these coexisting problems were obtained either from the sub-jects' referring clinicians or their records of special education services. In the 1980 study, 15% of the 20 stutterers, age 5–11 years, had coexisting articulation disorders; 15% had coexisting language disorders; and 15% had both articulation and language disorders. Of the 17 stutterers in the 1987 study, 6–12 years, only 2 (12%) were reported to have coexisting articulation disorders, 1 of these in combination with a learning disability. The remaining stuttering group with other problems were being treated concurrently for learning and/or academic difficulties.

From questionnaires of 358 school clinicians regarding their caseloads, Blood and Seider (1981) analyzed the results of 1,060 stutterers. Coexisting articulation disorders were present in 16%, language disorders in 10%, and voice disorders in 1% of these subjects. An additional 2% had cleft palates or other speech, language, or hearing disorders.

Seider, Gladstien, and Kidd (1982) carefully analyzed a group of several hundred stutterers and their siblings for other speech or language problems. They found that 201 stutterers did not differ significantly from their same-sex siblings on the subjects' or parents' memories of whether their language onset was "early," "normal," or "late" (Seider et al., 1982, p. 483). Queries were also analyzed from a sample of 834 stutterers and 914 nonstuttering siblings relative to "any speech problem other than stuttering." Coexisting articulation disorders were reported for 8% of the stutterers and 5% of the siblings. "Language problems" were reported for 2% and 1% of the stutterers and siblings, respectively (Seider et al., 1982, p. 485).[3] The authors found trends-but nonsignificant differences-for more coexisting problems in stutterers with positive family histories of stuttering, persistent (versus recovered) stuttering, and "late" versus "early" or "average" talkers. There was no difference for males versus females.

Homzie, Lindsay, Simpson, and Hasenstab (1988) surveyed 190 adults stutterers from two national self-help organizations described as being above average in educational achievement. Delayed language was recalled for 19%, and articulation disorders in 22%, of the sample.

The literature just reviewed illustrates clearly the problems inherent in recall studies. The sort of question asked, the memory and awareness of the respondent, the time elapsed since the alleged event all affect the outcome. For example, in the Seider et al. (1982) investigation, it is likely that the low percentages for language problems are due in large part to the fact that adult stutterers, who comprised a major portion of the sample, would be unaware of early language problems or late talking. In addition, it is likely that nonstuttering "speech problems" reported by subjects might not be classified as language disorders. Nevertheless, these studies strongly suggest that stutterers often do have coexisting communicative problems.

3.4.2 Studies Based on Testing

McDowell (1928) examined the spontaneous speech of 33 pairs of elementary school-age stutterers and nonstut-

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[3] These figures are incorrectly reported by Seider et al. (1982) in Table 6 (p. 485), apparently because of errors in rounding and conversion to percentages.

terers and determined their articulation skills. The mean error rate for stutterers was 19% compared to 16% for the controls. This difference, though small, was statistically significant. Using articulation tests, Schindler (1955) reported a similar investigation of children throughout grades 1–12. Forty-nine percent of the 126 stutterers had "some type of articulation error," in sharp contrast to 15% of the 252 nonstutterers.

In the longitudinal study in Newcastle Upon Tyne, England, referred to in the previous section, Morley (1965) reported that *fewer* stutterers than nonstutterers had articulation errors at 3 and 4 years of age, 50% versus 58%, and 25% versus 36%, respectively. The reverse was true at 6 years, such that articulatory errors were present in 14% of the stutterers and 5% of the nonstutterers.

E. Silverman and D. E. Williams (1967) utilized a spontaneous language sampling technique to compare the language structures of 22 kindergarten and first-grade stutterers with their matched controls group. Stutterers were statistically inferior to nonstutterers on the number of 1-word responses. How much this was due to truncated patterns of speaking learned by the stutterers cannot be determined. They were also inferior, yet nonsignificantly so, for four other language structural measures, including mean length of utterance. A similar, unpublished study of 30 matched pairs of school-age stutterers and nonstutterers revealed no significant differences on any of the same language measures (Peters, 1968). Williams was also involved in another investigation of coexisting articulation disorders with stutterers (D. E. Williams & F. Silverman, 1968). In this study, the spontaneous speech of 115 matched pairs of subjects from kindergarten to grade 9 were analyzed for consistent articulatory distortions, omissions, and substitutions. More stutterers than nonstutterers manifested consistent misarticulations, more so at lower than upper grades. In all, 24% of the stutterers had articulation errors compared to 9% of the nonstutterers.

Perozzi and Kunze (1969) matched 20 stuttering and nonstuttering second and third graders and compared their performance on receptive and expressive language tests. Scores for the two groups were nearly identical on a picture vocabulary test, mean length of utterance, and a structural complexity score. The authors did observe a significant advantage of control over experimental subjects on a visual subtest of the Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk & McCarthy, 1961). By contrast, D. E. Williams, Melrose, and Woods (1969) administered a vocabulary test to 400 sixth graders: 100 stutterers, and 300 nonstutterers and found the stutterers to be an average of $7\frac{1}{2}$ months delayed.

Muma (1971) compared 13 "highly fluent" with 13 "highly disfluent" 4-year-olds who, importantly, were not diagnosed as stutterers. Using a transformational analyses of language samples, he found that the "highly disfluent" group used relatively more single-based transformations but fewer double-based transformations than the "highly fluent" group. From the reverse perspective, Caldwell (1971) found that nonstuttering 4-year-olds with lower scores on comprehension tests were more disfluent than those with higher scores. Berryman and Kools (1975)

found that 92 nonstuttering first graders' disfluencies did not correlate with listener judgments of language development. Neither did disfluencies correlate with Developmental Sentence Scores (DSS) (Lee, 1974) of 30 4- to 8-year olds (Haynes & Hood, 1977). Other investigations have shown a relationship between children's increased disfluencies as the level of language complexity increases (Colburn & Mysak, 1982a, 1982b; DeJoy & Gregory, 1973; Gordon, 1982; Haynes & Hood, 1978; Pearl & Bernthal, 1980).

An interesting study by Merits-Patterson and Reed (1981) compared the frequency of disfluencies of 18 language-delayed children, ages 4–6, half in therapy and half not in therapy, with a control group. The two experimental groups were roughly equivalent on language measures, and both far below the normals, but the group in therapy had nearly twice as many disfluencies as the nontherapy language-delayed group and the controls. These latter two groups were practically the same for disfluencies.

A. Williams and Marks (1972) compared 28 5- to 9-year-old stuttering children on the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1965) and the ITPA (Kirk & McCarthy, 1961). Subjects were constrained to have normal hearing and articulation. The group was above average on the PPVT, with the mean IQ being 106. Mean scores were not reported for the ITPA, although, when subtests for individual subjects were compared to their overall language ages, various subtests were higher than average (i.e., auditory vocal association and vocal encoding), and others were lower (i.e., auditory vocal sequencing). Stocker and Parker (1977) found preschool and elementary school-aged stutterers to be no different from control group members on the auditory sequential memory subtest of a later version of the ITPA (Kirk, McCarthy, & Kirk, 1968) but to be 3 years behind the control group on the auditory attention span for related syllables subtest of the Detroit Test of Learning Aptitude (H. J. Baker & Leland, 1967).

In two related investigations, Daly and A. Smith (1976) and Daly, Kimbarow, and A. Smith (1977) administered comprehensive neuropsychological evaluations to 45 and 27 stutterers. Twenty-five percent of the total group were isolated as having articulation disorders or learning disabilities. Moreover, this subgroup with associated articulation or learning problems were more severe than the remaining subjects who did not have such problems.

Murray and Reed (1977) found that seven preschool stutterers were inferior to matched controls on two standardized language tests. Similarly, Kline and Starkweather (1979) reported that young stutterers had reduced receptive and expressive language skills compared to nonstutterers. Hall (1977) described two severely language-impaired elementary schoolchildren who began to stutter during language therapy. Interestingly, both of these children had coexisting articulation disorders, and one had a mild hearing loss.

G. D. Riley and J. Riley (1979) described a component model of stuttering in which stuttering is often associated with other "neurological components." They reported that 31% of their young stutterers manifested coexisting sentence formulation disorders, and 69% had oral motor dis-

orders, including 33% who manifested articulation disorders.

Westby (1979) compared kindergarten stutterers to highly disfluent (but nonstuttering) and typically disfluent children on DSS scores and other standardized tests. There were no significant differences on language complexity on the DSS, but stutterers and highly disfluent nonstutterers were inferior to control group members on the number of grammatical errors and scores on the PPVT.

In a syntactic study of the spontaneous speech of four matched pairs of 5- to 6-year-old stutterers and controls, considerable intersubject variability was observed but, in general, "stutterers used simpler, less mature language than the nonstutterers" (Wall, 1980, p. 349). In this study, children who were referred to the clinic for articulation or language problems were excluded. In South Africa, Pitluk (1982) found that there were not important differences between a small group of 9- to 11-year-old stutterers and their control group members on an expressive language test.

Thompson (1983) reported on two groups of school-age stutterers in Ohio ($N = 31$ and $N = 17$). These children were tested by the author and other SLPs. Only 31% had no "suspected deficits" in coexisting areas (including articulation, voice, language, auditory memory, and breath control). The following percentages represent those stutterers with coexisting disorders: articulation—42%; language—37% (syntax—4%, semantics—4%, performatives—27%, and word retrieval—2%); and voice—29%.

In a Norwegian study mentioned previously, Preus (1981) found 9% of a group of 100 16- to 21-year-old stutterers to have articulatory defects on a word-articulation test. Moreover, 32% manifested signs of cluttering (fast speech rate, omission of sounds or syllables as in slurring, or "jumbled" or "insufficiently programmed" syntactic structures).

Meyers and Freeman (1985) compared 12 pairs of stuttering and nonstuttering boys between the ages of 4 and 6 years. All subjects scored within 1 standard deviation below the mean on standardized speech and language tests. Even so, stutterers were lower than control group members on the Templin-Darley Screening Test of Articulation (Templin & Darley, 1969), with mean scores of 36.9 versus 46.3, respectively. Mean Receptive Vocabulary Scores on the PPVT-R (Dunn & Dunn, 1981) were also lower for stutterers (100.8) than nonstutterers (110.1). Although not reported by the authors, t tests carried out on individual subject scores revealed that stutterers were significantly worse than controls for both measures. Seven of the stutterers were labeled severe and five moderate. Templin-Darley scores for severe stutterers were about the same as scores for moderate stutterers, 37.1 versus 36.6. However, PPVT-R scores were lower, though not significantly so, for the severe stutterers (98.3) than moderate stutterers (104.2). As noted, these mean scores for tests were not reported by the authors, but mean difference on mean length of utterance in words (MLU) and mean length for the longest fluent utterances (MLLFU) were included. Nonsignificant trends for longer utterances from severe stutterers to moderate stutterers to control group members

were observed. However, statistically significant differences between all groups were present for MLLFU. Values for MLU were, respectively, 3.73, 3.90, and 4.50; analogous means for MLLFU were 5.39, 7.55, and 10.13. Together, these results suggest that, even in a carefully designed study in which language and articulation are controlled, stutterers are more likely to manifest coexisting communicative deficits than nonstutterers.

Byrd and E. B. Cooper (1989) administered the Test of Language Development Primary (TOLD-P) (Newcomer & Hammill, 1982) and the Test of Auditory Comprehension of Language-Revised (TACL-R) (Carrow-Woolfolk, 1985) to 16 stutterers, ages 5 to 9. Comparing subject scores with normative samples from the tests, stutterers were approximately at their expected age level for the TACL-R (2 months below their mean chronological age of 7:4). By contrast, they were 10 months delayed on the TOLD-P, listed as an expressive language test. The latter difference was statistically significant.

Molt (1990) reported a study of 5-year-old stutterers in which a sample of stutterers uncontaminated by other communicative disorders was desired. To obtain 5 experimental subjects, the author mentioned in passing that 17 young stutterers were screened and 12 excluded. Five of the 12 excluded stutterers had articulation disorders; 4 had language disorders; 2 manifested neurological problems; and 1 had a hearing loss. In other words, 71% of the stutterers the author screened had coexisting communicative disorders.

3.5 COEXISTENCE IN HEARING DISORDERS

3.5.1 Severe-Profound Hearing Impairment

The inability to hear presents a formidable, often insurmountable, impediment to the acquisition of verbal speech and language. To say that the speech of children with severe-profound hearing impairment demonstrates coexisting disorders of articulation, voice, and language is, perhaps, an oversimplification. Volumes have been written to describe verbal communication problems of students at schools for the deaf (e.g., Calvert and Silverman, 1975; Ling, 1989). These observations, based on the institutionalized deaf, may not be directly pertinent to a discussion of the NSHS results because over 90% of hearing-impaired subjects in the NSHS sample had no more than a moderate degree of loss. However, a brief delineation of the physiological and acoustical dimensions of speech that experiments have shown to be affected by deafness may provide a starting point for future research into the high prevalence of coexisting articulation and voice deviance among hearing-impaired subjects in the NSHS.

Articulation and Voice Deviance. The deviant breathing patterns, phonation, and articulation of children with severe-profound hearing impairment all have overlapping effects on their speech production.

Faulty coordination of breathing and speaking is a funda-

mental error of speech production often associated with deafness. Speakers may produce only a few syllables per breath, breathe in the middle of words or phrases, or even attempt to speak while inhaling. Measurements of respiratory aerodynamics document the inefficient use of pulmonary air by speakers with severe-profound hearing impairment (Forner & Hixon, 1977; Hutchinson & L. L. Smith, 1976; Hutchinson, L. L. Smith, Kornhauser, D. S. Beasley, & D. Beasley, 1978; Whitehead, 1983). Aberrant airflow rates have also been observed during production of fricative consonants (Whitehead & Barefoot, 1983). Faulty breathing patterns disrupt the normal rhythm of speech and contribute to slow speaking rates (Forner & Hixon, 1977; Osberger & Levitt, 1979).

Difficulty controlling vocal fold tension, subglottal air pressure, and the extent of glottal closure also results in abberations of phonation that manifest in a variety of errors produced by speakers with severe-profound hearing impairment, such as abnormally high vocal pitch, poor control of vocal loudness, vocal fry, and diplophonia (Angelocci, Kopp, & Holbrook, 1964; Monsen, Engebretson, & Vemula, 1979). Deviant phonation of this sort contributes to the perception that the voice quality of deaf children is "tense," "flat," "breathy," "throaty," or "harsh" (Calvert, 1962; Forner & Hixon, 1977).

Prosodic aspects of deaf speech are also affected by poor control of phonation. The inability to produce normal patterns of fundamental frequency and intensity alterations results in distorted intonation, inappropriate or inadequate use of stress, and prolongation of syllables (John & Howarth, 1965; Monsen, 1979; Monsen et al., 1979; Osberger & Levitt, 1979).

Production of the visible features of articulation are least affected by severe-profound hearing impairment. For this reason, the bilabial consonants, the glides, and /f/ and /v/ are more likely to be produced correctly, whereas errors are most common for the palatal and alveolar fricatives, the affricates, and /ŋ/ (Markides, 1970; Nober, 1967; C. R. Smith, 1975). Errors of omission are most common, followed by substitution and distortion misarticulations. Errors are about equally likely in the initial or medial position, but final position errors are far more common (C. R. Smith, 1975). Consonant production is also affected by poor coordination of phonation with articulation, resulting in inappropriate voicing of voiceless consonants, and vice versa (Gold, 1980; Markides, 1970; Nober, 1967; C. R. Smith, 1975).

Children with severe-profound hearing impairment also misarticulate vowels and diphthongs. Their poor vowel articulation, for the most part, is associated with attempts to produce different vowels by making only minimal changes in the position and movement of the articulators. This is especially true of the tongue, which often assumes a neutral position and moves only slightly as different vowels are produced. Spectrally, this "neutralization of vowels" (Hudgins and Numbers, 1942) is evidenced by a second formant frequency that changes little from vowel to vowel (Angelocci et al., 1964; Monsen, 1978, 1983). Many vowel sounds produced by deaf speakers cannot be readily identified as any particular phoneme (C. R. Smith, 1975).

In addition to faulty production of individual phonemes, speakers with severe-profound hearing impairment also have difficulty coordinating articulatory transitions from one phoneme to the next, and articulation varies little with changes in phonemic context (e.g., Monsen, 1974; Tye-Murray, 1987; Whitehead & Jones, 1978).

Analyses of the speech of the hearing impaired provide, perhaps, the best evidence that errors arbitrarily dichotomized as "voice" or "articulation" deviance are often reflections of the same disordered speech process. For instance, variables that measure articulatory skill, particularly voice onset-times for stop consonant production and vowel formant frequencies, correlate much more highly with speech intelligibility than do prosodic variables (Metz, Samar, Schiavetti, Sitler, & Whitehead, 1985; Metz, Schiavetti, Samar, & Sitler, 1990; Monsen, 1978; Parkhurst & Levitt, 1978; C. R. Smith, 1975). However, the effects of poor control of phonation and abnormal vowel resonances will almost certainly be apparent in the suprasegmental voice characteristics of speakers with unintelligible articulation. The interrelation between articulation and voice deviance in speakers with severe-profound hearing loss is clearly demonstrated in a study of 30 students at Central Institute for the Deaf, which found a correlation between speech intelligibility scores and listeners' evaluations of voice quality of 0.91. This near-perfect relationship led the author to observe that "intelligible talkers have good voice quality and the unintelligible talkers have relatively poor voice quality" (Monsen, 1983, p. 13).

Language. The literature on language characteristics of hearing-impaired children is voluminous. Kretschmer and Kretschmer (1978) provide a comprehensive discussion of this topic, and more concise reviews are available in J. M. Davis & Hardick (1981) and Seyfried et al. (1989). The work of Quigley and his associates (e.g., Russell, Quigley, & Power, 1976; Quigley, Wilbur, Power, Montinelli, & Steinkamp, 1976) represents the most definitive studies available on the syntax employed by the deaf. The essence of this information is summarized below.

Severely delayed vocabulary development is characteristic of children with severe-profound hearing loss. General vocabulary knowledge increases with age, but at a much slower rate than in normally hearing children. The vocabulary of a normal child grows systematically and globally from exposure to natural language experiences. In contrast, a deaf child's acquisition of new vocabulary depends largely on what has been taught. Consequently, children with severe-profound hearing impairment generally show an erratic pattern of word knowledge, relatively advanced in areas emphasized by the teaching curriculum, severely delayed in others. They also demonstrate special difficulty understanding the multiple meanings of words, and the subtle, semantic differences associated with using a word in different contexts.

Severe-profound hearing loss seriously impairs the acquisition of grammatical rules for use in comprehension and expression of spoken and written language. Children with this degree of impairment tend to adhere to simple subject-verb-object sentence structures, and may never learn to use some complex sentence forms correctly. The

sentences they produce contain a high proportion of nouns and verbs, while function words are commonly omitted. As a consequence of their limited knowledge of English syntax, children with severe-profound hearing impairment may produce agrammatical sentences and misinterpret complex sentences presented to them.

Thus, the development of English language skills is severely delayed in children with severe-profound hearing impairment, and their acquisition of new skills proceeds slowly. Furthermore, at about 12 years of age, most deaf children appear to reach a plateau beyond which little, if any, growth in knowledge of English vocabulary and grammar occurs.

3.5.2 Mild-Moderate Hearing Impairment

Because the great majority of hearing-impaired children in the NSHS sample had no more than a moderate loss, a review of the literature on the speech and language skills of this population is particularly pertinent. Unfortunately, research in this area is limited.

Articulation and Voice Deviance. Research on the speech of children with severe-profound hearing impairment has repeatedly demonstrated a high correlation between deviance of speech and degree of hearing loss (e.g., Markides, 1970; Metz, et al., 1985; Monsen, 1978; C. R. Smith, 1975). It is tempting to extrapolate from these data that the relation between speech deviance and hearing loss represents a continuum in which children with lesser degrees of hearing impairment have correspondingly better speech. Although research findings are limited, the available data do not support this hypothesis. Apparently, the speech of children with mild-moderate hearing impairment bears little resemblance to that produced by the more severely hearing impaired.

In-depth phonological analyses of a few children with mild-moderate hearing impairment indicated that, although their development is delayed, they acquire and use speech sounds in the same order as normally hearing children (Oller & Kelley, 1974; West & Weber, 1974).

In his study of speech characteristics and intelligibility of hearing-impaired children, Markides (1970) included a group of 27 "partially-hearing" children, with a "mean hearing loss" of 57 dB (reference not specified). All children were either 7 or 9 years old. Articulation test results indicated that these children rarely misarticulated vowels. Substitution errors were the most common form of consonant misarticulations, which primarily involved the phonemes /s/, /z/, /ʃ/, and /tʃ/.

The literature on mild-moderate hearing impairment provides no evidence that voice deviance is a characteristic of this population. In fact, many students at Central Institute for the Deaf with severe hearing impairment are able to produce normal patterns of phonation, whereas the most deviant types of production are found among the profoundly hearing impaired (Monsen et al., 1979). It appears that even limited ability to hear speech permits the development of reasonably good control of respiration and phonation (Subtelny & Walter, 1975).

Although research data are limited, the general consensus is that the primary speech errors of children with mild-moderate impairment involve articulation of single consonants and consonant blends; their speech is intelligible; and vowel articulation, voice quality, and suprasegmental features are comparable to children with normal hearing (J. M. Davis & Hardick, 1981; Jensema et al., 1978; Seyfried et al., 1989).

Language. Hardy, M. D. Pauls, and Harkins (1958) evaluated the language skills of 20 hearing-impaired children enrolled in regular schools. Pure-tone averages ranged from 27 to 57 dB (reference not specified) in this group of 6- to 15-year-olds. Pictures were used to obtain language samples in sentence imitation and elicitation tasks. IQ and academic achievement tests, which included measures of vocabulary acquisition, were also administered. The authors found that hearing-impaired children had significantly poorer vocabulary scores and that they used somewhat shorter sentences than a control group of normally hearing children. However, the two groups produced sentences of equivalent complexity.

Brannon and Murry (1966) contrasted total output and syntactic accuracy of a spoken language sample of 50 sentences, elicited by pictures, from 30 hearing-impaired children and 30 normally hearing, age-matched cohorts. Syntax was scored after Myklebust (1964). The hearing-impaired group, composed of noninstitutionalized children, with a mean age of 12.6 years, was divided into two subgroups of 15 hard-of-hearing (PTA's 27–66 dB re: ASA, 1951), and 15 deaf (PTA > 75 dB in better ear). The results showed that hard-of-hearing children were not significantly different from normal-hearing children in the productivity measure of words per sentence, but were significantly worse in measures of structural accuracy, i.e., total errors, corrected sentence length, and syntax score. Hard-of-hearing children exceeded their deaf peers in all language measures. For the hearing-impaired group as a whole, syntax errors, in order of frequency, were substitutions, additions, omissions, and word-order errors. Degree of loss was significantly correlated with syntax error rates ($r = 0.6$–0.81).

Markides (1970) evaluated vocabulary development in his sample of 27 partially-hearing children. All children were either 7 or 9 years old. Their performance on the Ammons Full-Range Vocabulary Test (R. B. Ammons & H. S. Ammons, 1948) revealed a 2- to 3-year delay in vocabulary development. Delays were most severe among older children.

Wilcox & Tobin (1974) analyzed the syntactic patterns of 11 students enrolled in a public school class for hearing-impaired children using a sentence repetition task. The hearing-impaired subjects had a mean age of 10 years and PTAs in the range of 47 to 88 dB HL. Compared with 11 normal-hearing peers, matched for grade and age, the hearing-impaired group achieved significantly lower means for all grammatical forms tested and tended to substitute simpler forms. Linguistic performance was similar to normal-hearing subjects, but showed a general delay in development. On this basis, the authors hypothesized that hearing-impaired children acquire language in developmental pat-

terns similar to those observed in normal-hearing children, but the developmental sequence is delayed.

The Boehm Test of Basic Concepts (Boehm, 1971) depicts 50 concepts whose mastery is important for successful academic achievement in the early school years. J. M. Davis (1974) administered this instrument to 40 hearing-impaired children, ages 6 through 8, with PTAs ranging up to 70 dB HL. Results showed that degree of impairment had a marked effect on concept development. Over 90% of children with PTAs between 51 and 70 dB HL scored below the 10th percentile of age-equivalent norms established for normally hearing children. In contrast, although the group of children whose losses did not exceed 50 dB did not perform as well as their normally hearing peers on the average, one-third of these children actually scored above the 50th percentile.

Subsequently, J. M. Davis, Elfenbein, Schum, and Bentler (1986) reported results from a battery of audiological, vocabulary, intelligence, psychoeducational, academic achievement, and personality tests for 40 hearing-impaired children. Subjects ranged in age from 5 to 18 years and had PTAs no poorer than 88 dB HL. Although substantial differences in individual performance were observed, average results on the Peabody Picture Vocabulary Test (Dunn & Dunn, 1981) revealed generally delayed vocabulary development for the hearing-impaired children. The amount of delay was greatest for older children, and ranged from about 1 year to more than 3 years, roughly depending on the degree of hearing loss.

On the basis of limited research, it appears that the language skills of children with mild-moderate hearing impairment is developmentally delayed, and the magnitude of delay increases with age and degree of hearing loss. However, a great deal of individual variability is evident. Some children with mild-moderate hearing loss, and even some with severe impairment, demonstrate normal verbal language skills.

Stuttering. Although deaf speakers often show abnormal pause behaviors related to poor coordination of respiration, the literature on hearing impairment reviewed for this monograph does not contain reports of disfluency akin to stuttering in speakers with normal hearing. However, an exhaustive review of the literature on stuttering led Andrews et al. (1983) to conclude that the prevalence of stuttering is low among the hearing impaired. This finding was confirmed in a recent survey (Montgomery & Fitch, 1988), which found a stuttering prevalence of 0.12% in the hearing-impaired population. Specifically, 12 cases of stuttering were identified among 9,930 children enrolled in schools for the deaf. Interestingly, three deaf students stuttered in the oral mode only; six demonstrated disfluency in manual communication only; and three were perceived to stutter in both modes of communication.

3.5.3 Speech and Language of Children With Otitis Media

The mild, fluctuating, conductive hearing loss often associated with otitis media has been implicated as a cause of speech and language disorders in children. Because otitis media is one of the most common childhood diseases (Klein, 1983), it probably accounts for a substantial number of the hearing-impaired subjects identified in the NSHS. Consequently, a review of this literature is warranted, although much of the research has been criticized for methodological inadequacies (e.g., Paradise, 1983; Ventry, 1983).

In a seminal work, Holm and Kunze (1969) used a battery of standardized tests, including the Templin-Darley Articulation Screening Test (Templin & Darley, 1960), the Peabody Picture Vocabulary Test (Dunn, 1965), the Mecham Verbal Language Development Scale (Mecham, 1959), and the Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk & McCarthy, 1961), to compare the speech and language abilities of 16 children with histories of recurrent otitis media against a group of healthy children matched according to age, sex, and socioeconomic background. The authors found that the otitis media group showed significantly poorer performance on all measures of verbal speech and language.

Needleman (1977) used the Templin-Darley Screening Test of Articulation (Templin & Darley, 1969), the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (Goldman, Fristoe, & Woodcock, 1970), sound blending and auditory closure subtests of the ITPA (Kirk et al., 1968), and an analysis of repeated sentences to investigate the effects of otitis media on children 3 to 8 years of age. The results for these children provided evidence of phonological delay and deviance when compared with the performance of a control group, matched for age, grade in school, mental age, and socioeconomic status.

After administering the Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1968), Lehman, Chairon, Kummer, and Keith (1979) concluded that the articulation development of a group of otitis-prone children was appreciably delayed.

Silva, Kirkland, Simpson, Stewart, and S. Williams (1982) tested the articulation of over 400, 5-year-old children in New Zealand. A group of 47 children with active middle-ear disease scored substantially below their healthy peers on a standardized articulation test developed in that country. Subsequently (Silva, Chalmers, and Stewart, 1986), the same children were retested at the age of 7 and again at age 9. The results of this follow-up revealed that children who had shown the effects of otitis media at age 5 continued to demonstrate low articulation scores.

Teele, Klien, and Rosner (1984) followed 205 children for 3 years after their birth. A battery of standardized speech and language tests was administered to each child when he or she reached 3 years of age. A significant relationship was found between frequent episodes of persistent otitis media and lower scores on the Peabody Picture Vocabulary Test (Dunn & Dunn, 1981) and the Preschool Language Scale (Zimmerman, Steiner, & Pond, 1979). Contrary to the studies cited above, however, performance on an articulation test (specified by the authors as the "Fisher-Logemann/Goldman-Fristoe Test of Articulation") showed no significant correlation with a history of otitis media. Measures of speech intelligibility, syntactic development,

and mean length of utterance also showed no association with a history of middle-ear disease.

Recently, research has focused on analysis of phonological processes to determine the effects of otitis media. These studies provide evidence of delayed phonological development among 3- to 5-year-old children with histories of recurrent otitis media (Churchill, Hodson, Jones, & Novak, 1988; Hasenstab, 1989; Shriberg, 1987).

Several studies have sought to determine the effects of otitis media on early language development. For instance, Friel-Patti, Finitzo-Hieber, Conti, and Brown (1982) used the Sequenced Inventory of Communication Development (SICD) (Hedrick, Prather, & Tobin, 1975) and the Receptive Expressive Emergent Language Scale (Bzoch & League, 1970) to assess language development in a group of 1- to 2-year-old children. They report that 43% of subjects with a history of chronic otitis media showed language delays of 6 months or more, compared with only 7% of those without the disease.

Allen and Robinson (1984) obtained contradictory evidence. They administered the SICD to 602 preschool children and found that children with a history of otitis media performed no differently than other children in the sample.

Somewhere in between are the results of Wallace, Gravel, McCarton, and Rubin (1988), who found that 1-year-old children with and without otitis media scored equivalently on the Bayley Scales of Infant Development (Bayley, 1969) and the revised SCID receptive scale (Hedrick, Prather, & Tobin, 1984). However, the otitis-prone group showed significantly lower expressive language scores on the SICD.

Although there is no universal consensus, the preponderance of research shows that children with otitis media often manifest speech and language disorders. It is not surprising that researchers disagree on the nature and extent of this relationship, since a host of factors may serve to mitigate or augment the effects of the disease. This is demonstrated most elegantly by Paden, Novak, and Beiter (1987), who performed a discriminant analysis on a number of variables in an attempt to identify factors valuable in predicting phonological delay in 3-year-old children with recurrent or persistent otitis media. They found that reliable predictions of future phonological development depended on a consideration of the combination of a number of factors. Of those variables investigated, low age-weighted scores on production of velars, liquids, and postvocalic singleton obstruents, along with elevated thresholds at 500 Hz and a history of early onset and late remission from otitis media, had the greatest value for predicting phonological delay at age 3.

3.6 COEXISTENCE: GENERAL

From 1959 to 1974 the Collaborative Perinatal Project (NCPP) of the National Institute of Neurological and Communication Disorders and Stroke (NINCDS) was carried out "to determine the relationships among factor's affecting women during pregnancy and the neurological and sensory defects of their offspring" (Fisch, 1980, p. 1). As part of this massive, longitudinal study, standardized speech, language, and hearing data were obtained on children at ages 3 and 8 years. This so-called NCPP study occurred at 12 different medical centers, all in the midwestern, eastern, and southern portions of the United States except for one site in Oregon. At 3 years, 19,885 children were tested; at 8 years the total number was 20,137. There were 12,464 subjects tested both at 3 and 8 years. The sample contained approximately equal proportions of males versus females and blacks versus whites (except at age 3 at which point 57% were black and 43% were white). The sample was skewed toward the lower side of the socioeconomic (SEI) scale as compared with the United States census population. Race and SEI were confounded such that the lower end of the scale contained a disproportionate number of blacks and the higher end, a disproportionate percentage of whites.

A battery of speech, language, and hearing tests was administered along with intelligence, personality, perceptual, and motor measures. All of these were compared, for correlation and predictive potential, among themselves and with several hundred SEI; pre-, peri-, and postnatal factors; medical examinations; and growth factors. Relevant to this review are the intercorrelations between speech, language, and hearing (SLH) variables at the 3-year or 8-year levels because they provide evidence of coexistence. There were 34 SLH variables at age 3 (e.g., identification of familiar objects, sentence length, initial consonants, etc.) and 43 at 8 years (18 for hearing and 25 for articulation, voice, language, memory, and the speech mechanism). These variables were then combined to generate 27 "indices" (e.g., speech mechanism, fluency, articulation, language comprehension, total conductive loss, and communicative effectiveness), 9 at age 3 and 18 at age 8. Most of the intercorrelations were reported for the 3-year and 8-year indices, although the individual variables were considered in special cases.

By and large, the correlations bearing on coexistence were fairly low (< .5); however, in a sample as large as that used in the NCPP, a correlation coefficient of .025 would be statistically significant. The authors generally considered coefficients below .10 or .20 to have little clinical significance, although small differences were discussed in terms of determining risk of later problems for earlier scores. The book *Early Correlates of Speech, Language, and Hearing* (Lassman, Fisch, Vetter, & E. LaBenz, 1980) contains a complete description and extensive appendices on this topic.

Table 2 shows a sampling of intercorrelations among 3- and 8-year indices. It should be noted that some variables occurred in more than one index (e.g., at 8 years, the score on the screening portion of the Templin-Darley Test of Articulation (Templin & Darley, 1960) was included in both the articulation index as the sole item and in the language production index as one of nine variables). Therefore, some higher correlations were influenced somewhat by the inclusion of identical information in the indices. It must also be noted that although vocal pitch, loudness, and quality were rated in both SLH examinations, they were not included in the indices. Hypernasality (3-year) and Palate

TABLE 2. Correlations between selected speech, language, and hearing indices of subjects tested at 3 and 8 years of age in the NCPP (Lassman, Fisch, Vetter, & P. LaBenz, 1980).

Index	3 yr. Hypernasality	3 yr. Fluency	3 yr. Articulation	3 yr. Language comprehension	3 yr. Sentence complexity	3 yr. Hearing screen	8 yr. Palate function/hypernasality	8 yr. Fluency	8 yr. Articulation	8 yr. Language comprehension	8 yr. Language production	8 yr. Hearing severity	8 yr. Total conductive loss	8 yr. Total sensorineural loss
3 yr. Hypernasality	—	−.01	.05	.03	.05	.01								
3 yr. Fluency		—	−.00	03	05	01								
3 yr. Articulation			—	.20	.27	.07								
3 yr. Language comprehension				—	.29	.10								
3 yr. Sentence complexity					—	.12								
3 yr. Hearing screen						—								
8 yr. Palate function/hypernasality							—	.04	.09	−.00	.03	−.05	.04	.03
8 yr. Fluency								—	.12	.05	.08	−.00	−.00	.00
8 yr. Articulation									—	.25	.48	−.17	.06	.07
8 yr. Language comprehension										—	.42	−.09	−.00	.03
8 yr. Language production											—	−.16	.05	.06
8 yr. Hearing severity												—	−.62	−.47
8 yr. Total conductive loss													—	.31
8 yr. Total sensorineural loss														—

Function/Hypernasality (8-year) were included. The table illustrates that 3-year-olds manifested articulation errors and lower scores on language comprehension and sentence complexity measures to a moderate degree. There was a weaker but positive relation between failing the hearing screening and lower scores on expressive and receptive language and articulation. A slight relationship existed between hypernasality and the two language measures and, not surprisingly, the articulation measure. A small relationship was present for fluency and the two language measures but not for fluency and articulation, hypernasality, or hearing.

At 8 years, the correlations were often higher. Language production and comprehension correlated to a substantial degree with each other and with articulation, again, highlighting the coexistence between these two disorders. Hearing severity correlated to a moderate degree with articulation and language production and to a mild degree with language comprehension. The total conductive loss and total sensorineural loss indices correlated strongly with hearing severity and with one another but to a slight extent with articulation, language production, and palate function/hypernasality. Articulation correlated with fluency and palate function/hypernasality to a mild degree. A slight positive relationship existed as well between fluency and both language indices. There was essentially no correlation between fluency and the hearing indices or between language comprehension and palate function/hypernasality or total conductive loss.

This study documents some degree of coexistence of speech-language-hearing disorders in preschool and early elementary-age children. Nevertheless, the correlations are not as high as might be expected. The only way one could know the actual degree of coexistence is to have frequency counts of the individuals who were judged to be deviant in two or more areas. Whether or not that information is available or could still be accessed in the NCPP is not reported.

Coexistence percentages on a few groups of subjects, i.e., stuttering, cleft palate, cerebral palsied, and others, were reported in various chapters. The stutterers included, in this analysis were the most severe category possible (i.e.,

TABLE 3. Comparison between a group of 35 severe stutterers and all 8-year-olds tested in the NCPP on several speech and language indices. (Adapted from Winitz & Darley, 1980, p. 299.)

8-year index	Stutterers		Total group	
	Mean	SD	Mean	SD
Articulation	38	13	46	6.4
Language comprehension	122	52	153	45
Language production	662	47	727	102
Intelligibility	2.5	.79	2.9	.29
Auditory memory span	141	57	170	41
Word identification*	55	13	62	9.9
Concept development	35	14	42	10
Written communication	163	71	202	57

* Word Identification is the raw score on the Peabody Picture Vocabulary Test (Dunn, 1965).

those at 8 years scored for having "many" dysfluent events and "many" struggle behaviors) and numbered 35 or only 0.17% of the total sample. This compared to 0.95% with "some" or "many" dysfluent events. The mean pure-tone threshold in the poorer ear of this stuttering subgroup was 11.4 dB compared to 8.6 dB for the total 8-year sample. Approximately 9% had conductive hearing losses, and 3% had sensorineural losses; analogous data for the total group were 5% and 2%, respectively (Schubert, Lassman, & P. LaBenz, 1980). Table 3, adapted from the chapter by Winitz and Darley (1980), shows the 35 severe stutterers' scores versus the total group for a number of other speech and language indices. It is clear that these stutterers as a group are inferior to the total group on all the variables. The magnitude of their deficits ranged from $\frac{2}{3}$ to $1\frac{1}{3}$ standard deviations.

King, Jones, and Lasky (1982) conducted a 15-year follow-up investigation of clients who had been diagnosed as having a communicative disorder. They contacted the families of previous clients and were able to locate 50 subjects, 36 males and 14 females. A questionnaire via telephone was used to obtain the information. Of the 50 individuals, a total of 48 had been recommended to receive speech-language services. Eighteen (36%) were labeled as language-disordered and another 18 (36%) articulation-impaired. A total of seven (14%) had combined articulation and language disorders, and two (4%) were diagnosed with articulation/fluency problems. Five subjects (10%) had been diagnosed as having no speech.

A series of epidemiological investigations by Cantwell and his associates (L. Baker & Cantwell, 1982; Cantwell & L. Baker, 1987; Cantwell, L. Baker, & Mattison, 1979) explored the prevalence of psychiatric disorders in samples of speech-, language-, or hearing-disordered children. Subjects were consecutive cases entering a community speech and hearing clinic in a large metropolitan area on the west coast of the United States. The data on psychiatric diagnoses are not particularly relevant here, but the degree of coexistence of communication disorders is quite pertinent. In the 1979 study of 100 consecutive cases (Cantwell et al., 1979), 35% of children had diagnoses for articulation only, 1% for voice only, and 8% for language only. Fifty-four percent were "significantly below normal limits" on both "speech and language." Two follow-up reports, one with 291 children (L. Baker & Cantwell, 1982) and one with 600 children (Cantwell & L. Baker, 1987) extended these findings. Again, children were classified as having disorders of "pure speech," "speech and language," and "language only." Mean ages for these three groups were about 6 years, 5 years, and 9 years, respectively, and males composed 60%–75% of each sample. The "speech and language"

group: (a) constituted 56%–59% of the total groups, (b) had the youngest mean age, and (c) had the lowest performance and verbal IQ's. In order of decreasing prevalence in the 1987 study, 95% of the "speech and language" group had articulation disorders; 63% had receptive language disorders; 32% had expressive language disorders; 5% had stuttering disorders and auditory processing disorders; and 2% had voice disorders. The exact combinations of coexistence patterns were not provided. Hearing problems were reported for 19% of the "speech and language" group in the 1982 study compared to 6%–8% for the other two groups. In the 600-case study, 31% of the "pure speech" group had at least one psychiatric diagnosis, as did 58% of the "speech and language" group and 73% of the "pure language" group.

In Canada, 46 6- to 12-year-old children, 40 boys and 6 girls, referred to a center for child psychiatric services, were administered a large battery of speech and language tests (Kotsopoulas & Boodoosingh, 1987). In all, 74% of the group had language impairments. Of those with mild language involvement (17% of the total), 2 (or 25%) had a coexisting articulation disorder. By contrast, 11 (or 42%) of those with moderate or severe language impairments had coexisting articulation disorders. None of these subjects were mentally retarded or neurologically-, physically-, or hearing-impaired.

Three studies in prison populations also are relevant to this review on coexistence of communication disorders. Reading (1971) reported that 48% of the population in a maximum security prison had speech and hearing disorders. Of this group, 40% had one disorder, 47% had two disorders, 11% had three disorders, and 2% had four disorders.

Wagner, Gray, and Potter (1983) screened 50 adult female offenders, ages 18–44 years, for articulation, voice, stuttering, receptive language, and hearing. In this study, 44% were diagnosed as having a communication disorder. Approximately 68% of this communicatively disordered group had one disorder, 23% had two, and 9% had three disorders. In the latter two coexistence groups (7 subjects or 14% of the total), articulation was most frequently disordered (5), followed by hearing (4), voice (3), language (1), and stuttering (1).

Evidence of coexistence was much lower in a screening study of 136 state penitentiary residents, ages 16–60 years (Belenchia & Crowe, 1983). A large number failed the hearing screening at 20 dB HL (49%) and at 30 dB HL (24%). Only 13 (10%) were identified as manifesting a speech disorder. Failure of hearing screening coexisted with seven of the speech disorders, and articulation and voice disorders were observed in one individual.

Chapter 4

Coexistence of Communication Disorders: Review of West Virginia Studies and Conclusion

4.1 PHONOLOGICAL DISORDERS

4.1.1 Introduction

In our investigations, which have utilized subjects with phonological disorders as a basis for study (Gross, St. Louis, Ruscello, & Hull, 1985; Ruscello, St. Louis, & Mason, in press) elementary, middle, and secondary students were included. This allowed us to access the data base in total and also permitted us to examine older subjects who are generally not included in such studies. In addition, different error patterns were determined *a priori*, so that subgroups within the general population of phonological disorders were studied.

It is obvious that investigations with such numbers of subjects across the school-age range could provide information in two important ways. First, trends observed in younger children with phonological disorders might be noted to diminish with age, or a particular trend might extend through the grade levels. In addition, potential differences not found in younger groups might be identified in the older groups. The previously cited studies, which are to be presented in summary form, examined coexistence from the perspective of phonological disorders—that is, what types of coexistence patterns might be identified in subjects who were selected on the basis of a phonological disorder.

4.1.2 Summary of Studies

Study I. The first investigation carried out by Gross et al. (1985) was designed to study the phonology and language form of normal and disordered subjects in grades 1, 3, 5, and 7. A total of 144 subjects were selected with each grade containing 36 subjects. Participants were further subdivided into normal controls and subjects with either residual or multiple phonological errors, based on definitions suggested by Shriberg (1980). All children selected for study had normal hearing thresholds as determined through the NSHS testing. Members of the residual phonological group were required to exhibit two or more errors for at least one of the phonemes: /s/, /r/, and /l/. The rationale behind the selection was that the three phonemes are frequently misarticulated by school children (Bralley & Stoudt, 1977; Sax, 1972; Templin, 1973), and restricting the number of phoneme errors would insure that subjects demonstrated mild to moderate phonological involvement.

The multiple error group was established on the basis of final position errors. It was hypothesized that individuals showing final position errors would have other positional errors and that errors in the final position would likely include deletion errors symptomatic of the "open syllable" (Panagos, 1974). The multiple error group subjects could also have /s/, /r/, or /l/ errors, but those errors were not included in the selection criteria. The normal articulation group contained subjects without phonological involvement.

The audiotaped articulation tests were independently rescored for the current study by judges, and language samples were transcribed and analyzed. Table 4 summarizes the phonological data for the study groups. The normal articulation group shows essentially no errors as designed, but both residual and multiple groups do. The difference between the two phonological groups is substantial at each grade level, and the difference in number of errors is generally consistent from grades 3–7. The multiple error group demonstrates a developmental decrease in errors from first to third grade and rather stable performance through the other grades. The residual group is consistent in the number of errors across the four grade levels. Statistical analysis indicated significant differences with respect to the number of errors between the two phonological disorders groups.

The two phonological groups not only differed in terms of the number of errors, but also in the error type. Using the traditional classification system of substitution, omission, and distortion, the data indicated that substitution and distortion errors predominated in both groups, but differed in the overall proportion because of the higher number of omission errors found with the multiple error group. The percentage for the residual group by error type were as follows: substitutions, 46%; distortions, 47%; and omissions, 7%. The multiple error group figures were as follows: substitutions, 39%; distortions, 39%; and omissions, 22%. The difference in the proportion of errors across the three categories was statistically significant.

In order to examine the language samples, a number of indices were calculated to provide measures of length, completeness, and complexity. Using a modification of the procedure developed by Loban (1976), samples were segmented into communication units (CUs) and the various structural measures found for each subject as described by Musselwhite, St. Louis, and Penick (1980).

Group differences were not found for mean length of utterance in words (MLU-W), indicating that utterance length was similar. It should be noted that the residual group (6.65) had a slightly higher overall MLU-W than either the normal articulation group (6.54) or the multiple error group (6.24). However, statistically significant differences were found for the other comparisons that were made. The measure of completeness, the percentage of utterances containing a noun phrase and a verb phrase (% NP + VP), indicated statistically significant differences for both groups and grade levels. The multiple error group had significantly fewer complete utterances (71%) than either the residual (81%) or normal articulation group (83%). Grade level comparisons showed significant differences between first grade and the other grades. In the case of com-

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TABLE 4. Mean number of phonological errors for the normal, residual, and multiple error groups by grade and total.

Group	Grades				Overall mean
	1	3	5	7	
Normal	0.17	0.00	0.00	0.00	0.04
Residual	5.00	4.83	4.33	4.83	4.75
Multiple	28.00	12.42	11.83	9.17	15.35

plexity, the average verbs per utterance (Vs/U) were also significantly lower for the multiple error group (1.10), when compared with the residual (1.26) and normal articulation groups (1.21); however, the two groups did not differ from each other. Finally, the average language error scores (LES) revealed significant differences among groups. The normal articulation group had significantly lower scores (1.90) than either of the two phonological groups, and the multiple error group (8.67) had a significantly lower score than the residual group (5.04).

The results of the investigation by Gross et al. (1985) indicated that language differences did coexist with specific subgroups of children who were identified as having phonological disorders. These groups were selected *a priori* with methodological considerations to specific phoneme errors and word position. With those constraints in mind, it was possible to identify subgroups that were similar with the distinctions proposed by Shriberg (1980). That is, phonological groups were formulated along the distinctions of limited involvement with particular phonemes, and multiple involvement with characteristic deletions, particularly of final consonants. It should be noted that Shriberg and Kwiatkowski (1982) further refined the diagnostic classification system to distinguish between delayed and residual phonologic disorders. These categories correspond to the current categories used; the delayed distinction would refer to our multiple error group.

The clinical implications of this study suggest that coexisting language problems may be present in school age children with phonological disorders up to the middle school years. Previous reports have discussed this relationship in study groups of young children, but the current data suggest that older children may also show this same pattern. The language data indicate a developmental trend with age for all groups; however, performance decrements were clearly present across ages for the multiple error group.

The coexistence between language and phonological disorders was also found to some extent in the language samples of the residual group. Overall language error scores were significantly higher for the residual group than for the normal group. This finding suggests that some children with residual problems may show very subtle problems in morphological, syntactic, or semantic utilization that might not be apparent, unless evaluated. Although this might not be true for all children exhibiting this phonological pattern, the finding of the current study indicates the need for speech-language pathologists to examine the communication abilities of clients, rather than to study each system in isolation (Bernthal & Bankson, 1981).

Study II. The purpose of the second investigation (Ruscello et al., 1991) was to study the coexistence of phonological disorders with other speech, language, and hearing disorders. Subjects were identified to include normal speakers and two groups of speakers with phonological disorders. As in the previous study, predetermined criteria were utilized to identify groups of phonologically disordered subjects and normal speakers.

A total of 72 subjects were selected for this investigation. There were three groups of 24 subjects with 2 subjects each in grades from 1–12. Potential subjects were initially selected from their score sheets to reflect no phonological disorders (normal group), mild-moderate phonological (i.e., articulation) deviance and moderate defectiveness in overall adequacy (residual articulation or RA group), and severe phonological deviance and severe defectiveness in overall adequacy (delayed articulation or DA group). It is worth recalling that the overall adequacy ratings were summary judgments made after testing in the original NSHS investigation. The rationale for selection was used to identify groups similar to the companion study conducted by Gross and her colleagues (1985). The normal articulation group was constrained to contain 12 males and 12 females with a mean age of 12.5 years. The residual group included 18 males and 6 females, and the mean age of the group was 12.6 years. The delayed group also contained 18 males and 6 females, with an average age of 12.5 years.

The phonological samples were rescored and errors categorized into the traditional system of substitution, omission, and distortion. The language samples were transcribed and analyzed. A number of indices were calculated and were identical to those employed by Gross et al. (1985), except for language error scores, which were not established. Voice ratings and hearing acuity ratings were taken from the original NSHS data.

The normal articulation group showed no phonological involvement, by definition, but the two experimental groups exhibited varying degrees of involvement. The residual group had an average of 5.9 errors, whereas the group had 19.5 errors. The distribution of errors according to type indicated that both groups had a high percentage of substitution and distortion errors, but the delayed group exhibited more omission errors. The distribution of error types for the residual group was as follows: substitutions, 70%; distortions, 18%; and omissions, 12%. Error types of the delayed group were as follows: substitutions, 57%; distortions, 19%; and omissions, 24%. Significant differences were found for both number of errors and distribution of errors across groups. Moreover, the error patterns are similar to those found in the companion study (Gross et al., 1985). Table 5 provides a summary of the data.

The language data indicated differences among the groups with respect to two of the three measures employed. The residual and delayed groups were significantly different from the normal articulation group with respect to length of utterance (MLU-W). The mean values were as follows: normal controls, 7.30; residual group, 6.28; and delayed group, 5.66. There were no group differences on the completeness measure (%NP + VP). The index to complexity (Vs/U) indicated that both phonological disordered

TABLE 5. Summary phonological data found for the normal, residual and delayed groups.

Groups	Normal group	Residual group	Delayed group
Mean number of errors	0.2	5.9	19.5
Error types (%)			
Substitutions	100%	70%	57%
Distortion	0%	18%	19%
Omissions	0%	12%	24%

groups (residual group, 1.35; delayed group, 1.26) differed significantly from the normal articulation group (1.49), but not from each other.

The voice rating data were collected during the original NSHS sampling process, and differences were found among groups. Approximately 29% of the normal articulation group were marked for voice deviations, but 75% of the subjects in each of the phonological disordered groups were marked for voice problems. In addition, there was a tendency for more of the members of the delayed group (21%) to receive ratings in the severe voice category than members of the residual group (12%). Finally, hearing data indicate that thresholds were higher for the experimental groups. The observed differences were significantly different with both groups different from the normal articulation groups.

The results of this investigation extended the findings of our initial study (Gross et al., 1985), and added further support to the coexistence of communication deficits among school-age children. Because of the large study population, we were able to identify groups of phonologically disordered subjects with specific production characteristics in both elementary and secondary school groups. Although we cannot suggest that coexistence is a universal phenomenon, its frequency was substantial in the study population. In looking at the phonological characteristics, there was a gap between the two groups in terms of number of errors and type of errors throughout the age range studied. However, the phonemes that were found to be in error were the same for both of the groups. Despite number and type of phonological error differences, coexistence with other speech-language disorders was similar. That is, severity of phonological disorder did not appear to result in large differences in proportions of subjects with coexisting speech and language disorders.

Inspection of the language measures indicated decrements in performance for both groups when compared with the normal subjects. Indices of length and complexity were reduced for both groups, but completeness was not. This is somewhat different from the results of Gross et al. (1985) wherein decrements in language performance appeared to vary on the basis of severity. Measures of completeness and complexity were reduced for the severe phonological group, but not for the moderate group. Although there is a difference between studies, the overall results suggest a tendency for some phonologically disor-

dered subjects to demonstrate a coexisting language disorder.

Some investigators (Shelton & McReynolds, 1979) have indicated that severity of the phonological disorder is a key factor with language involvement; however, that generalization may not be true for older children. That is, some children with phonological disorders may have coexisting language disorders and not exhibit a problem that would be described as severe. In sum, the two investigations are consistent with other studies that have identified language disorders as a component in their study populations of phonologically disordered subjects (Shriberg et al., 1986; Shriner et al., 1969; Smit & Bernthal, 1983; Whitacre et al., 1970).

A high frequency of voice disorders was also found in both of the experimental groups. However, we must temper the former statement because the reported data were part of the original NSHS survey findings and were not rescored. Additional literature regarding coexistence between phonological and voice disorders is somewhat limited, but the trend reported herein is similar to that reported by others. James and E. B. Cooper (1966) found coexistence; however, the subject characteristics of the study population are not clear from their report. In a more recent study, Shriberg et al. (1986) found a coexistence rate of 50% in a large group of children who had phonological disorders.

The final study variable of hearing sensitivity also showed slightly higher thresholds for the experimental groups. It should be noted that average thresholds were within acceptable limits, but the differences accentuate the need to study the complex relationship between mild hearing loss and phonological disorders (Shriberg, 1987). A number of investigators (Churchill et al., 1988; Paden et al., 1987; Roberts, Burchinal, Koch, Footo, & Henderson, 1988) have studied the subgroup of phonological disordered children with middle-ear disease, but additional research is necessary. It is sufficient to say that the speech-language pathologist must be cognizant of the potential problem and monitor the hearing status of those children who are enrolled in treatment programs.

Figures 20a and 20b illustrate the degree of coexistence in the Ruscello et al. (1991) study. Bars for articulation, voice, and stuttering reflect NSHS examiners' ratings. The bars of language reflect the percentage of subjects in which at least two out of the three measures were at least one standard deviation below the means for the control group. The hearing data are those subjects for whom the best binaural averages of 500, 1,000, and 2,000 Hz were 16 dB HL or worse. In this case the *better* of the two thresholds in either ear at each of the three "speech frequencies" was used. The bars reaching to 100% for articulation in the figure marked "given" reflect subject selection criteria only; that is, all of the subjects were required to be scored mild-moderate or severe in residual and delayed groups, respectively.

The figures illustrate the substantial coexistence of voice disorders and language disorders in both the residual articulation and delayed articulation groups. Coexisting stuttering and hearing impairments were also observed in a few of the delayed articulation subjects.

RESIDUAL ARTICULATION

DELAYED ARTICULATION
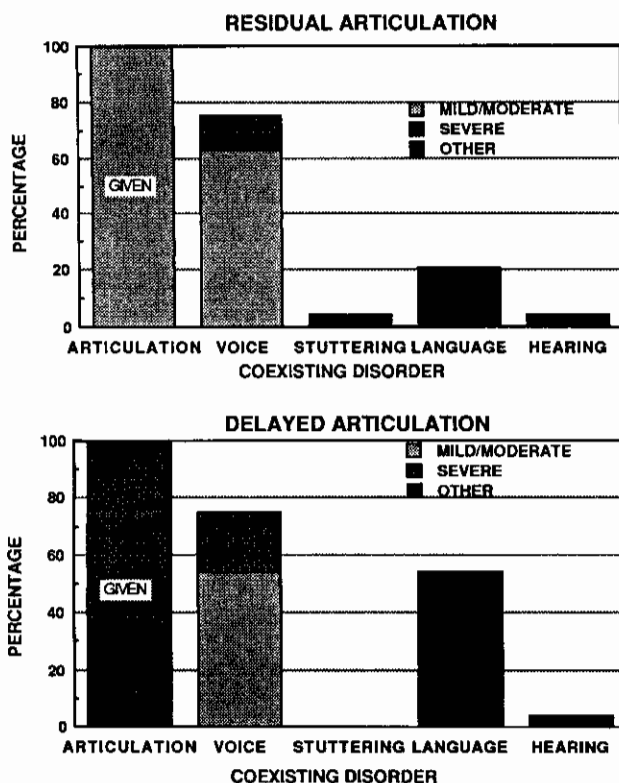
FIGURES 20a and 20b. Percentage of subjects in the (a) residual articulation group, and (b) delayed articulation group with coexisting disorders.
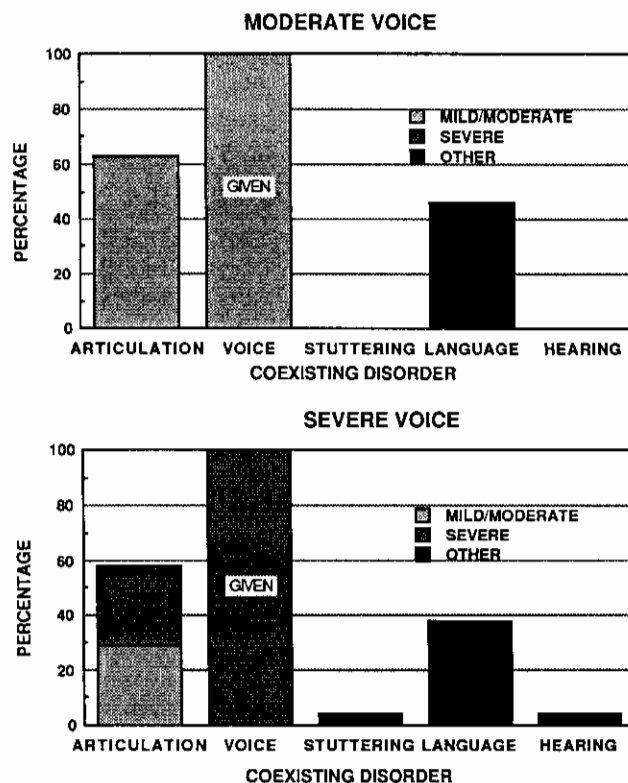
4.2 VOICE DISORDERS

Following the results of the studies just reported, it became clear that voice disorders coexist with a significant percentage of articulation disorders. Logically, it made sense to explore this relationship from the reciprocal perspective of voice disorders. Therefore, a study was designed to determine the extent of coexistence of other communication disorders within NSHS subjects identified as having voice disorders (St. Louis, Hansen, Buch, & Oliver, 1992). The design and method were quite similar to the articulation studies just described. Twenty-four subjects, two from each grade, who scored mild-moderate for voice and moderate for overall adequacy (MV) were compared with 24 who scored severe for both voice and overall (SV) and 24 who rated as normal for voice and overall. The data were analyzed the same as for the articulation (phonological) disordered groups with the following exception: short, tape-recorded speech samples, about 1–2 minutes in length for each subject, were prepared. These samples were then played and rated by a research assistant, using D. K. Wilson's (1979) version of the *Buffalo Voice Profile.* This is a 7-point equal appearing interval scale that includes consideration of a variety of perceptual categories, including loudness, pitch, quality, resonance, and use of the voice. Inter- and intrajudge reliability were carefully assessed and determined to be satisfactory.

Briefly, the results of this investigation were as follows.

The two groups, MV and SV, were significantly different in the expected direction with respect to both number and severity of voice deviations on the Wilson *Profile.* Hoarseness and loudness deviations were the most commonly identified disorders. Hoarseness was observed in 83% of the SV group and 79% of the MV group. Parallel percentages for loudness were 42% and 46%, respectively. Mean severity ratings for "overall voice efficiency" (on a 1–7 scale) were 3.7 for the SV group and 2.4 for the MV group. As in the articulation-disordered subjects, there were more males than females in both voice-disordered groups, 3:1 males to females in the MV group and 3.8:1 in the SV group. Figures 21a and 21b show the degree of coexistence of other disorders in these voice groups. NSHS examiners' ratings revealed that 63% of MV subjects had mild-moderate articulation deviation. This compares to 29% of the SV group manifesting mild-moderate and 29% manifesting severe articulation deviations. The only stutterer who was identified in this study was one in the SV group (4%).

Again, protocols transcribed from the NSHS tapes were analyzed for measures of length (MLU-W), complexity (Vs/U), and completeness (%(NP + VP). The percentage of subjects in each group that were below 1 standard deviation of the control group in at least two out of three language measures was 46% for the MV group and 33% for the SV group. Unlike the results for articulation disorders, the MV group appeared to have more language involvement than the SV group. Using the best binaural average data,

MODERATE VOICE

SEVERE VOICE

FIGURES 21a and 21b. Percentage of subjects in the (a) moderate voice group and in (b) the severe voice group with coexisting disorders.

only one SV subject and none of the MV subjects had unsatisfactory hearing.

We can see that the two groups had voice disorders with severity differences in the expected direction. Clearly, problems in other areas often coexist with voice disorders: deviancies of articulation, stuttering, and language. There were no obvious disorders of hearing, although differences in thresholds did exist.

4.3 FLUENCY DISORDERS

4.3.1 Stuttering

Several years ago St. Louis and Hinzman (1988) undertook a study to explore the coexistence of other communication disorders among stutterers because a previous study in the area of cluttering, which will be described later in this section, raised questions about such coexistence (St. Louis, Hinzman, & Hull, 1985).

The St. Louis and Hinzman (1988) investigation used essentially the same methodology as the second articulation study and the voice study described previously. Twenty-four moderate stutterers (MS) and 24 severe stutterers (SS)[4] were compared to 24 controls. The language measures were recalculated for this monograph to correct for some slight differences in methodology so that direct comparisons could be made between this and the two aforementioned studies. For each subject, percentages were calculated for typical stuttering disfluencies (sound/syllable repetitions and prolongations), typical normal disfluencies (word and phrase repetitions), and fillers (word and nonword varieties.)

As expected, the SS group had significantly more disfluencies overall as well as more disfluencies typical of stuttering than the MS group. In terms of percentages of the total words in spontaneous speech, the MS group had 1.2% sound/syllable repetitions and prolongations, and the SS group had 5.6%. MS subjects emitted 2.5% word and phrase repetitions compared to 2.8% for SS subjects. Word and nonword fillers constituted 2.9% and 4.1% of the MS and SS groups, respectively. Total disfluencies were 6.5% for the MS group and 12.5% for the SS group.

The sex ratios were also quite interesting. In the MS group, the ratio was 2:1, males to females; in the SS group it was 11:1.

Figures 22a and 22b show coexistence percentages for these stutterers. NSHS articulation deviations were reported for 67% of the MS group, all of these in the mild-moderate range. Surprisingly, 96% of the SS group had articulation deviations, 71% mild-moderate and 25% severe. Similarly for voice deviations, 66% of the MS group were identified, 58% mild-moderate and 8% severe, compared

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[4] In the St. Louis and Hinzman (1988) article, these groups are identified as ST(MD) and ST(SD), respectively, because they were technically stutterers with either moderate or severe disorders in overall adequacy. Unlike the previous investigations of articulation and voice, the NSHS results did not permit selecting stutterers on the basis of stuttering severity, per se.
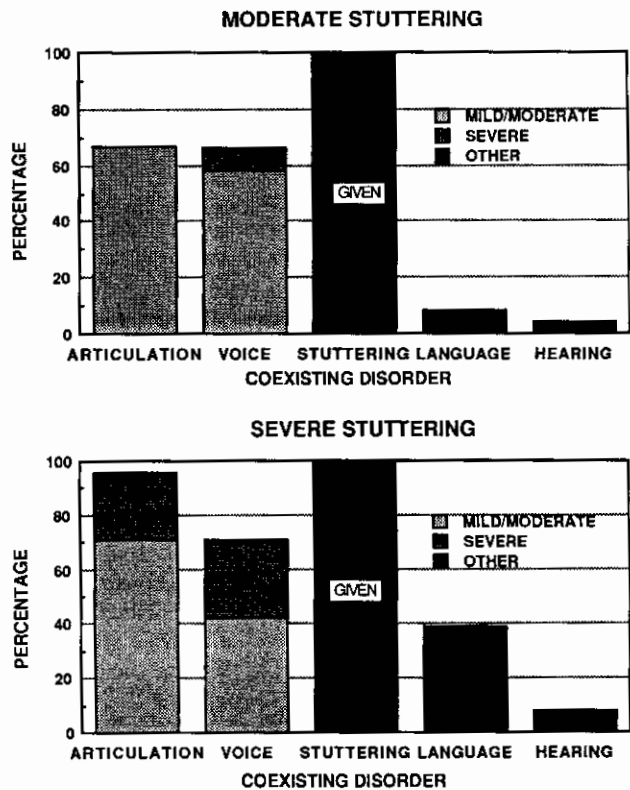
FIGURES 22a and 22b. Percentage of subjects in the (a) moderate stuttering group and (b) severe stuttering group with coexisting disorders.

to 71% of the SS group, with 42% as mild-moderate and 29% severe. Eight percent of the MS subjects had deviant language scores in at least two out of three structural measures compared to 39% for the SS group. Four and 8%, respectively, of the MS and SS groups had best binaural averages beyond the normal range.

Again, it is clear that a surprisingly large percentage of stutterers with moderate overall ratings like the articulatory and voice deviant groups just described have coexisting communication disorders. Also, those with severe overall ratings have even more frequent—and more severe—coexisting problems than the moderate groups.

This raised the question, "Did the fact that we constrained these stutterers to have moderate or severe overall ratings predispose them to have more coexisting problems than a randomly selected group not so constrained?" An investigation to test this question was carried out (St. Louis, Chambers, & Ashworth, 1991). Again, 24 stutterers were selected, but only on the basis of the presence of a judgment of stuttering by NSHS examiners that was confirmed by the authors. Articulation, voice, hearing, and overall ratings were permitted to vary at random. These subjects were termed random stutterers (RS).

The sex ratio of this group, 3.8:1, males to females, is similar to that observed in the entire survey and in the literature (Bloodstein, 1987). Furthermore, as we shall point out later, the distribution of identified deviations in articu-

lation and voice were not significantly different from the entire survey sample of stutterers.

The RS group had more stuttering and nonstuttering types of disfluencies than either of the two previous groups: 4.9% sound/syllable repetitions and prolongations, 3.7% word and phrase repetitions, 7.5% word and non-word fillers, and 16.0% total. By comparison, the RS group falls between the MS and SS groups in terms of frequency of stuttering disfluencies, i.e., sound/syllable repetitions and prolongations. Percentages were substantially higher than either of the previous groups for nonstuttering disfluencies, resulting in a substantially higher total disfluency percentage. The reason for these higher counts is not apparent; however, it is likely that different criteria by different judges was partly responsible. Relative to coexistence of articulatory deviations, Figure 23 illustrates that 67% of the RS group were identified by NSHS examiners, 54% as mild-moderate and 13% as severe. Forty-two percent had mild-moderate voice deviations, and 8% had severe—for a total of 50%. For language, 25% had deviations in at least two out of three structural measures. None of the RS group had significant hearing losses. In most of these measures, the RS group was more similar to the MS than the SS group.

Another group of stutterers from the NSHS data was tested several years ago in the cluttering study mentioned earlier (St. Louis et al., 1985). These stutterers were chosen to compare to a group of possible clutterers and controls. Unlike the studies just described, these stutterers were required to have no articulation deviations and to have normal hearing. Thus we refer to this group as "pure" stutterers (PS).[5] The PS group was younger than those just described; it was comprised of 24 subjects, one half each in grades 1–3 and 4–6.

The sex ratio of 1.67:1, males to females, was constrained by the possible cluttering group to which stutterers were matched. For this group, sound/syllable repetitions and prolongations made up 2.9% of the total words; word and phrase repetitions, 3.7%; word and nonword filler, 5.7%, and total disfluencies, 12.3%. The coexistence data are shown in Figure 24. By definition, none of the PS group had articulatory deviations. What was surprising was that 71% had mild-moderate voice deviations. In terms of the language measures we have described, 17% of the PS group had deviancies in two out of three variables. All of the best binaural hearing averages were normal, no doubt because of selection criteria.

The picture that emerges from these four studies of stutterers is quite clear. Coexisting deficits in articulation and voice are present in at least half of stutterers, if randomly selected. The prevalence of such problems seems to be higher in more severe stutterers. Evidence of decreased performance in language production measures also coexists in about 1 or 2 stutterers in 10, but may be as high as 4 in 10 among severe stutterers. Although mean thresholds are slightly worse for stutterers than controls, stutterers do not

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[5] These subjects were simply identified as stutterers by St. Louis et al. (1985) but as ST(−AD) (stutterers without articulation disorders) for comparative purposes in the St. Louis and Hinzman (1988) article.
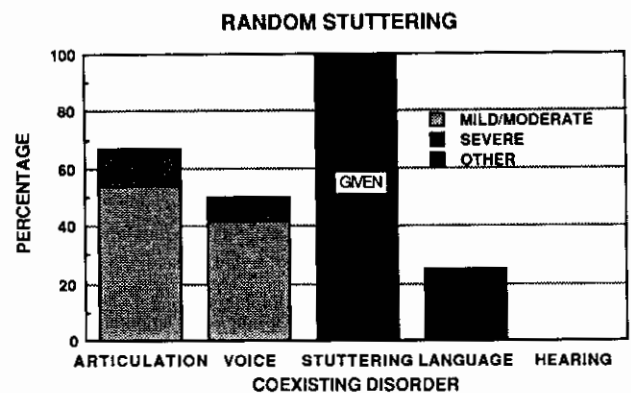

FIGURE 23. Percentage of subjects in the random stuttering group with coexisting disorders.

typically manifest as clinically significant hearing problems.

4.3.2 Cluttering

We carried out two studies designed to investigate disfluency and language differences among clutterers (St. Louis, in press; St. Louis et al., 1985). The subjects in the 1985 study were 24 first through sixth graders, half in grades 1–3 and half in grades 4–6, selected from the NSHS data base as follows. They had been scored by NSHS examiners as having problems of "fluency" but were *not* identified as stutterers (See Chapter 1). Moreover, subjects were also required to have articulation deviations. Ninety-two percent were scored mild-to-moderate for articulation; 8% were rated severe. Overall adequacy ratings, which were not constrained in subject selection were as follows: 75% mild, 25% moderate, and 0% severe. As noted earlier, this group of "possible clutterers" or "articulation deviant disfluent nonstutterers" (ADDN) were compared to the PS and a control group. The sex ratio of the ADDN group was 1.67 males to 1 female.

In a later study, six additional "possible clutterers" in grades 1–6 were selected according to deviations in fluency and rate but not stuttering. In these subjects, articulation was allowed to vary. The entire NSHS sample was screened to obtain potential subjects. Next, an examiner listened to each potential subject and accepted only those who unmistakably had rapid and irregular speech rates but who did not stutter. We called this group "rate deviant disfluent nonstutterers" (RDDN). In the group were 5 males and 1 female, and, fortuitously, there was one subject in each grade from 1 to 6. Utterances that were at least 10 words in length were analyzed, revealing that both the ADDN and RDDN groups had speaking rates that were faster than the PS group, but the controls were slightly greater than the ADDN group. The ADDN group had the fastest rates, no doubt due in part to our selection criteria. Both "possible cluttering" groups also had normal levels for sound/syllable repetition and prolongations, typical stuttering disfluencies, but abnormally high levels of word and phrase repetitions. Figure 25 shows a comparison of
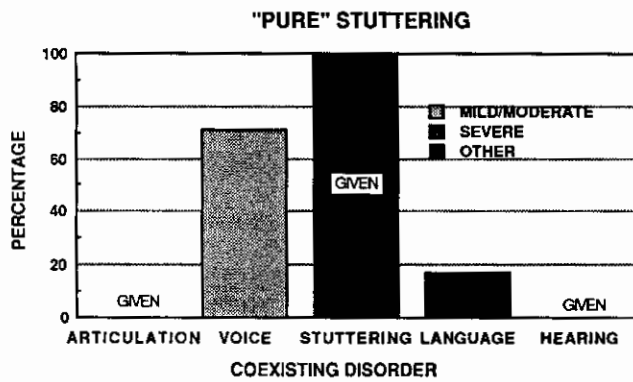
"PURE" STUTTERING

FIGURE 24. Percentage of subjects in the pure stuttering group with coexisting disorders.

these levels with the PS group and controls from St. Louis (in press) and St. Louis et al. (1985).

These possible clutterers also had marked evidence of coexisting disorders as seen in Figure 26a and 26b. All of the ADDN subjects had articulation deviations (92% mild-moderate and 8% severe), *by definition*, but so did two-thirds of the RDDN group, all of mild-moderate degree. Voice deviations were observed for 62% of the ADDN group (58% mild-moderate and 4% severe) and for 83% of the RDDN group (67% mild-moderate and 17% severe). One-third and two-thirds, respectively, of the ADDN and RDDN groups had evidence of language deficiencies. All of the subjects in both groups had normal hearing as determined by the best binaural average. The ADDN group was so constrained during selection.

To the extent that these groups are characteristic of clutterers (St. Louis et al., 1985), there is no doubt that clutterers manifest coexisting communication disorders. It appears that the degree of coexistence is approximately as high as it is in severe stutterers.

4.4 COEXISTENCE: CONCLUDING STATEMENT

The preceding review of coexistence of communicative disorders, depending on one's point of view, might provide
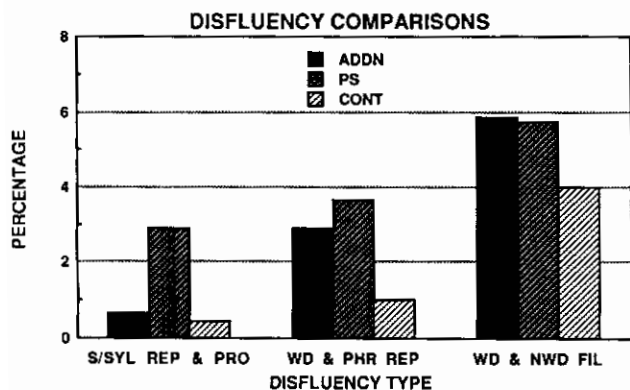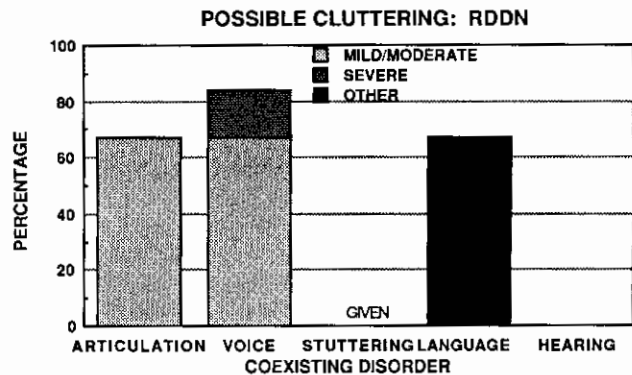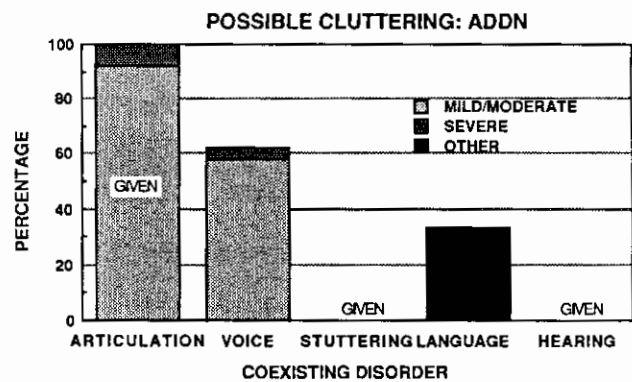
DISFLUENCY COMPARISONS

FIGURE 25. Comparison of stuttering and nonstuttering disfluency types in three groups: possible clutterers (ADDN), pure stutterers, and controls.

POSSIBLE CLUTTERING: ADDN

POSSIBLE CLUTTERING: RDDN

FIGURES 26a and 26b. Percentage of subjects in the possible cluttering (a) ADDN group and (b) RDDN group with coexisting disorders.

startling revelations or simply a restatement of the obvious. We view it both ways. Past research efforts that have documented coexisting communication disorders were far more common and consistent than we had expected. Nevertheless, when we considered our own clients, we thought, "Of course, many of them did have more than one disorder."

This review of past research and recent studies at West Virginia University documents quite clearly that speech, language, and hearing disorders frequently coexist. Language disorders are likely to coexist with articulation disorders. Moreover, this is a reciprocal relationship; articulation problems are frequently observed in language disorders as well.

Both articulation and language problems are more common among the hearing impaired than would be expected by chance; however, the reverse is not obviously true, perhaps because clinically significant hearing loss is less prevalent than either of these disorders (e.g., Leske, 1981a, 1981b). Another one-way pattern of coexistence characterizes stutterers, who have been shown to be likely to have articulation and language delays. The reverse is not necessarily the case. Again, we speculate that different incidence rates provide a partial explanation. As with those who are hearing impaired, there are so few stutterers that they make up only a fraction of the populations with some degree of articulation or voice deviance. Therefore, a random cast into either of these populations is not likely to catch a stutterer.

Voice disorders, though shown to coexist in some disor-

dered samples in the literature, are typically not mentioned in studies of coexistence. Even in studies documenting coexistence of voice disorders with other communicative disorders, the likelihood of coexistence is generally quite low. This is in sharp contrast to results obtained in several studies utilizing the NSHS, in which voice disorders have been seen to coexist with articulation disorders reciprocally, and also with stuttering and hearing loss.

We speculate that several factors are responsible for the conspicuous absence of voice disorders in most studies. Voice disorders are often unrecognized, both by the public and by clinicians (Boone & McFarlane, 1988; Culton, 1986; James & E. B. Cooper, 1966). In addition, voice disorders are often considered less serious than other disorders (Van Riper & Emerick, 1984), and obtaining satisfactory reliability of perceptual voice ratings has been a continual problem (D. K. Wilson, 1987). Finally, it seems plausible to suggest that clinicians and researchers alike simply fail to consider voice at all. It has been documented that voice disorders make up a smaller proportion of most clinicians' caseloads than prevalence estimates would predict (Kahane & Mayo, 1989; D. K. Wilson; 1987). From the perspective of research, an example may illustrate further. In the large epidemiological study described earlier (Lassman et al., 1980), vocal quality, loudness, and pitch deviations were scored by examiners; nevertheless, these were not included in any of the indices, or as their own index, alongside articulation, language, and so on.

One could easily conclude from the literature review that voice disorders are rare and generally do not coexist with other communication disorders. Nevertheless, because our data suggests strongly that voice disorders are highly likely to coexist with other communication disorders, we believe that this conclusion is premature and probably erroneous. Instead, we believe that the general lack of attention to voice, for the reasons just cited, are responsible for the low levels of coexistence for voice disorders reported in the literature.

As the severity of various disorders increases, so does the likelihood of coexisting communicative disorders. This generalization, though not particularly surprising, seems to hold for the entire range of disorders reviewed.

Another finding that emerges from the literature unambiguously is that more males than females manifest communication disorders. The finding that approximately three to four times more males than females who stutter is accepted as fact (Bloodstein, 1987). This had not been widely accepted for other disorders. Nevertheless, the studies reviewed indicate that in such areas as articulation, language, or hearing, females enjoy the advantage of being more likely to escape disorders. In children, it appears that the same holds true for voice.

Chapter 5

Integration and Implications

5.1 WEST VIRGINIA UNIVERSITY STUDIES

5.1.1 Sample Considerations

The results reviewed in the previous chapters, both from the available NSHS data and the West Virginia University studies using samples from that database, suggest a high degree of overlap between articulation and voice disorders. In addition, although stutterers are not common among either the articulation or voice-disordered samples, both articulation and voice disorders are very common among stutterers.

The question arises, "To what extent were subjects in these studies representative of the NSHS random distribution?" Following are three figures (Figures 27a, 27b, and 27c) showing prevalence percentages of the total NSHS sample for the degree and type of disorder coexistence and the same prevalence figures for a number of our samples. Figure 27a shows results for three stuttering groups, RS, MS, and SS. As shown, the bars of the RS and NSHS samples are visibly similar. The MS group was somewhat dissimilar, and the SS group was markedly dissimilar.

Figure 27b shows analogous figures for articulation groups. Neither the RA nor the DA group were similar to the NSHS group, both showing fewer pure articulation disorders and more coexisting with voice.

The percentages for the MV and SV groups (Figure 27c) are similar to those for articulation. Neither group is similar to the NSHS group, again showing more overlap with articulation and few "pure" voice disorder occurrences.

These results indicate that the six groups of moderate and severe articulation, voice, and stuttering disorders had more coexisting deviancies than the total NSHS sample. Only the random stuttering group, as expected, was similar in composition to the NSHS data.

5.1.2 Combined Coexistence

Table 6 shows the degree of communication disorders coexistence among possible clutterers, stutterers, articulation, and voice-disordered subjects. The table lists the percentage of subjects in the NSHS scored as disordered for rate, fluency without stuttering, stuttering, hearing loss (BBAs worse than 15 dB), articulation (mild-to-moderate and severe), and voice (mild-to-moderate and severe). The foregoing results are confirmed; that is, voice and articulation disorders coexist to a high degree with each other. When the dimension of abnormal fluency (which in these groups was not stuttering) and articulation are combined, coexisting language and voice disorders are very likely. Similarly, when rate and fluency are combined, all of the remaining coexisting problems are likely.

There appears to be a hierarchy involved. As noted in Chapter 4, different prevalence rates for the various disorders appear to be partly responsible. In other words, we find more cases of common disorders coexisting with uncommon disorders than uncommon disorders coexisting with common disorders. Table 6 provides support for the
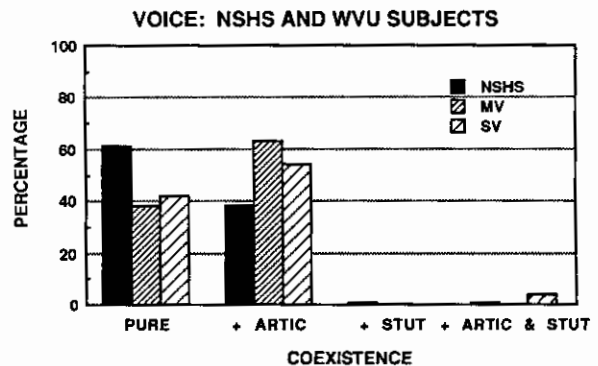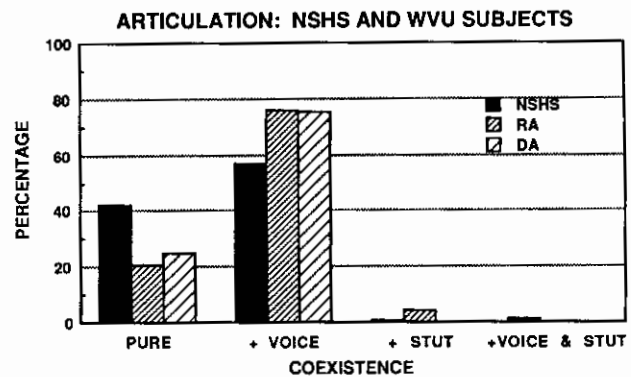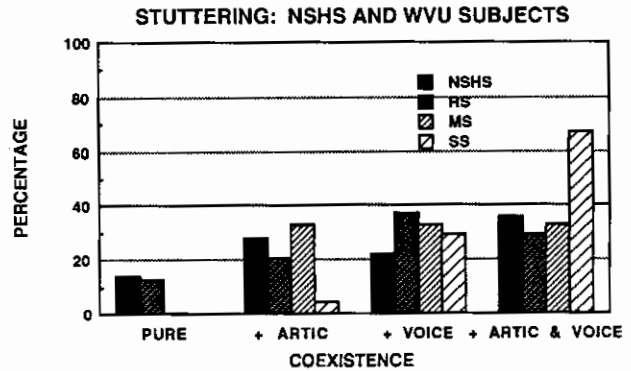
FIGURES 27a, 27b, and 27c. Percentage of (a) stuttering subjects with pure and coexisting deviations in the NSHS sample compared to the random, moderate, and severe stuttering groups; (b) articulation-disordered subjects with pure and coexisting deviations in the NSHS sample compared to the residual and delayed articulation groups; and (c) voice-disordered subjects with pure and coexisting deviations in the NSHS sample compared to the moderate and severe voice groups.

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positive relationship between frequency of occurrence and coexistence.

It is entirely possible that other factors are involved as well. One that appears to be operative is an "underlying factor" that could produce a variety of communicative disorders, depending on the degree to which the factor is involved. It appears that a speaker's rate and fluency of speaking are relatively more immune from disorder than his/her language, articulation, and voice. However, when rate and fluency are affected, the speaker's entire communication system is often so adversely affected that language, articulation, or voice disorders are very likely to coexist. The "underlying factor" has been discussed widely for a number of years. Weiss (1964) discussed the concept of "central language imbalance" in clutterers, which could affect all channels of speech and language as well as written language. A number of authors have speculated that stuttering can be viewed as a specific type of language disturbance (Homzie & Lindsay, 1984; Wall & Myers, 1982, 1984; Wingate, 1988). Ham (1990) introduced the concept of "neural integrity," specifically in relation to causality of stuttering.

McDonald (1964) speculated that phonological disorders of a functional origin may be the result of various coexisting factors that adversely affect speech production capabilities. Factors such as oral structure, motor, sensory, psychological, and social variables interact, and potential negative interactions may result in a disorder. That is, a person at threshold for several coexisting variables may develop a communication disorder. Taken further, the postulation may be applied to persons with coexisting factors because a number of variables may interact in a way that may affect differentially the communication system. Although purely speculative, description of subjects along the various dimensions of those systems that support communication may provide further insights into this claim (Shriberg & Kwiatkowski, 1982; Shriberg & Kwiatkowski, 1988).

We do not wish to overstate the position that there is a common etiological factor underlying different disorders. We only wish to point out that the data we have reviewed are partly consistent with such a viewpoint.

5.1.3 Diagnosis of Coexisting Disorders

As emphasized repeatedly in this monograph, we have been impressed with evidence of coexistence. Recently, we began a series of investigations to further explore this phenomenon in terms of identification of coexisting communication disorders (St. Louis, Ruscello, & Lass, 1990–1991). We selected audiotaped samples from our series of studies, which included normal speakers, speakers with articulation, voice, and stuttering disorders, and speakers with coexisting speech disorders. The speech samples were randomly compiled on a tape and played to listeners who were asked to identify the presence and type of disorder. There were four choices on each score sheet: stuttering, articulation disorder, voice disorder, or normal. Three conditions

were presented in which different groups of 20 listeners were asked to select the *one* category that diagnosed the speaker, *all* categories, or *all* categories *rank-ordered* by degree of salience.

A majority of the subjects in the three listening groups did identify the normal speaking controls correctly. The correct identification of pure speech disorders proved problematic for the groups, but not to the extent of the coexisting disorders. On the average, approximately 50% of the subjects in each group correctly identified the speech samples of persons with disorders of articulation, voice, and stuttering. The level of identification remained similar regardless of whether the response options required a single choice, multiple choice, or a rank ordering of choices. The variability present in the identifications of the coexisting disorders suggests that these clinical entities were more problematic for the identification task. There was a very pronounced response bias for listeners to indicate a single disorder, despite the presence of coexisting disorders and multiple response choices for two of the three listening groups. Data reported from this initial study suggest that the perceptual diagnosis of coexisting disorders is a difficult task.

5.2 NSHS DATABASE CONSIDERATIONS

5.2.1 Strengths

The NSHS database is a unique and valuable resource. The data that we have reviewed call into question some of the assumptions speech-language pathologists and audiologists have taken for granted about diagnosis—that is, that most clients can be fit into neat, mutually exclusive categories. It becomes prudent, therefore, to look at the database to find reasons for the unusually high degree of coexistence.

The studies at West Virginia University that we reviewed are rare in the sense that selection of disordered subjects is as nearly random as has been achieved by any large investi-

TABLE 6. Coexistence with other disorders in 10 studies.

| Group | Rate | Percent with deviance | | | | |
		Fluency	Stutter	Artic	Voice	Lang
Clut (RDDN)	*100**	*100**	*0**	67	80	67
Clut (ADDN)	8	*100**	*0**	*100**	63	33
Stut (PS)	8	*100**	*100**	*0**	71	17
Stut (RS)	8	*100**	*100**	67	50	25
Stut (MS)	4	*100**	*100**	67	67	8
Stut (SS)	29	*100**	*100**	96	71	39
Artic (RA)	4	25	4	*100**	63	21
Artic (DA)	8	21	0	*100**	58	54
Voice (MV)	0	8	0	63	*100**	46
Voice (SV)	4	8	4	58	*100**	38

* Starred, italicized figures reflect selection criteria.

gation reported to date. Our disordered groups were obtained from a nationwide testing program. Subject selection was not, *in any way,* influenced by referral lists or case loads. With a few notable exceptions, such as the longitudinal Newcastle Upon Tyne Study (Andrews & Harris, 1964) and the National Collaborative Perinatal Project (NCPP) (Lassman et al., 1980) this is generally not the case. It is possible, therefore, that the subjects in the NSHS groups may not be as severely impaired as those derived from caseloads or referrals (e.g., Cantwell & L. Baker, 1987). Second, it is possible that some of our subjects, particularly those with coexisting disorders, were, or would have been, placed in other diagnostic categories than the categories we randomly selected. In cases where coexisting disorders were identified, we had no way of knowing which disorders were the most salient to the NSHS examiners.

In the recent study of diagnostic identification reviewed herein (St. Louis et al., 1990–1991), the majority of listeners identified the diagnostic categories into which subjects were placed in our investigations only in 50%–65% of the cases with individual speech disorders. The percentages of listener identification are not extremely high, indicating that the perceptual task of identifying speakers with speech disorders was difficult. The accuracy of listener identification was diminished further in those samples exhibiting coexisting speech disorders. The listeners selected these categories less frequently, with correct identification in 35%–50% of the cases.

The NSHS database permits sampling across a wide range of ages, cultural backgrounds, and geographic areas. For example, one study was undertaken that attempted to determine the effects of population density on the prevalence of various speech and hearing variables (St. Louis, Haines, Bebout, Irons-Dotts, & Oliver, 1989). The results of that study showed a rather confusing variety of effects, none large, which do not support the common assumption that rural areas have a higher incidence of comunication disorders than suburban or urban areas.

As noted in Chapter 1, the NSHS database again has been rendered accessible by computer. Therefore, further analyses on specific subject samples can be carried out quickly and efficiently. One of the most valuable aspects of the NSHS database is the fact that audiotapes exist for every subject. With these tapes, verification of NSHS ratings can be achieved and further analyses can be carried out, particularly in the area of language.

5.2.2 Weaknesses

There are also weaknesses in using the NSHS sample. First, it is more than 20 years old. Even though we assume that most relevant aspects of communication have not changed significantly in 2 decades, it is possible that some have. Second, there is no systematic information available on such important variables as subjects' families, socio-economic level, intelligence, academic achievement, health, or history of therapy. All that is provided is their age, school, city, grade, gender, and name.

5.3 IMPLICATIONS OF THE LIKELIHOOD OF COEXISTING DISORDERS

5.3.1 Research

If communication disorders are as likely to coexist as we have suggested in this monograph, the implications for research are both exciting and troubling. By now, the reader has undoubtedly considered the possibility that many, if not most, research investigations about specific disorders (e.g., articulation disorders, language disorders, or stuttering) may be confounded by subjects with other disorders that were unnoticed or ignored. If so, the inferences drawn in these investigations must be extended to clinical populations that are both pure and coexisting. In most cases, it is clear that this was not the authors' intentions. Instead, most researchers have felt comfortable generalizing their results to the study populations in question and have essentially ignored the influence of confounding from other disorders.

From the point of view of stuttering, wherein the past research documenting coexistence of communicative disorders is common, Yairi (1990) writes:

> In spite of the diversity in stuttering manifestations and . . . references to typology in the literature, the overwhelming attitude among experts, especially the researchers, has been to approach stuttering as a pathognomonic monolith. . . . In countless studies and clinical programs aimed at adults and children, subjects were indiscriminately included because they were labeled "stutterers" and assumed to exhibit a single disorder. Ambiguity in the outcome of this work may be the direct effect of a long-term reluctance to consider subgroups. (p. 50)

Rentschler (1984) made essentially the same point and then proceeded to show how "functional" stutterers differed from "organic" stutterers on a number of neuropsychological indices. The same criticism could be leveled against workers in other areas as well. Though sounding a note of support for Yairi's comment, we must in fairness, however, point out that exclusion of subgrouping is not inherently a flawed investigative strategy. If communicative disorders coexist to the extent that we have suggested, then generalizations about the total population, for instance, of stutterers, must include representative samples of the coexisting subgroups, however defined, as well as the pure subgroups. In fact, all of these subjects are included in the disorder in question. The same is true for variations in intelligence, personality, and so on.

On the other hand, given that coexistence is commonplace, inferences about isolated disordered populations are, to an indeterminate extent, erroneous because of the confounding that has occurred. For example, it is probably not clear how much the findings on oral-motor skills of language-disordered individuals are influenced by those subjects who had coexisting articulation disorders (Winitz, 1969). Or, as Nippold (1990) points out, generalizations about stutterers' language abilities are undoubtedly affected by coexisting communicative disorders.

A few specific examples from the literature might be helpful to illustrate the problems that are encountered, once the likelihood of coexisting disorders is embraced. The study by Merits-Patterson and Reed (1981) is a well-designed and well-analyzed study of the effect of language therapy on the disfluencies of language-disordered preschoolers. Two groups of language-disordered children, one in therapy and one that had not received therapy, were compared with a control group having normal language. The group in therapy had significantly more word and part-word repetitions in their speech than the other two groups. Recognizing that the study was limited by the lack of pre-therapy disfluency levels for the group in therapy, the authors concluded, tentatively, "that language therapy may be related to increased disfluencies" (58). They proceeded to suggest two hypotheses for how language therapy might increase disfluencies or the possibility that disfluencies are unrelated to language therapy. Starkweather (1987, 1990) agreed that the study strongly suggests that language therapy, not the presence of a language disorder, increases the risk of stuttering.

We do not take issue with the authors' conclusion but offer another possible interpretation. The selection of children in language therapy may have been unwittingly influenced by the coexistence of disfluencies. Of course, pretherapy assessment would have helped rule out this possibility. The important point here is that the possibility was never considered, presumably because the likelihood of coexisting disorders has not been emphasized, despite being identified rather consistently herein.

A recent survey of speech disorders among college freshmen is also illustrative (Culton, 1986). The investigation involved screening more than 30,500 incoming freshmen over the course of 13 years at a large university. Examiners classified suspected disordered or recovered cases "one of three categories": articulation, voice, and fluency (stuttering). The results of the study were prevalence figures for the three disorder categories. There is absolutely *no* evidence of coexistence in this study, due obviously to the mutually exclusive system by which the students were categorized. Considering other evidence arguing for coexistence in the multitude of studies reviewed here, we must conclude that this study does not find coexisting disorders because its design did not permit them. This does not invalidate the results but indicates again that the perspective of the researcher has a profound effect on the results.

Another troubling issue raised by the likelihood of coexisting communication disorders in substantial subgroups of speech, language, or hearing clients is the number of permutations of disorder groups that emerge; the implications are staggering. For example, should individuals with both voice- and articulation-disordered subject groups be considered separate from either one alone or from voice-artic-ulation-language-involved clients? Aside from the existing special populations, such as cerebral palsy and cleft palate, if we were to consider all the pure and coexisting subgroups of articulation, voice, language, stuttering, and hearing disorders, there would be a very large number of possibilities.

We emphatically do not suggest that each possible subgroup be treated as a separate population. In the first place, there are a host of other important variables to consider, such as severity, type of errors, and duration of the problem. Moreover, there are important influences of intelligence, perceptual and motor skills, and personality. There is no way to subgroup or stratify research samples so that all sources of confounding are eliminated. The best that we can hope for is that the most important sources of error are identified and their effects estimated.

5.3.2 Clinical Considerations

The overall findings suggest two important considerations for the practicing speech-language pathologist or audiologist. First, communication systems are interrelated and must be examined as such because clients may exhibit coexisting speech, language, and hearing disorders. Our investigations used large samples of subjects with communication disorders, and coexistence was substantial in all cases. Speech-language-hearing professionals who provide services to children should be alert to the presence of persons with coexisting communication disorders.

Second, treatment plans for such clients must attend to the various disorders in the most beneficial way. It is possible that a coexisting disorder may be ignored because another appears to have a more negative effect on the communication skills of the individual. For example, a client might present a severe phonological disorder and moderate voice disorder. If the client is unintelligible, treatment might be directed to the phonological component exclusively. Perhaps the child was engaging in vocal abusive behaviors, but treatment was not directed to the problem. Ignoring one coexisting disorder in favor of another might not be in the best interest of the client. In other cases it might be appropriate to monitor and not treat a disorder, while focus is directed to another. This type of case management cannot occur unless the clinician is aware of coexistence and considers the overall communication skills of the client in developing a comprehensive treatment plan. Although we know that most speech-language-hearing professionals are aware of coexisting disorders, we feel that the magnitude of the problem has been underestimated in the past. Our analysis of the NSHS data certainly emphasize the need to be aware of coexisting communication disorders and to consider all coexisting problems in formulating a management plan for a particular client.

5.3.3 Education and Clinical Training

The academic and clinical experiences of students enrolled in speech-language pathology programs are a combination of academic and supervised clinical practice in communication disorders. The organization and provision of such an educational curriculum can generally be divided into speech and language disorders (Aram & Kahmi, 1982). Courses are provided under the various disorder headings

so that a student is exposed to all communication disorders as single entities. For example, the curriculum typically contains individual courses that deal specifically with speech disorders (i.e., articulation, voice, and fluency), whereas other courses are concerned exclusively with language disorders. This dichotomy has also been used in clinic practicum as hours are categorized according to the speech and language designation. The division has been and continues to be useful for the organization and administration of the curriculum. However, the typology does not, in our opinion, adequately address the possibility of coexisting communication disorders.

The literature provided herein and the results of an initial study on the identification of coexistence (St. Louis et al., 1990–1991) suggest that additional attention should be devoted to the knowledge of, and exposure to, coexisting speech, language, and hearing disorders. Coursework and clinical practicum should include this exposure so that students may understand and deal with the population of coexisting communication disorders.

Chapter 6

Future Directions

6.1 RESEARCH NEEDS

This monograph leads us to suspect a substantial incidence of coexisting communication disorders. The only way we can estimate incidence with an appropriate degree of certainty is to conduct epidemiological studies on large, random samples of the population, such as was done in the NSHS, but with refined techniques. These investigations, although expensive and difficult to carry out, should include objective, reliable measures of articulation, voice, language, and hearing but also information on other variables such as cognition, socioeconomic status, birth and developmental history, and psychological adjustment, and families. Cross-sectional studies across a wide age range, beginning as early as the first year of life and sampling various ages up to—and including—adults, should be carried out first. If possible, individuals identified as having disorders could then be studied longitudinally along with randomly selected subsamples of normal subjects for comparative purposes. The cross-sectional component would provide updated estimates of prevalence of pure and coexisting disorders. The longitudinal component would document new onsets and recoveries of all coexisting disorders and thereby generate estimates of incidence. From such data on a large sample of children, profiles of the relative risks of various disorders and the probabilities for the coexistence of various disorders could emerge. If these studies were carried out with careful attention to family histories and testing of relatives, inheritance patterns could be analyzed as well.

Echoing previous work (e.g., Rentschler, 1984; H. D. Schwartz & Conture, 1988), a recent report on research needs in stuttering (J. A. Cooper, 1990b) highlighted the need for research efforts that deal with subtypes of stutterers (Conture, 1990a; J. A. Cooper, 1990a; Ludlow, 1990; D. L. Pauls, 1990; A. Smith, 1990; Starkweather, 1990; Yairi, 1990). Several authors in that report recommended longitudinal research of a large number of *at-risk* individuals such that subtypes postulated *a priori* could be investigated carefully. In addition, careful longitudinal studies at a number of institutions would permit cluster or factor analyses of data to generate *a posteriori* subtypes. Yairi's (1990) excellent description of such a possible study could serve as a prototype for a longitudinal investigation covering all of the common communication disorders in childhood. Similar recommendations were advanced by McNutt and Haymayan (1984) for study of subgroups of articulation-disordered children.

Longitudinal research is singularly difficult to carry out. Maintaining contact and motivation of subjects is extremely time-consuming and frustrating. Inevitably, some subjects are eliminated because of myriad reasons (e.g., moving away, refusing to continue, and missing appoint-

ments). Also, as Templin (1973) points out: the longitudinal investigator is "always out of phase with current interests." When the *zeitgeist* has moved the profession on to other areas of inquiry, the person engaged in longitudinal research must patiently persist in an area wherein interest "has already crested" (66).

Although large, properly designed and analyzed cross-sectional and longitudinal studies would be helpful, a number of other research efforts would be valuable as well and perhaps should precede these major efforts. In order to better estimate the prevalence of coexisting disorders, other databases such as those reported by Templin (1968; 1973), Lassman et al. (1980), Cantwell & L. Baker (1987), and H. D. Schwartz & Conture (1988), could be further analyzed to provide percentages of subjects with various coexisting disorders. The Andrews and Harris (1964) reanalysis of the Newcastle Upon Tyne study provides a case in point. In order to compare across samples, information on socioeconomic level, race, other languages spoken, and developmental landmarks for subjects should be provided. In cases where various judgments were not made in original studies (e.g., voice pitch, loudness, and quality) tape-recorded samples, which are often available, could be reanalyzed to add recoverable data.

In our opinion, future reports of investigations of clinical populations should include consideration of coexisting disorders. In addition to mean or median results for entire groups, results for possible subgroups with coexisting communicative disorders could be presented as well. In many studies, the numbers of subjects in subgroups would be too small to permit inferential statistical analysis; nevertheless, trends could be identified and related to overall effects.

Identification of coexisting disorders in subject samples would undoubtedly sensitize the research community to the potential confounding in many current studies (e.g., Yairi, 1990). Those investigators, then, who wished to infer *only* to the disorder in question would very likely take considerable care in excluding subjects with coexisting speech, language, and hearing problems from their study groups, just as they currently do for low intelligence, neurological impairment, physical problems, and so on. After a few years, it is possible that the practitioner would have a much better handle on generalizations that apply to the disorder in general, including coexisting disorders, versus those that can more safely be assumed to apply only to pure cases of the disorder.

Likewise, it appears reasonable to suggest that researchers consider publishing postscripts to previously published investigations if their raw data provide recoverable information on coexisting communication disorders. These postscripts might take the form of letters to the editor in scientific journals and include percentages of subjects in previous investigations classified according to coexisting disorder subtypes. If available, tabular results for

each group might be provided as well. Finally, differences in interpretation of the results that accrue from this additional information might be provided. In many cases, of course, the conclusions would not change; however, we hasten to point out that this is necessary and valuable information if we are to better understand the influence of coexisting conditions on current knowledge bases relating to the various disorders. On the other hand, a number of authors (e.g., Rentschler, 1984; St. Louis, 1986; St. Louis & Hinzman, 1988) have suggested that subgrouping communication disorder groups on the basis of coexisting disorders may result in different results than those obtained when viewing them as a homogeneous group. Determining the extent to which this is true should become a research priority.

Another example in the area of stuttering will illustrate. Two studies, noted earlier, were designed to assess laryngeal reaction time and other skills of stuttering and nonstuttering children (Cullinan & Springer, 1980; McKnight & Cullinan, 1987). In general, these studies found that stutterers with coexisting articulation, language, and/or learning disorders were significantly inferior to the control group. By contrast, however, the stutterers without coexisting disorders were not significantly different from the nonstutterers. These investigations provide solid evidence that subgrouping stutterers on the basis of coexisting communication disorders is a useful procedure and has the potential to explain past, seemingly conflicting, research results.

Finally, we believe that the time has come to begin to design and conduct clinical treatment studies based on coexisting disorders. At Syracuse University, a joint stuttering and disordered phonology treatment program provides a particularly noteworthy example of needed work in this area (Louko, Conture, & Edwards, 1990; Louko, Edwards, & Conture, 1988; Louko, Wolk, Edwards, & Conture, 1989).

6.2 FUTURE NSHS APPLICATIONS

6.2.1 Computer Database

The original computer tape files are not readily accessible because they were written in an obscure format (SCOPE INTERNAL) on obsolete seven-track tapes. In 1990, however, they were translated to a standard format (unlabeled, nine-track, EBCDIC tape, at 6250 bpi) that can be readily accessed and reproduced electronically. The NSHS data stored on this medium are available for further computerized analyses. Additional information on the computerized database is provided in Appendix D.

6.2.2 Audiotape Library

Audiotapes for all of the subjects in the NSHS database are available as noted. None of the audiotapes was analyzed for the Hull et al. (1976) final grant report. Nevertheless,

as our studies of West Virginia University have illustrated, these tapes are extremely valuable, each containing the articulation test, spontaneous speech-language samples, four prolonged vowels (in most cases), and four imitated sentences for every NSHS subject. The tapes allow investigators to conduct language analyses on spontaneous language samples and to verify the original NSHS judgments for articulation, voice, dialect, fluency, rate, and overall adequacy. As noted earlier, the tapes are high-fidelity recordings made on quality tape recorders. To date, all of the tapes we have analyzed are of good to excellent quality, despite the years lapsed since the NSHS was carried out.

To our knowledge, no other tape library of speech and language characteristics of nearly 39,000 randomly selected subjects exists. For this reason, maintaining the tapes in good condition is a priority. We also wish to make them available to other interested investigators. If investigators wish to utilize the tapes, arrangements can be made to allow the person(s) to reproduce selected samples for analysis.

6.2.3 Possible Research Projects

Following is a list of research projects that we believe would be useful and could be carried out using the NSHS computer database and/or audiotape library.
A. Language
   1. Development of a variety of morphological and syntactic structures in older children and adolescents.
   2. Regional and/or dialectic variations in linguistic skills and patterns.
   3. Comparison of children's and adolescents' use of slang in 1968–1969 with current usage.
B. Articulation
   1. Descriptive analysis of articulation errors in older populations, e.g., erred sounds and types of errors.
   2. Changes—or lack of changes—in error patterns over time as function of type of articulation error. For example, do errors progress from omissions to substitutions to distortions?
   3. Changes in phonological processes over time. (The Goldman-Fristoe [1968] test responses can easily be converted to phonological process data, using the Khan-Lewis [1986] protocol.)
   4. The relationship of suprasegmental features (e.g., intonation, stress, and juncture) to articulation disorders. Suprasegmental differences in the population might be related to prognosis for improvement of misarticulations. That is, subgroups may permit better definition and identification of high-risk groups for treatment. Spectographic analysis of selected tapes may assist in these suprasegmental studies.
   5. Comparisons of articulatory errors and dialectic phonological variations in Black English versus Standard English.
C. Voice
   1. Normative studies over a wide age range on such vocal measures as fundamental frequency ranges

and pitch perturbation. The audiotaped data could be searched for criterion samples for acoustic analysis by computer assisted instruments.

D. Fluency
  1. Normative studies of rate over a wide age range.
  2. Normative studies of disfluency types over a wide age range.

E. Hearing
  1. Determination of whether or not hearing loss prevalence shows significant regional differences.
  2. Determination of whether hearing loss prevalence varies according to the urban, suburban, or rural character of the school district.
  3. Analysis of the number and type of phonemes misarticulated as a function of children's hearing ability.
  4. Examination of the factors underlying judgments of voice deviance in children with decreased hearing.
  5. Analysis of audiotapes to evaluate language development in children with slight, mild, and moderate hearing impairment.

Acknowledgments

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Appendix A

List of NSHS Test Sites*

100 sampling points from which data for the National Speech and Hearing Survey were collected (1968–1969).

1. Birmingham, AL	51. Troy, MO
2. Cullman, AL	52. Sidney, MT
3. Tuscaloosa, AL	53. Omaha, NB
4. Phoenix, AZ	54. Las Vegas, NV
5. Magnolia, AR	55. Reno, NV
6. Pine Bluff, AR	56. Cresskill, NJ
7. Anaheim, CA	57. Lakewood, NJ
8. Campbell, CA	58. Madison (Old Bridge) NJ
9. Dos Palos, CA	59. Buffalo, NY
10. Edwards, CA	60. Burnt Hills, NY
11. Fresno, CA	61. Cohoes, NY
12. Los Angeles, CA	62. Monroe, NY
13. Monterrey, CA	63. New City, NY
14. Paramount, CA	64. New York, NY
15. San Francisco, CA	65. New York, NY
16. Simi, CA	66. Niagra Falls, NY
17. Denver, CO	67. Ashville, NC
18. Branford, CT	68. Durham, NC
19. Colchester, CT	69. Gastonia, NC
20. Manchester, CT	70. Greensboro, NC
21. Shelton, CT	71. Centerville, OH
22. Washington, DC	72. Cleveland, OH
23. Gainsville, FL	73. Genoa, OH
24. Jacksonville, FL	74. Lakewood, OH
25. St. Petersburg, FL	75. Parma, OH
26. Columbus, GA	76. Heppner, OR
27. Newnan, GA	77. Oregon City, OR
28. Chicago, IL	78. Conemaugh, PA
29. Elmhurst, IL	79. Media, PA
30. Jerseyville, IL	80. Philadelphia, PA
31. Marissa, IL	81. Uniontown, PA
32. Rockford, IL	82. Cayce, SC
33. Battleground, IN	83. Spartanburg, SC
34. Indianapolis, IN	84. Huron, SD
35. Marshalltown, IA	85. Rapid City, SD
36. Arkansas City, KS	86. Winner, SD
37. Boone, KY	87. Johnson City, TN
38. Alexandria, LA	88. Brownsfield, TX
39. New Orleans, LA	89. Dallas, TX
40. Baltimore, MD	90. Karnes City, TX
41. North Brookfield, MA	91. Laporte, TX
42. Benton Harbor, MI	92. Longview, TX
43. Gobles, MI	93. San Antonio, TX
44. Livonia, MI	94. Winchester, VA
45. Scottville, MI	95. Parkersburg, WV
46. Wayne County (Detroit) MI	96. Point Pleasant, WV
47. Mound, MN	97. Spokane, WA
48. Clarksdale, MS	98. Belleville, WI
49. Jackson, MS	99. Milwaukee, WI
50. Ripley, MS	100. Oak Creek, WI

* *From Hull et al. (1976) p. 18.*

Appendix B

Stimulus Materials Used in NSHS Speech Testing*

Picture Story Stimulus Cards

Picture cards were used to stimulate subjects in Grades 1–9 to tell a story. The purpose was to evoke connected speech. The nature of the picture cards and thus, the characteristics of the connected speech pattern produced varied answers from one grade group to another.

Grades 1–3. Stimulus cards of the Goldman-Fristoe Sounds-in-Sentences Subtest of the articulation test were used for grades 1, 2, and 3. There are two sets of four-card stories in the subtest.

> Story I: *A Bad Night for Jerry*
> Story II: *Jack and Ricky*

The subjects were stimulated with the story cards according to the instructions in the Goldman-Fristoe Test of Articulation. Only one story was presented to each subject.

Grades 4–6. Two "sets" of pictures were used to evoke connected speech from this group of subjects. All subjects were stimulated with both "sets." One was a single picture and the subject was asked to "make up a story" about the picture.

The second set consisted of a two-picture sequence and the subject was asked to "make up a story" about the two pictures.

Grades 7–9. Two "sets" of pictures were used to evoke connected speech from these subjects. The first was the same picture used for the 4–6 grade group.

The second set consisted of a sequence of eight pictures. The subject was asked to make up a story about the sequence.

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* From Hull et al. (1976), pp. 153–155.

Discussion Topics

All subjects in each of the 12 grades were asked to discuss specific topics. The nature of the topics varied from grade level to grade level but within a grade-level group the evaluator attempted to discuss the same topic.

Grades 1–6

1. Discussion of subject's family.
2. Discussion of subject's favorite TV programs.

Grades 7–9

1. Discussion of subject's family.
2. Age when person should be qualified to have a driver's license.
3. Subject asked to give directions for walking from school to his home.

Grades 10–12

1. Discussion of subject's plans after he had finished high school.
2. Subject's opinion about the legal voting age—18 or 21 years. (At the time of the screening, the legal voting age was 21 years.)

Sentence Repetition

Each subject repeated four sentences when stimulated verbally.

1. My papers and pencils are in the desk.
2. Larry brought his ball and bat to the game.
3. Do you like to drink out of paper cups?
4. Mary ran when she heard the school bell ring.

Appendix C
Sample NSHS Data Sheet
NATIONAL SPEECH AND HEARING SURVEY
Colorado State University*

Name _____

City _____

State _____

S.N. [____]

Sex: [____]
Age: [____]

Grade: [____]

CODE: [1]

Date: [____]

Absent: [____]

Census District [____]
School District [____]
Team Number [____]

Left Ear W/O Masking

4K	.5K	2K	3K	1K

22 [____] [____] [____] [____] [____]

Right Ear W/O Masking

4K	.5K	2K	3K	1K

32 [____] [____] [____] [____] [____]

Ear Masked

4K	.5K	2K	3K	1K

43 [____] [____] [____] [____] [____]

Reliability
Environment
Child's Behavior
Physical Deformity
Evaluator

[____]

58 Articulation [____]
61 Stuttering [____]
64 Voice [____]
67 Quality [____]

Dialect [____]
Rate [____]
Pitch [____]
Overall [____]

Reliability [____]
Fluency [____]
Loudness [____]
Evaluator [____]

1-h	2-s	3-t	4-f	5-k	6-p	7-g	8-n	9-n	10-f	11-w	12-d

8

13-g	14-hw	15-k	16-z	17-p	18-s	19-z	20-z	21-d	22-k	23-y	24-l

20

25-v	26-m	27-ch	28-l	29-sh	30-v	31-r	32-r	33-b	34-f	35-sh	36-ch

32

37-ch	38-th	39-p	40-s	41-th	42-r	43-t	44-j	45-th	46-t	47-b	48-b

44

49-th	50-th	51-ng	52-ng	53-j	54-j	55-pl	56-bl	57-br	58-sh	59-dr	60-m

56

61-fl	62-g	63-n	64-kl	65-kr	66-m	67-tr	68-skw	69-l	70-sl	71-d	72-st

68

73-v

80

* From Hull et al. (1976), p. 158.

NATIONAL SPEECH AND HEARING SURVEY
Colorado State University*

CODE: 2

Name _____

City _____

State _____

S.N.

Sex:
Age:

Grade:

Date:

Absent:

Census District
School District
Team Number

Right Ear W/O Masking

3K	1K	2K	.5K	4K

Left Ear W/O Masking

3K	1K	2K	.5K	4K

Ear Masked

3K	1K	2K	.5K	4K

Reliability
Environment
Child's Behavior
Physical Deformity
Evaluator

Articulation
Stuttering
Voice
Quality

Dialect
Rate
Pitch
Overall

Reliability
Fluency
Loudness
Evaluator

1-h	2-s	3-t	4-f	5-k	6-p	7-g	8-n	9-n	10-f	11-w	12-d

13-g	14-hw	15-k	16-z	17-p	18-s	19-z	20-z	21-d	22-k	23-y	24-l

25-v	26-m	27-ch	28-l	29-sh	30-v	31-r	32-r	33-b	34-f	35-sh	36-ch

37-ch	38-th	39-p	40-s	41-th	42-r	43-t	44-j	45-th	46-t	47-b	48-b

49-th	50-th	51-ng	52-ng	53-j	54-j	55-pl	56-bl	57-br	58-sh	59-dr	60-m

61-fl	62-g	63-n	64-kl	65-kr	66-m	67-tr	68-skw	69-l	70-sl	71-d	72-st

73-v

* From Hull et al. (1976), p. 159.

Appendix D

Variables Recorded on Each NSHS Data Sheet and Computerized Codes

The NSHS database, consisting of the information recorded on data sheets like those shown in Appendix C, has been computerized and stored in two different formats. One is an EBCDIC text file providing, in essence, an electronic image of the computer cards on which the data were originally keypunched. Each record in the file contains the data for one subject in the NSHS sample. The record is 160 bytes (i.e., characters) long, which corresponds to the two, 80-column computer cards that originally contained each subject's data. Variables are identified by their position (i.e., column) in the record. The key for identifying and retrieving a specific variable value according to its position in the record is given in the last column of Table D1. For instance, the subject's sex is coded by the sixteenth character in the record, the next three characters give his/her age in months, etc.

In order to facilitate analysis, the NSHS database has also been stored as a SAS data set. All data are saved as 2-byte, integer variables, except for the date of testing, which is stored in the SAS "MMDDYY6." format. Variable names, stored with the data, are shown in the first column of Table D1.

Variable values are specified in the second column of Table D1, and a brief explanation of the information coded by a given value is provided in the third column. Chapter 1 contains more detailed information on the coding protocols.

Most of Table D1 is self-explanatory. However, the method for presenting hearing thresholds and phoneme articulation scores warrants further explanation.

In order to avoid order effects in the measurement of hearing thresholds, the sequence in which ears and frequencies were tested was counterbalanced according to two different schedules. These are shown on the two data sheets in Appendix C. The value of the CODE variable specifies which of the two sequences was employed for a given subject. Hearing threshold information, listed in Table D1 as "first threshold," "second threshold," etc., may be interpreted by first noting the CODE value for an individual, and then referring to the appropriate data sheet in Appendix C.

The array of variables listed as P1-P73 in the table represent scores for subjects' articulation of the 73 phonemes tested in the NSHS. The data sheets in Appendix C provide the key for determining which phoneme is referenced by a variable value. For instance, P1 gives the score for articulation of /h/, P2 corresponds to /s/, etc.

TABLE D1. Computer storage of NSHS data in SAS and text file formats.

SAS variable name	Variable values	Interpretation	Text column(s)
Code	1 =	form 1 sequence of data collection.	1
	2 =	form 2 sequence of data collection.	
Date	MMDDYY =	month/day/year of testing.	2–7
Absent	0 =	present for testing.	8
	1 =	absent–not tested.	
Census	1–9 =	U.S. Census district.	9
School	00–99 =	identification code for each school.	10–11
Team	1–6 =	identification code for each team.	12
Subject	001–999 =	identification code for each subject.	13–15
Sex	0 =	male.	16
	1 =	female.	
Age	mmm =	age in months.	17–19
Grade	01–12 =	grade in school.	20–21
T1	00–99* =	first hearing threshold in dB HL.	22–23
T2	00–99 =	second hearing threshold in dB HL.	24–25
T3	00–99 =	third hearing threshold in dB HL.	26–27
T4	00–99 =	fourth hearing threshold in dB HL.	28–29
T5	00–99 =	fifth hearing threshold in dB HL.	30–31
T6	00–99 =	sixth hearing threshold in dB HL.	32–33
T7	00–99 =	seventh hearing threshold in dB HL.	34–35
T8	00–99 =	eighth hearing threshold in dB HL.	36–37
T9	00–99 =	ninth hearing threshold in dB HL.	38–39
T10	00–99 =	tenth hearing threshold in dB HL.	40–41
Masked	0 =	no masking used.	42
	1 =	left ear tested while masking right.	
	2 =	right ear tested while masking left.	
M1	00–99 =	first masked threshold in dB HL.	43–44
M2	00–99 =	second masked threshold in dB HL.	45–46
M3	00–99 =	third masked threshold in dB HL.	47–48
M4	00–99 =	fourth masked threshold in dB HL.	49–50
M5	00–99 =	fifth masked threshold in dB HL.	51–52
Hrely	0 =	hearing results judged to be reliable.	53
	1 =	hearing results judged to be unreliable.	
Environ	0 =	acceptable test environment.	54
	1 =	unacceptable test environment.	
Behav	0 =	child's behavior was acceptable.	55
	1 =	child's behavior was unacceptable.	
Deform	0 =	no visible deformity.	56
	1 =	deformity was visible.	
Hevltr	1–3 =	hearing evaluator's identification.	57
Artic	0 =	no articulation deviation.	58
	1 =	mild to moderate articulation deviation.	
	2 =	severe articulation deviation.	
Dialect	0 =	no dialect.	59
	1 =	deviates from AGA dialect.	
Srely	0 =	speech results judged to be reliable.	60
	1 =	speech results judged to be unreliable.	
Stut	0 =	stuttering is absent.	61
	1 =	stuttering is present.	
Rate	0 =	normal speaking rate.	62
	1 =	abnormal speaking rate.	
Fluncy	0 =	normal fluency.	63
	1 =	abnormal fluency.	
Voice	0 =	no voice deviance.	64
	1 =	mild to moderate voice deviance.	
	2 =	severe voice deviance.	
Pitch	0 =	normal vocal pitch.	65
	1 =	abnormally high or low pitched voice.	
Loud	0 =	normal vocal loudness.	66
	1 =	abnormally loud or soft voice.	
Qual	0 =	normal voice resonance/quality.	67
	1 =	hypernasal or hyponasal.	
	2 =	breathiness.	
	3 =	hoarseness.	
Overall	0 =	no deviance of overall speech adequacy.	68
	1 =	mild deviance of overall speech adequacy.	
	2 =	moderate deviance of overall speech adequacy.	
	3 =	severe speech deviance.	
Sevltr	1–3 =	speech evaluator's identification.	69
Aerr1	0–73 =	number of nonstimulable articulation errors.	75–76
Aerr2	0–73 =	number of stimulable articulation errors.	77–78
Aerrtot	0–73 =	total number of articulation errors.	79–80
P1–P73	0 =	phoneme produced correctly.	88–160
	1 =	nonstimulable error.	
	2 =	stimulable error.	

* No response by the subject is coded as 99 dB HL.

Appendix E

Percentages of NSHS subjects scored for combinations of articulation, voice, and stuttering

NSHS Rating*			% Prevalence TOTAL NSHS N = 38,802	Stuttering				Articulation			Voice		
Artic-ulation	Voice	Stut-tering		NSHS % Total stutterers~ N = 320	% RS N = 24	% MS N = 24	% SS N = 24	NSHS % Total articulation deviance~ N = 13,038	% RA N = 24	% DA N = 24	NSHS % Total voice deviance~ N = 19,376	% MV N = 24	% SV N = 24
0	0	1	0.116	(14.1)	13	0	0	—	—	—	—	—	—
0	1	1	0.201	(24.4)	17	29	0	—	—	—	(0.4)	0	0+
0	2	1	0.026	(3.1)	4	4	4	—	—	—	(0.1)	0+	0
1	0	1	0.157	(19.1)	33	33	21	(0.5)	4	0+	—	—	—
2	0	1	0.021	(2.5)	4	0	8	(0.1)	0+	0	—	—	—
1	1	1	0.219	(26.6)	17	29	29	(0.7)	0	0+	(0.4)	0	0+
1	2	1	0.039	(4.7)	4	4	21	(0.1)	0	0+	(0.1)	0+	4
2	1	1	0.028	(3.4)	8	0	13	(0.1)	0+	0	(0.1)	0	0+
2	2	1	0.016	(1.9)	0	0	4	(0.0)	0+	0	(0.0)	0+	0
0	1	0	28.937	—	—	—	—	—	—	—	(57.9)	38	0+
0	2	0	1.307	—	—	—	—	—	—	—	(2.6)	0+	42
1	0	0	13.419	—	—	—	—	(39.9)	21	0+	—	—	—
2	0	0	0.598	—	—	—	—	(1.8)	0+	25	—	—	—
1	1	0	16.293	—	—	—	—	(48.5)	63	0+	(32.6)	63	0+
1	2	0	1.430	—	—	—	—	(4.3)	13	0+	(2.9)	0+	25
2	1	0	1.041	—	—	—	—	(3.1)	0+	54	(2.1)	0	0+
2	2	0	0.266	—	—	—	—	(0.8)	0+	21	(0.5)	0+	29

* Includes subjects scored as "mild, moderate, or severe" overall.

~ Does not total 100% of articulation, voice, and stuttering because a few subjects (≤0.3%) were scored with disorders but "normal" overall.

+ Could not be selected because of sampling criteria.