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Self-Monitoring and Generalization in Preschool Speech-Delayed Children

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Self-monitoring and generalization were observed as eight preschool children progressed in management programs for their developmental phonological disorders. Changes in the production of target and non-target sounds and behaviors presumed to reflect self-monitoring were tallied as they occurred concurrently in conversational speech samples. With some notable exceptions, generalization data for target and non-target sound changes were consistent with linguistic patterns reported in the literature. Self-monitoring behaviors were observed to vary in type, frequency, and point of onset in relation to generalization data. A consistent observation across children was that self-monitoring behaviors neither always nor only occurred in temporal association with generalization. Alternative hypotheses concerning the occurrence of self-monitoring behaviors in stimulus and response generalization are considered.

KEY WORDS: Self-monitoring, generalization, phonology, management

The impetus for this paper was a finding from a recent retrospective study of the efficacy of speech intervention strategies (Shriberg & Kwiatkowski, 1987). Among four strategies incorporated in 17 types of experimental management programs for young children with phonological disorders of unknown origin (*auditory bombardment, auditory discrimination, minimal contrasts,* and *self-monitoring*), *self-monitoring* was the only strategy found to be significantly associated with stimulus generalization. It seemed useful to follow up this large group retrospective finding with more recent case study data from individual children receiving speech management services in our phonology clinic.

Self-Monitoring and Generalization

Variants of the construct of self-monitoring are evident in the diverse theoretical views underlying generalization programming in communicative disorders. For example, behaviorally oriented generalization approaches have reinforced self-reporting of correct responses using hand raising (Engel & Groth, 1976), charting procedures (Diedrich, 1971; Kern Koegel, Koegel, & Costello Ingham, 1986), and counting devices both within and outside the clinic setting (Johnson & Johnson, 1972; Koegel, Kern Koegel, Van Voy, & Costello Ingham, 1988). Articulatory control approaches have emphasized cognitive processes and the use of proprioceptive and tactile cues for speech motor planning early in response acquisition (Ruscello & Shelton, 1979). Cognitive-linguistic approaches have focused on prompting self-correction in pragmatically valid contexts when the listener signals misunderstanding (Hagood & Dunn, 1985; Leach, 1984; Weiner & Ostrowski, 1979). Each of these and other theoretical views (see recent discussions by Connell, 1988; Fey, 1988; Johnston, 1988; Kamhi, 1988; Warren, 1988) posit differing intervening constructs and processes to explain both the consistency of findings across subjects (e.g., Weaver-Spurlock & Brasseur, 1988; Wolf, Blocker, & Prater, 1988) and the well-documented individual differences in patterns and rates of generalization (e.g., Costello & Bosler, 1976; Costello & Onstine, 1976; Elbert & McReynolds, 1975, 1978, 1985; Elbert, Shelton, & Arndt, 1967; McReynolds & Bennett, 1972; McReynolds & Elbert, 1981; McReynolds & Jetzke, 1986; Olswang & Bain, 1985a; Rockman & Elbert, 1984). More recently, a child's productive knowledge of the sound system has been proposed to account for significant individual differences in children's patterns and rates of generalization (e.g., Elbert, Dinnsen, & Powell, 1984; Gierut, 1985; Williams, 1988).

Viewed in relation to contemporary accounts of normal and disordered speech acquisition, self-monitoring processes are assumed to involve some level of "linguistic, metalinguistic, and motoric proficiency" (Hagood & Dunn, 1985). That is, self-monitoring would seem to require that the child have a linguistic representation of the intended form, have the metalinguistic awareness to detect when features of a surface form differ significantly from those expected in the ambient community, and have the articulatory ability to produce the correctly revised form. It is unclear, however, whether the metalinguistic awareness

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needed to make comparisons between intended and produced forms for self-monitoring strategies is available to preschool children. A position advanced by Liberman (1973) suggests that the ability to segment words and syllables into phonemes begins to develop only after age 5. An alternative position appearing in the same year as the Liberman paper, however, reported some success in training children as young as 3 years old to identify a phoneme in the initial position of words (Zhurova, 1973). In the one and one-half decades since publication of these papers almost all of the clinical reports and notes on the efficacy of self-monitoring have dealt with school-aged children. And in the one retrospective clinical study that included preschool children (lowest age, 4 years, 2 months) self-monitoring was statistically associated with stimulus generalization only for children no younger than 5 years old (Shriberg & Kwiatkowski, 1987).

Several sources of evidence in the developmental literature suggest that the metalinguistic awareness required for self-monitoring may be available to young children. Children as young as 2 years old have demonstrated phonetic repairs both spontaneously (Clark & Andersen, 1979) and in response to requests for clarification in communication contexts (Gallagher, 1977). Although these revision behaviors do not represent explicit, metalinguistic manipulation of phonological segments (van Kleeck, 1982; Hakes, 1982), they do reflect awareness of speech sounds at some level. Metalinguistic awareness, according to some researchers, develops gradually and thus might range from vague and inexplicit responses to internal and external feedback, to explicit and conscious reflections on language forms (Clark, 1978; Levelt, Sinclair, & Jarvella, 1978; Saywitz & Cherry Wilkinson, 1982). Such a developmental perspective would support the clinical potential to train young speech-disordered children from inexplicit awareness to explicit self-monitoring for corrective control.

The following case study data address associations among speech-sound generalization and behaviors judged to reflect self-monitoring in eight preschool children who were being seen for management of their speech disorders of unknown origin. The measurement procedures attempted to describe the occurrences of sound change and self-monitoring behaviors during spontaneous continuous speech and to determine if events in the two domains were temporally associated. Data were gathered both retrospectively (Study I) and prospectively (Study II), with the general goal of identifying potential directions for controlled studies of self-monitoring strategies for preschool children with delayed speech development.

METHOD

Subjects

Table 1 includes a description of the eight subjects. The five girls and three boys ranged in age from 3:8 to 5:7. Child 3 and Child 4 were identical twins. Only Child 1 had had prior speech therapy. Severity of speech involvement, as assessed by Percentage of Consonants Correct (PCC) (Shriberg & Kwiatkowski, 1982c), ranged from 50%–78%, with approximately half of the children considered mild-moderate and half moderate-severe on the basis of PCC scores only (c.f., Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986).

The remaining columns in Table 1 include relevant categories and descriptive data from a six-category diagnostic classification system (Shriberg et al., 1986; Shriberg & Kwiatkowski, 1982a). As shown in Table 1, six of the children had marginal (less than six episodes) to significant (more than six episodes) histories of recurrent otitis media with effusion (OME). Of these children, two reportedly had

TABLE 1. Demographic and relevant descriptive data from a diagnostic classification system (Shriberg & Kwiatkowski, 1982a) for the eight children.

						DCS Causal Correlate Categories			
						Mechanism: Hearing		*Cognitive Linguistic: Production*	*Psychosocial Behaviors*
Child[a]	*Study*	*Gender*	*Age yrs.;mos.*	*PCC*	*Severity*[d]	*Positive OME History*	*Fluctuant Hearing Loss*	*Syntax Delay*	*Expressed Concerns*
1[b]	I	M	3;10	65	MM	X		X	
2	I	M	4;4	54	MS	X		X	
3[c]	I	F	4;9	78	MM	X	X	X	
4[c]	I	F	4;9	68	MM	X		X	
5	II	F	3;8	66	MM			X	
6	II	F	4;4	61	MS			X	X
7	II	M	4;8	65	MM	X		X	
8	II	F	5;7	50	MS	X	X	X	X

[a]Data for children 1–4 were assembled retrospectively; data for children 5–8 were obtained prospectively.
[b]Had prior therapy.
[c]Twins.
[d]Severity adjectives correspond to Percentage of Consonants.
Correct values (Shriberg & Kwiatkowski, 1982b): MM = Mild-Moderate; MS = Moderate-Severe.

reduced hearing concurrent with OME. Only Child 8's hearing fluctuated somewhat throughout the study, with pure tone averages for 500, 1K and 2K Hz ranging from 0 to 20 dB HL, as assessed by weekly pure-tone testing before each management session. None of the children had structural or functional deviations of the speech mechanism. All were within normal limits for language comprehension as measured by the Peabody Picture Vocabulary Test, Form M (Dunn & Dunn, 1981) and the Preschool Language Test (Zimmerman, Steiner, & Pond, 1979). All children demonstrated a 6-month to 1 year delay in the production of syntactic forms (Miller, 1981). Although most of the children were described as normal for psychosocial development, the parents of Child 6 and Child 8 expressed concern about manipulative and noncompliant behaviors. Such individual differences in etiologic correlates typify children with speech disorders of unknown origin and later will be invoked in discussion of findings.

Additional information on each child's production of consonants in conversational speech probes administered prior to treatment is presented in the Appendix. Errors were primarily on velars, fricatives, affricates, and liquids, in both singletons and clusters.

Training Programs

Children were seen in 50-minute intervention sessions,

TABLE 2. Linguistic tasks and self-monitoring tasks included in the treatment program.

Step	*Number of sessions per step Study I*	*Study II*	*Linguistic task*	*Self-monitoring task*
1	8	4	Child produces sound in words imitatively and spontaneously and at the end of carrier phrases spontaneously (List 1, List 2: 5 pictured words per list)	None
2A	~	4	a. Child produces sound at end and embedded in carrier phrases spontaneously (List 3, List 4: 5 pictured words per list)	Recognition. The clinician identifies four non-target words that contain the target when she produces each for the first time during spontaneous verbalization that preceeds the carrier phrase task. The child spontaneously imitates this behavior.
			b. Child produces sound in 4 different phrases in the context of a play routine (words and phrases vary dependent on activity) following imitative drill of the phrases.	
2B[a]		2	Same play routines as 2A	Recognition. Same as 2A, during spontaneous verbalization that preceded the drill for the first 4 phrase play routine.
				Elicited Self-correction. During the second 4 phrase play routine, the clinician signals an error by saying "I don't know what you said." The child responds by immediately correcting the error.
3[a]		5	Same as 2B	Elicited Self-correction. Same as 2B during the first 4 phrase play routine.
				Self-evaluation. During the second 4 phrase play routine, the clincian signals the child to evaluate response accuracy by saying "Do I know what you said?" The child responds "Yes" if the response was judged correct and "No" if the response was judged incorrect.
4A[a]		4	Child produces sound in spontaneous speech during a variety of activities.	Spontaneous Self-correction. The clinician indicates that all immediately correct and self-corrected responses will be reinforced during the activity. The child spontaneously, immediately corrects all errors.
4B[a]		~	Same as 4A	Spontaneous Self-correction. Same as 4A but now the clinician indicates that correct and self-corrected responses will earn extrinsic reinforcement.

~ = Variable.
[a] = Children 5–8 only.

twice weekly for approximately one academic semester. All sessions were conducted by two master's level student clinicians who were trained in the treatment program.

The treatment program[1], as summarized in Table 2, included tasks for training speech targets at increasingly more complex linguistic levels (beginning with Step 1) and tasks that were assumed to require monitoring of speech sounds (beginning with Step 2). *Recognition* was trained indirectly through clinician modelling of the behavior, while training for *Self-evaluation* and *Self-correction* involved direct practice within one of the several activities included during each treatment session. All training was conducted within the context of meaningful preschool activities such as games, role play, daily routines, and construction activities. The treatment programs for children 5–8 (Study II) differed in two ways from the treatment programs for children 1–4 (Study I). For these later four subjects, whose case study data were obtained prospectively, Steps 2B, 3, and 4 were added to their programs (see Table 2). Because children moved through the steps on a predetermined time schedule during the semester, children 5–8 spent less average time at each step of their four-step program.

The entry requirement for the management program in Table 2 was the ability to produce the target(s) at the imitative word level. When necessary, standard drills were used to shape the required word-level production. Progress in the treatment program was monitored via conversational speech probes. Treatment was terminated when the trained sound was 50% correct or better during two successive conversational speech probes (cf. Olswang & Bain, 1985b).

Speech targets. The three criteria for target sound selection were: (a) 0% to 15% correct production in baseline spontaneous, conversational speech probes, (b) 0% correct production on a five-word spontaneous word- and phrase-level probe, and, (c) documented stimulability at the isolated sound level or better when provided with an auditory model. A total of nine different sounds were included in at least one of the eight training programs. Children 1–4 were trained on two sounds concurrently, with half of each session allocated for each sound. Children 5–8 also worked on two sounds, but sounds were trained in sequence with training on a second sound initiated only after the termination criterion was met for the first sound. For the serial training programs, the second target sound was selected from a different manner class than the first target. Targets included word-initial /k/, /f/, /s/, /sp/, /st/, /sk/, and /l/ and word-final /s/ and /k/.

Procedures

Speech production. Conversational speech probes were obtained in alternate sessions from children 1–4 and at the beginning of each session for children 5–8. A posttreatment maintenance probe was obtained from all subjects one-to-three months after termination of treatment. All probes involved a spontaneous, 5-minute conversational interchange, with the clinician manipulating topics as needed to obtain a minimum of four word types for all current targets. All probes were tape recorded using Marantz PMD201 audio-cassette recorders with matching condenser microphones and high quality audio-cassette tapes. Microphone to lip distance was maintained at approximately 15 cm.

To monitor child progress after each session, the clinicians routinely listened to the audio tapes and transcribed words that contained the target sound(s). Data obtained from the conversational speech probes were judged to accurately reflect the child's current speech production in other environments, based on observation of the child's production outside the treatment room and parent report (see also Olswang & Bain, 1985a).

For purposes of the current study, the following retrospective conversational speech probes were transcribed by one of the authors (JK) using a Dictaphone 2550 transcriber and a system for narrow phonetic transcription (Shriberg, 1986; Shriberg & Kent, 1982): (a) baseline probes that preceded work on each target, (b) all probes administered prior to the onset of each new step in the treatment program (the number of probes per target varied because not all sounds were trained at all steps), (c) each probe in which at least 30% correct production of a trained sound was first obtained, (d) each probe in which the termination criterion of at least 50% correct in two consecutive spontaneous conversational probes was met, and (e) all posttreatment maintenance probes. All speech samples for a single child were transcribed in a randomized order within a 1-week period. Later, additional samples were transcribed for some children to clarify trends in children's resolution of errors. For the initial baseline probes, percentage correct values were determined for all consonants in singletons and clusters in all positions. For subsequent probes, percentage correct values were determined only for consonants that were incorrect in baseline. Only one token of each lexical type was counted when production was consistently correct or incorrect. Two tokens of each lexical type were counted to sample both the correct and incorrect forms when production was variable.

Self-monitoring behaviors. The seven speech behaviors described in Table 3 are presumed to reflect differing levels of awareness of speech sounds subsumed by the term *self-monitoring*. The behaviors in Table 3 were selected because they had been observed to occur sporadically in the course of intervention programming with speech-disordered children in our clinic. Moreover, some forms of the behaviors termed *Pre-planning, Self-evaluation*, and *Self-correction* have also been reported in the clinical literature on revisions and self-monitoring (e.g., Kern, Koegel, & Costello Ingham, 1986; Ruscello & Shelton, 1979).

Sources for observing the occurrence of these self-monitoring behaviors included their occurrence in treat-

[1]The complete management program is available by writing to the authors.

TABLE 3. Description of seven speech behaviors presumed to reflect the construct of *self-monitoring.*

Behavior	*Description*
Overgeneralization	Substitution of the target for the replacement sound or for other sounds in any word position.
Recognition	Unsolicited identification of a word containing the target in the child's own speech or in the speech of others.
Preplanning	Extending the duration of any sound or pausing prior to producing a word with the target sound.
Self-evaluation	Immediate evaluation of the correctness of target production when the clinician solicited evaluation with the question "Do you think I know what you said?"
Elicited Self-Correction	Correction of any sound when the clinician directly signalled an error with the comment "I don't know what you said."
Prompted Self-Correction	Correction of any sound when the clinician unintentionally signalled an error when commenting or glossing the child's utterance.
Spontaneous Self-Correction	Correction of any sound that was neither elicited nor prompted.

ment data, in conversational speech probes, and in special diary reports kept by parents of children 5–8. Not all behaviors could be observed in all contexts or for all targets. As shown in Table 2, children 1–4 were trained only on the *Recognition* tasks. Among the other four children, training on self-monitoring tasks was not initiated if termination criteria for the sound was met prior to reaching that program step. Data on the occurrence of *Overgeneralization, Recognition, Pre-planning, Prompted Self-correction,* and *Spontaneous Self-correction* on both trained and untrained error sounds were available from conversational speech probes. The conversational speech probes were the primary source for self-monitoring data. Behaviors reported on trained sounds in the diary reports included *Overgeneralization, Recognition,* and *Spontaneous Self-correction.* Diary reports were initiated beginning with Step 2 of the treatment program and continued until the termination criterion was met. Parents were asked to listen for the occurrence of the selected self-monitoring behaviors during a predetermined half-hour period four times per week, when the child was engaged in spontaneous verbalization in the context of play or a daily routine. All observations and recording of behaviors were to be inconspicuous. Whenever a parent returned a completed diary form, the clinician privately interviewed her to check the accuracy of interpretation of the child's behavior. During the interview the clinician obtained sufficient information about (a) the observed behavior, (b) the situation in which the behavior occurred, and (c) events that preceded the observed behavior so that she could independently judge whether the behavior qualified as self-monitoring. Only diary reports that were supported by clinician judgment were included in the data.

Reliability

The average point-to-point interjudge agreement for correct-incorrect scoring of trained sounds between the transcriber and the two clinicians, including all data points in Figure 1, was 98.6%. The average point-to-point intrajudge agreement was 98.2%, based on one randomly selected sample from each of the eight children, including sequential utterances containing 30 different word types. The average Percentage of Consonants Correct for the eight samples used to assess intrajudge agreement was 71.6%., with a range of 57% to 78%.

Several procedures were designed to insure reliable coding and statistical summary of the self-monitoring behaviors listed in Table 3. First, definitions for each behaviors were written to reflect readily observable behaviors, rather than require subjective judgments. Thus, with the exception of Pre-planning judgments discussed below, coding the occurrence of the self-monitoring behaviors required attention and identification, rather than discrimination. Second, the summary data for statistical purposes were designed to be conservative, reflecting only the nominal level of measurement. Based on the coded data for each of the self-monitoring behaviors, children were classified as either evidencing or not ever evidencing each behavior. Third, the same samples that were used for checking transcription reliability were recoded to assess the reliability of self-monitoring coding. Results indicated 100% agreement, supporting both the exact temporal identification of the self-monitoring events and exact classification of events. Included in this assessment were five items on which Pre-planning was coded reliably, as well as four eligible items (i.e., same target sound; see Table 3) for which Pre-planning was reliably not coded. Finally, as described previously, the accuracy of data obtained from diary reports, which represented approximately 25% of the available data, was confirmed by the child's clinician in interviews with the parent.

RESULTS AND DISCUSSION

It is important to underscore the case study nature of these data. Comparable sets of raw data across children were not available for all variables. Rather, individual clinical data were used to deliberate certain claims about self-monitoring and generalization, with evidence mar-

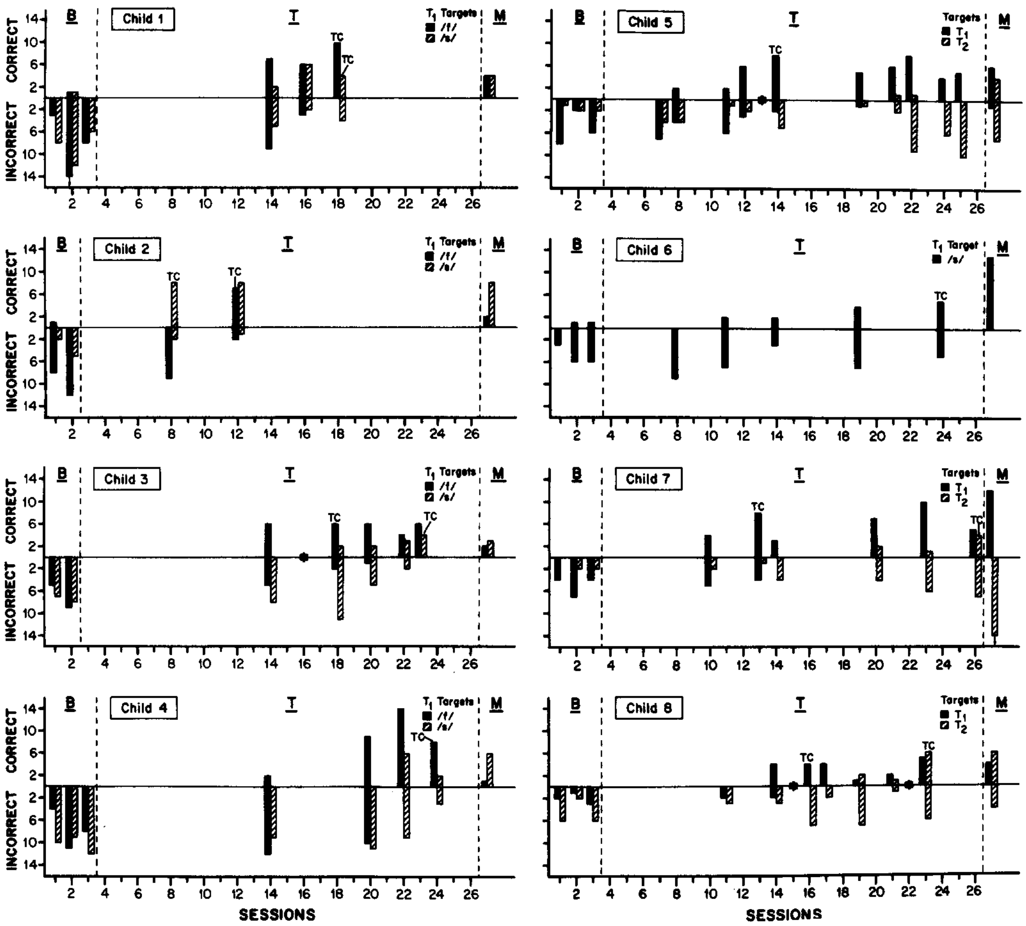

FIGURE 1. Individual data for the eight children, including target production during conversational speech probes obtained during baseline (B), treatment (T), and maintenance (M) periods. Number of correct productions are plotted as bars above the line, number incorrect below. The "TC" marker identified the point at which the termination criterion was met and training on a second target was initiated for Child 5, 7, and 8. An asterisk identifies points at which data were relevant to TC determination for Child 3, 5, and 8, but were not available. In the later cases, TC was established in the session succeeding the asterisk.

shalled in the form of descriptive statistics and relevant counter-examples.

Patterns of Generalization

To examine sound changes associated with generalization, structurally similar data sets for trained and untrained error sounds were created from the baseline, treatment, and maintenance data obtained from conversational speech probes. Because these plots are extensive, only data for the trained sounds are included in Figure 1. For analysis purposes, however, generalization data for untrained error sounds (not shown) were plotted similarly for each target according to the following combinations of manner class and word position: (a) same manner feature and same word position as each target sound, (b) same word position, but different manner feature, (c) same manner feature, but different word position, and (d) different manner feature and word position than each target. Because data for some of the untrained error sounds were limited, frequency data rather than percentage-transformed scores were used to represent data for both trained and untrained error sounds. The number of correct productions are plotted as bars above the line, with the number of incorrect productions plotted below the line (see Figure 1). Although there were sometimes relatively few data points for each trained and untrained error sound, the available data were consistent with clinician observations and parental reports. Several trends across all eight children are notable.

As shown by the termination criterion (TC) markers in Figure 1 for trained sounds, seven of the eight children (Child 4 excluded) reached termination criterion (at least 50% generalization to spontaneous speech in two successive conversational speech probes) on their first target. Two of the three children (Child 7, Child 8) who worked on a second target, after reaching the termination criterion on the first, also reached the termination criterion for that target (excepting Child 5). Furthermore, except for Child 8's second target, generalization was completed for all targets without additional training after the termination criterion was met, as demonstrated by data points only above the line during subsequent conversational probes administered during treatment and/or maintenance. Note that even for children who did not reach the termination criterion for all trained sounds within the treatment period (Child 4, Child 5), some generalization was evident by the maintenance probes. Similar occurrences of spontaneous generalization have been reported elsewhere (cf., Olswang & Bain, 1985a).

The patterns of change observed for *untrained* sounds across the treatment periods generally followed feature-based response generalization functions. First, six of the eight children (excepting Child 6 and Child 8) demonstrated an increase over time in the number of correct productions of sounds having the same manner feature and same word position as the trained sound. Such increases occurred on untrained singletons or clusters containing the same sound as the target and on cognates. In comparison, only three children (Child 3, Child 4, Child 7) showed an increase in the number of correct productions of sounds that were in a different manner class then the trained sound, but in the same word position. In all cases the sound that developed was /l/. Only Child 7 demonstrated correct productions of untrained sounds that had the same manner feature, but were in a different word position than the trained sound. This change, however, represented correct production of the trained sound to an untrained position and to the cognate in that untrained position. Finally, only Child 7 evidenced increases in the correct production of sounds that differed from the trained sound in both manner and word position. Sounds on which change occurred included palatal fricatives and affricates during training on the first target.

These patterns of sound change for untrained error sounds are consistent with both general trends and individual differences reported in the generalization literature. Generalization occurred primarily within manner feature class (Costello & Onstine, 1976; Elbert & McReynolds, 1985; McReynolds & Elbert, 1981), word position (Elbert & McReynolds, 1975, 1978; Olswang & Bain, 1985a), canonical form (Olswang & Bain, 1985a) and cognates (Elbert, Shelton, & Arndt, 1967; McReynolds & Jetzke, 1986). As described above, however, the finding that sound change also occurred *across* manner class for some children and did not obtain at all for others, suggests that feature-based (place-manner-voicing) generalization mechanisms do not provide a sufficient explanation for all of the observed patterns.

Rates of Generalization

The total number of treatment sessions required to reach the termination criterion for each trained sound is displayed in Table 4. Overall these data indicate large individual differences in the rates of stimulus generalization for target sounds trained both concurrently (children 1–4) and serially (children 5–8). Children 1–4 took from 10 to 21 sessions to reach the termination criterion for /f/ and from 6 to 21 sessions for /s/. Children 5–8 took from 10 to 21 sessions for the first target and from 8 to 14 sessions for the second.

Rate differences were also evident in generalization from trained to untrained word positions and across singleton and cluster forms. For some children, generalization to untrained contexts was at least as rapid, and in some cases more rapid, than generalization to trained contexts. Generalization data for Child 7, as shown in Figure 2, provide an example. As indicated by the data for Session 14, 100% generalization to spontaneous speech occurred on the same sampling date for both the trained position (/k/ initial) and the two *untrained* word positions (/k/ medial, /k/ final). The data for Child 3, as shown in Figure 3, illustrate another generalization difference between trained and untrained sounds. As shown, 100% generalization to untrained contexts (i.e., /s/ initial clusters) occurred *prior* to the session in which 100% generalization to conversational speech was obtained for the trained singleton /s/. Together with the previous data, these case study examples call to question both the descriptive and explanatory adequacy of phonetic fea-

TABLE 4. Rate of sound change as indicated by number of treatment sessions required to reach termination criterion for all trained sounds.

		Number of sessions					
		First Target				*Second Target*	
Study	*Child*	/f/(*I*)	/s/(*I*)	/k/(*I*)	/l/(*I*)	/k/(*F*)	/s/-*clusters* (*I*)
I	1	15	15				
I	2	10	6				
I	3	16(3)[a]	21(3)				
I	4	21(4)	21(6)[b]				
II	5			11(2)			12(4)[b]
II	6		21				
II	7			10(4)			14(3)
II	8				13	8	

[a]The number of sessions required to shape word-level production for entry into the management program is included in the parentheses.
[b]Did not meet termination criterion during the management period within the indicated number of management sessions.

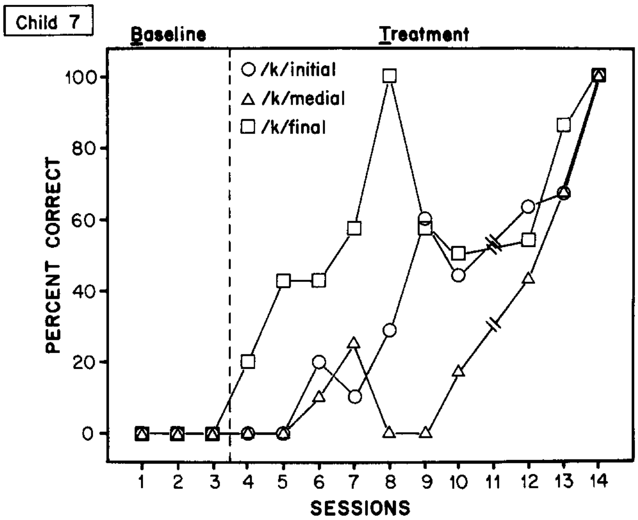

FIGURE 2. Generalization data for Child 7. The trained sound is /k/ in the initial position and the untrained sounds are /k/ medial and /k/ final.

ture-based mechanisms to fully explain generalization. Alternative hypotheses will be offered in later discussion.

Patterns of Self-Monitoring Behaviors

Table 5 includes type and token data for the self-monitoring behaviors that occurred in the transcribed conversational speech probes and in diary reports during the treatment period. Data drawn from diary reports were minimal because information that could not be validated by clinician interview was excluded. It should be noted that self-monitoring behaviors never occurred in the initial baseline conversational speech samples and occurred in maintenance probes as *Pre-planning* responses

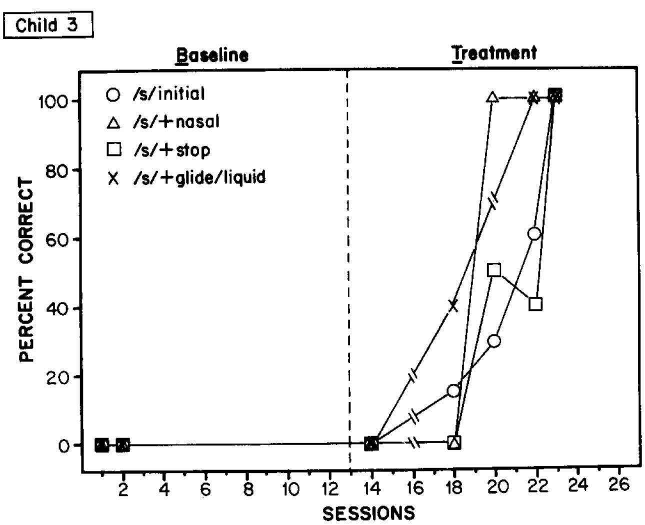

FIGURE 3. Generalization data for Child 3. The trained sound is /s/ singleton in the initial position and the untrained sounds are several /s/ clusters in initial position.

only for Child 2 and Child 3. Furthermore, with the exception of Child 8, all children routinely accomplished self-monitoring tasks during in-session training. These training data are not reported because the termination criterion was reached at different points in the training program for different target sounds; therefore, not all children were trained on all self-monitoring tasks for all targets.

As shown in Table 5, seven of the eight children demonstrated at least two different self-monitoring behaviors during spontaneous speech. These behaviors were sometimes scattered throughout the speech sample and sometimes clustered in only one part of the sample. *Spontaneous Self-correction* was the only behavior demonstrated by all seven children, although for Child 2 the one attempt was unsuccessful. There were too few data to identify any child-specific "preferences" for type of self-monitoring behavior. However, the frequency of *Pre-planning* responses, in contrast to the limited number of different types of self-monitoring behaviors for Child 2, might support the construct of a preference for the pre-response monitoring strategy of *Pre-planning* for this child over the post-response strategy of *Self-correction*.

The types of self-monitoring behaviors reported for each subject in Table 5 are consistent with behaviors observed during spontaneous verbalization under non-sampling conditions. The limited number of tokens for each response type may reflect the inherent difficulty of self-monitoring, rather than methodological constraints associated with sample length. To the degree that self-monitoring behaviors require metalinguistic awareness, they make demands on attentional processes for conscious manipulation of language form, while simultaneously attending to the content of a message. For the young children in the current study, developmental constraints associated with the preoperational period of cognitive development, might be offered as a explanation for the paucity of self-monitoring data. A Piagetian view of cognitive development would suggest that preoperational children have difficulty attending simultaneously to form and content. In the present case, this would mean that children could readily attend to some aspect of phonetic form or to some aspect of the message content, but not both. Whereas much of the young child's awareness of language has been shown to reflect a focus on content rather than form (e.g., de Villiers & de Villiers, 1972; Gleitman, Gleitman, & Shipley, 1972; Papandropoulou & Sinclair, 1974), self-monitoring behaviors indicating phonologic-level, metalinguistic processes are likely to be infrequent in the spontaneous conversations of young children, and perhaps especially infrequent in the conversations of speech-disordered children. However, cognitive constraints cannot adequately explain the low frequency of self-monitoring data for two reasons. First, the ability of at least some children during early preoperational development to focus simultaneously on language content and form is supported by frequency data for phonological repairs reported by Clark and Andersen (1979) that excede the frequency of self-monitoring behaviors reported in the current study. Second, as is routinely evident in clinical practice, even

TABLE 5. Number of types and tokens of behaviors assumed to reflect self-monitoring. Data were obtained from conversational speech probes and available diary reports during the treatment period.

		Number of Tokens per Type				
Child	*Number of types*	*Overgeneralization*	*Recognition*	*Preplanning*	*Prompted Self-correction*	*Spontaneous Self-correction*
1	4	1	1	3	0	1
2	2	0	0	7	0	1
3	4	0	5	5	3	7
4	3	0	1	1	0	2
5	3	1	0	2	0	2
6	4	2	0	2	1	2
7	3	7	7	0	0	3
8	0	0	0	0	0	0

older children and adults have difficulty self-monitoring speech production.

Associations Among Sound Change and Self-Monitoring

The available data allowed questions to be posed about possible functional associations between sound changes (including in-session acquisition and generalization reflected in the conversational speech probes) and self-monitoring behaviors. The data were first examined to determine if temporal ordering might relate the occurrence of behaviors in one domain to the onset of behaviors in the other.

The first observation was that sound change in some context appeared to be a necessary condition for the occurrence of self-monitoring behaviors. For trained sounds, self-monitoring behaviors were observed to occur only on those sounds that were readily produced correctly during training trials in the management program and may also have begun to generalize to the conversational speech probes. These included the trained sounds in the trained word position and almost as frequently for some children, in untrained positions, in untrained singleton or cluster canonical forms, and in cognates. For a few children and in only a few occurrences, self-monitoring behaviors also occurred on improving sounds that were not related to a target by place or manner feature. In no instance, however, was a self-monitoring behavior recorded for a sound that was not undergoing improvement in the treatment program training data or in the conversational speech probes. In addition, self-monitoring behaviors were never observed while children were at the pre-word evocation level of training nor did the early inclusion of pre-word training influence the onset of self-monitoring behaviors in any predictable way. For example, as shown in parentheses in Table 4, Child 3 was trained at the pre-word level for the same number of sessions for both targets, but demonstrated self-monitoring behaviors earlier for one target than for the other. Child 4, who trained at the pre-word level for a different number of sessions for both targets, demonstrated self-monitoring behaviors earlier for the target that had had fewer treatment sessions.

A second observation concerns associations between speech proficiency and self-monitoring behaviors. Data from conversational speech probes were assembled to examine the hypothesis that relative speech proficiency might mediate the temporal onset of self-monitoring behaviors. Table 6 includes information on relationships among the five self-monitoring behaviors (as observed in conversational speech) in relation to children's percent correct scores on trained sounds (including trained and untrained word positions and canonical forms) when each of the self-monitoring behaviors was first observed. As shown in Table 6, the minimum percentage values of 0% for *Overgeneralization, Recognition,* and unsuccessful attempts at *Spontaneous Self-Correction* indicate that developing speech proficiency (as assessed in in-session conversational speech probes) was not associated with the onset of these self-monitoring behaviors. For at least some children, behaviors in these categories had their onset before the probes documented speech proficiency.

TABLE 6. Percentage correct production of the trained sound in trained and untrained word positions and the first occurence of each self-monitoring awareness behavior for each child for whom the behavior was observed.

Percentage correct range	*Number of children*	*Self-monitoring behavior*
0–100	4	Overgeneralization
0–100	4	Recognition
15–75	2	Prompted Self-correction
22–100	6	Preplanning Spontaneous Self-correction
0–50	2	Unsuccessful attempt
40–100	7	Successful attempt

In contrast, percentage correct levels as low as 15% for *Prompted Self-correction,* 22% for *Pre-planning,* and 40% for successful attempts at *Spontaneous Self-correction,* suggest that the first successful occurrence of the remaining three self-monitoring behaviors might have required some minimal level of developing speech skill.

These few data suggest that the nominal classification of self-monitoring behaviors developed for this study might also have some ordinal properties. That is, the differences in minimum skill levels associated with onset of each self-monitoring behavior may reflect increasing levels of linguistic knowledge (e.g., Saywitz & Cherry Wilkinson, 1982), consistent with a developmental progression for self-monitoring behaviors. From this developmental perspective, *Overgeneralization* and *Recognition* behaviors, which occurred for some children in the absence of demonstrated speech proficiency, might require only some "vague, inexplicit awareness of speech sounds." In contrast, *Spontaneous Self-correction,* which occurred successfully only at higher proficiency levels, might require a more explicit level of awareness. Whatever the validity of such developmental speculations, the large range of proficiency levels (as high as 100%) in Table 6 suggests that relative speech proficiency does not provide a tidy explanation for the onset of self-monitoring behaviors.

A third observation on associations between the two domains concerns the relationship between the rates at which trained sounds were learned (as shown in Table 4) and the occurrence of self-monitoring behaviors. Two of the four children who trained on two sounds concurrently (Child 2, Child 3) had markedly differing rates of acquisition for the two sounds, although they evidenced self-monitoring behaviors on both targets. Moreover, two of the four children who were trained serially on two sounds did not show more rapid changes on the second target after having evidenced self-monitoring behaviors for the first target.

Overall these three sets of observations suggest that speech-sound generalization and the onset of self-monitoring behaviors were not functionally associated in these case study data. Even allowing for the few data for any one child, the several analyses suggested that responses in one domain could not be predicted by the type, frequency, or point of onset of responses in the other.

Alternative Hypotheses

If the occurrence of self-monitoring behaviors and speech-sound generalization are not highly correlated temporally, perhaps other variables mediate their individual and conjoint occurrence. The plausibility of two hypotheses are explored.

A response-contingency hypothesis. One hypothesis, consistent with clinical experience, is that both classes of speech responses primarily reflect children's views of contingencies in speech therapy. That is, clinicians and parents might become discriminative stimuli for the child to demonstrate "working on speech" by making certain statements (i.e., verbal behaviors that indicate self-monitoring), and by speaking in ways that are extrinsically reinforced by clinicians and caregivers.

Two observations in the present data provide counter-evidence for the hypothesis. First, children's metalinguistic awareness behaviors appeared to occur spontaneously and they sounded natural in prosodic topography. Anecdotally, they did not seem deliberately contrived to win reinforcing comments from the adults. Second, and more telling, the onset of these behaviors in many children occurred in spontaneous speech samples prior to the time that training began for the self-monitoring behaviors in the treatment program. Table 7 provides information on the number of children whose first occurrence of each self-monitoring behavior in conversational speech occurred prior to or after training. Recall that children 1–4 were trained only on *Recognition* tasks and that not all of the other children were trained for each self-monitoring behavior for both targets. The current analysis included data for only those self-monitoring behaviors that were trained on directly (i.e., *Recognition* and *Self-correction*) or indirectly during treatment. *Pre-planning* was assumed to be an indirect product of training in *Self-evaluation* and *Self-correction.* Of the seven children who showed self-monitoring behaviors during spontaneous speech, two children had *Recognition* responses before the training that began at Step 2. Moreover, prior to training at Step 3 for *Self-evaluation* and *Self-correction,* two children showed *Pre-planning,* one child had *Prompted Self-correction* responses, and six children showed *Spontaneous Self-correction.* These observations, particularly those for *Spontaneous Self-correction* suggest that most children's self-monitoring behaviors occurred independent of training, rather than as an apparent consequence of training.

The individual data for the remaining two children (Child 6 and Child 8) warrant discussion relative to possible support for a response contingency hypothesis. Recall that Child 8 did not successfully accomplish self-monitoring tasks during treatment and did not demonstrate self-monitoring behaviors in spontaneous speech. Post-

TABLE 7. Temporal relationships between the first occurrence of self-monitoring behaviors in conversational speech probes and training for these behaviors.

	Number of children showing self-monitoring behaviors		
Self-monitoring behavior	*Prior to training*	*Only with training*	*Total*
Recognition	2	2	4
Preplanning	2	5	7
Prompted Self-correction	1	1	2
Spontaneous Self-correction	6	1	7

study clinical records indicated that Child 8 continued to be unsuccessful on self-monitoring tasks under standard training conditions. However, when finally offered powerful extrinsic reinforcers (a desired toy) for each set number of correct target productions at home and in training sessions, she successfully performed all self-monitoring tasks during training and even demonstrated self-correction behaviors in spontaneous conversational speech.

The data for Child 6 provide the other example of the effects of extrinsic reinforcement on the occurrence of self-monitoring behaviors. Child 6 did not show *Pre-planning* or *Prompted Self-correction* during conversational speech probes until after formal training. Similarly, she was the only child who did not show *Spontaneous Self-correction* until after formal training. She took nearly the entire semester to reach the termination criterion for a single trained sound (Figure 1), even though she had (a) shown knowledge of the target sound as reflected in variably correct production in baseline conversational speech probes (Elbert, Dinnsen, & Powell, 1984), (b) begun to show generalization approximately 2 months before reaching the termination criterion, and (c) readily performed all speech production and self-monitoring tasks during treatment.

A motivational hypothesis. A second hypothesis that might explain the observed patterns of generalization and self-monitoring behaviors might be termed the *motivational* hypothesis. Motivation is a primary concern of the practitioner and motivational constructs are central to a variety of theoretical views of management (Creaghead, Newman, & Secord, 1989). In the present context the hypothesis would predict that children who are intrinsically motivated for sound change would spontaneously deploy any available metalinguistic processes as part of an active effort to effect change.

A motivational hypothesis could account for several, but not all, of the present findings. Individual differences in the degree of motivation for sound change might account for the finding that self-monitoring behaviors were observed for six of the eight children prior to the time training for these behaviors was introduced in the treatment program. That is, not only were these children aware of the differences between their surface forms and those preferred by the ambient community—they might have been intrinsically motivated to match their delayed forms to those perceived to be the correct ambient forms. A motivational hypothesis might also be invoked to account for the findings for Child 6 and Child 8, each of whom demonstrated self-monitoring behaviors only when motivated by extrinsic reinforcers. These children may not have been intrinsically motivated for sound change, but they responded well (as discussed previously) to response contingencies designed to motivate them. Finally, a motivational hypothesis could explain the finding that first occurrences of self-monitoring behaviors ranged widely across speech proficiency levels (Table 6). Thus, the onset of self-monitoring behaviors would require only some minimal level of speech proficiency, with the key element being some minimal level of motivation for sound change.

A motivation for sound change hypothesis, however, cannot account for generalization data in which the children evidenced changes in speech proficiency and/or self-monitoring behaviors on only some of their trained sounds. The data for Child 2 reflect just one of these situations; self-monitoring behaviors were evident for one of his concurrently trained sounds, but not for the other. A purely motivational hypothesis would need to be complicated in some fashion to account for all such instances of within-subject differences in patterns and rates of sound change and self-monitoring behaviors.

CONCLUSIONS

Data from the current study suggest several directions for controlled studies of self-monitoring and speech sound generalization.

First, young speech-delayed children apparently *can* be trained for the explicit metalinguistic awareness of their phonetic output required for self-monitoring behaviors such as self-evaluation and self-correction. It would appear, however, that awareness of speech sounds is accomplished via direct training on sounds. Most of the eight children in this study demonstrated self-monitoring behaviors before the relevant tasks were introduced within their treatment program, but not before training on the speech sound. This assumption does not preclude the possibility of facilitating more rapid generalization through training on self-monitoring behaviors. For example, effective self-monitoring strategies might be included in treatment for speech-delayed children in whom motivation for sound change is questionable. Among the seven self-monitoring behaviors studied here, the behavior termed *Spontaneous Self-correction* most closely reflects the types of self-monitoring tasks that have been found to facilitate stimulus generalization (e.g., Engel & Groth, 1976; Kern Koegel, Koegel, & Costello Ingham, 1986; Koegel, Kern Koegel, & Costello Ingham, 1988). In the current study *Spontaneous Self-correction* was scheduled late in the treatment program and included in training only for Child 6. Interestingly, it was only after training for *Spontaneous Self-correction* was initiated that Child 6 reached the termination criterion. Perhaps training in self-correction should be scheduled earlier for the child with questionable motivation for speech change, provided the child demonstrated some minimal level of articulatory competence on the target sound and some minimal level of competence on tasks lower in the putative developmental schedule of self-monitoring.

Second, the self-monitoring behaviors described in this paper warrant further explication relative to their clinical demands for differing levels of attentional and representational processing. Task analyses of each of these seven behaviors and other candidates associated with self-monitoring could yield a clinically useful ordering. For example, the self-monitoring behavior termed *Pre-planning* would seem to require some type of look-ahead mechanism to anticipate occurrence of a sound, while *Self-correction* required attention and the facility to formulate a corrected response following feedback for an incorrect response. The data on individual differences in speech proficiency in relation to the types of self-monitoring suggest a possible gradient, wherein *Overgeneralization* and *Recognition* responses may require less explicit levels of phonological awareness than the processes involved in *Self-evaluation, Pre-planning,* and *Self-correction.*

Finally, together with emerging data on etiologic factors in children with speech disorders of heretofore unknown origin (Shriberg, 1987; Shriberg & Kwiatkowski, 1988; Shriberg et al., 1986; Thielke & Shriberg, 1987, 1990), the present findings lend support to a developing four-factor normalization model. Consider the following summary of the present predictive findings: (a) speech proficiency levels prior to treatment and during treatment tasks did not themselves predict generalization (e.g., Child 6), (b) a phonetic-features model predicted most, but not all patterns of generalization and failed to account for generalization reversals (i.e., more rapid rates of generalization for untrained sounds in untrained positions), and (c) the type, frequency, or point of onset of self-monitoring data did not predict response or stimulus generalization. What factors might be weighted towards a sufficient predictive model of speech sound normalization with or without speech intervention programming?

The first factor that appears to warrant weighting in an eventually successful predictive model is the child's *etiologic status.* Such individual difference variables (see Table 1) may be particularly important to weigh for their potential to *inhibit* generalization. In the present study the two children (Child 6 and 8) for whom there was caregiver concern about psychosocial behaviors (Table 1) were the only children who did not demonstrate response generalization. Child 6 was slow to generalize despite evident articulatory competence and occurrences of self-monitoring behaviors early in treatment. Child 8's speech improvement may also have been further limited by fluctuant hearing levels due to persistent middle ear involvement throughout the treatment period. She was the only child who did not demonstrate continued spontaneous generalization of a target after reaching the termination criterion.

Each of the other three factors discussed above would also require negative and positive algebraic weightings in some form of a linear predictive normalization model. A child's *phonological status* may itself constrain generalization, with some minimal level of articulatory skill and phonologic organization required before generalization can occur. Similarly, a child's overall *metalinguistic status* may be required to approach some minimal potential before the specific mechanisms required of metaphonological awareness can be actuated. And lastly, a child's *motivational status* may play the crucial role in mediating the effects of the other three variables. Several studies in progress are testing the ability of this four-factor framework to predict speech sound normalization.

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REFERENCES

CLARK, E. (1978). Awareness of language: Some evidence from what children say and do. In A. Sinclair, R. Javella, & W. Levelt (Eds.), *The child's conception of language* (pp. 17–43). New York: Springer-Verlag.

CLARK, E. V., & ANDERSEN, E. S. (1979). Spontaneous repairs: Awareness in the process of acquiring language. *Papers and Reports on Child Language Development,* Stanford University, *16,* 1–13.

CONNELL, P. J. (1988). Induction, generalization, and deduction: Models for defining language generalization. *Language, Speech, and Hearing Services in Schools, 19,* 282–291.

COSTELLO, J., & BOSLER, S. (1976). Generalization and articulation instruction. *Journal of Speech and Hearing Disorders, 41,* 359–373.

COSTELLO, J., & ONSTINE, J. (1976). The modification of multiple articulation errors based on distinctive feature theory. *Journal of Speech and Hearing Disorders, 41,* 199–215.

CREAGHEAD, N. A., NEWMAN, P. W., & SECORD, W. A. (1989). *Assessment and remediation of articulatory and phonological disorders,* Columbus: Merrill.

DE VILLIERS, P. A., & DE VILLIERS, J. G. (1972). Early judgments of semantic and syntactic acceptability by children. *Journal of Psycholinguistic Research, 1,* 299–310.

DIEDRICH, W. (1971). Procedures for counting and charting a target phoneme. *Language, Speech, and Hearing Services in the Schools, 5,* 18–32.

DUNN, L., & DUNN, L. (1981). *Peabody Picture Vocabulary Test-Revised.* Minnesota: American Guidance Service.

ELBERT, M., DINNSEN, D. A., & POWELL, T. W. (1984). On the prediction of phonologic generalization learning patterns. *Journal of Speech and Hearing Disorders, 49,* 309–317.

ELBERT, M., & MCREYNOLDS, L. V. (1975). Transfer of /r/ across contexts. *Journal of Speech and Hearing Disorders, 40,* 380–387.

ELBERT, M., & MCREYNOLDS, L. V. (1978). An experimental analysis of misarticulating children's generalization. *Journal of Speech and Hearing Research, 21,* 136–150.

ELBERT, M., & MCREYNOLDS, L. V. (1985). The generalization hypothesis: Final consonant deletion. *Language and Speech, 28,* 281–293.

ELBERT, M., SHELTON, R. L., & ARNDT, W. B. (1967). A task for evaluation of articulation change: 1. Development of methodology. *Journal of Speech and Hearing Research, 10,* 281–288.

ENGEL, P., & GROTH, L. (1976). Case studies of the effects on carry-over of reinforcing post-articulation responses based on feedback. *Language, Speech, and Hearing Services in the Schools, 7,* 93–101.

FEY, M. E. (1988). Generalization issues facing language interventionists: An introduction. *Language, Speech, and Hearing Services in Schools, 19,* 272–281.

GALLAGHER, T. (1977). Revision behaviors in the speech of normal children developing language. *Journal of Speech and Hearing Research, 20,* 303–318.

GIERUT, J. (1985). *On the relationship between phonological knowledge and generalization learning in misarticulating children.* Unpublished doctoral dissertation, Indiana University, Bloomington.

GLEITMAN, L. R., GLEITMAN, H., & SHIPLEY, E. F. (1972). The emergence of the child as grammarian. *Cognition, 1,* 137–164.

HAGOOD, L., & DUNN, C. (1985). *Self-monitoring in phonological acquisition.* Paper presented at the Child Phonology Meeting, Purdue University, West Lafayette.

HAKES, D. T. (1982). The development of metalinguistic abilities: What develops? In S. Kuczaj (Ed.), *Language develop-*

ment: Volume 2. Language, thought, and culture (pp. 163–209). Hillsdale, NJ: Lawrence Erlbaum Associates.

JOHNSON, J. M., & JOHNSON, G. T. (1972). Modification of consonant speech-sound articulation in young children. *Journal of Applied Behavior Analysis, 5,* 233–246.

JOHNSTON, J. R. (1988). Generalization: The nature of change. *Language, Speech, and Hearing Services in Schools, 19,* 314–329.

KAMHI, A. G. (1988). A reconceptualization of generalization and generalization problems. *Language, Speech, and Hearing Services in Schools, 19,* 304–313.

KERN KOEGEL, L., KOEGEL, R. L., & COSTELLO INGHAM, J. (1986). Programming rapid generalization of correct articulation through self-monitoring procedures. *Journal of Speech and Hearing Disorders, 51,* 24–32.

KOEGEL, R. L., KERN KOEGEL, L., VAN VOY, K., & COSTELLO INGHAM, J. (1988). Within clinic versus outside clinic self monitoring of articulation to promote generalization. *Journal of Speech and Hearing Disorders, 53,* 392–399.

LEACH, E. (1984). Correcting misarticulations by the use of semantic conflict. In H. Winitz (Ed.), *Treating articulation disorders: For clinicians by clinicians* (pp. 153–160). Baltimore: University Park Press.

LEVELT, W. J. M., SINCLAIR, A., & JARVELLA, R. J. (1978). Causes and functions of linguistic awareness in language acquisition: Some introductory remarks. In A. SINCLAIR, R. J. JARVELLA, & W. J. M. LEVELT (Eds.), *The child's conception of language* (pp. 1–14). Berlin: Springer-Verlag.

LIBERMAN, I. (1973). Segmentation of the spoken word and reading acquisition. *Bulletin of the Orton Society, 23,* 65–77.

MCREYNOLDS, L. V., & BENNETT, S. (1972). Distinctive feature generalization in articulation training. *Journal of Speech and Hearing Disorders, 37,* 462–470.

MCREYNOLDS, L. V., & ELBERT, M. F. (1981). Generalization of correct articulation in clusters. *Applied Psycholinguistics, 2,* 119–132.

MCREYNOLDS, L. V., & JETZKE, E. (1986). Articulation generalization of voiced-voiceless sounds in hearing-impaired children. *Journal of Speech and Hearing Disorders, 51,* 348–355.

MILLER, J. (1981). *Assessing language production in children.* Baltimore: University Park Press.

OLSWANG, L. B., & BAIN, B. A. (1985a). The natural occurrence of generalization during articulation treatment. *Journal of Communication Disorders, 18,* 109–129.

OLSWANG, L. B., & BAIN, B. A. (1985b). Monitoring phoneme acquisition for making treatment withdrawal decisions. *Applied Psycholinguistics, 6,* 17–37.

PAPANDROPOULOU, I., & SINCLAIR, H. (1974). What is a word? Experimental study of children's ideas on grammar. *Human Development, 17,* 241–258.

ROCKMAN, B., & ELBERT, M. (1984). Generalization in articulation training. In H. Winitz (Ed.), *Treating articulation disorders: For clinicians by clinicians* (pp. 131–151). Baltimore: University Park Press.

RUSCELLO, D. M., & SHELTON, R. L. (1979). Planning and self-assessment in articulatory training. *Journal of Speech and Hearing Disorders, 44,* 504–512.

SAYWITZ, K., & CHERRY WILKINSON, C. (1982). Age related differences in metalinguistic awareness. In S. Kuczaj (Ed.), *Language development: Volume 2. Language, thought, and culture* (pp. 229–250). Hillsdale, NJ: Lawrence Erlbaum Associates.

SHRIBERG, L. D. (1986). PEPPER: Programs to Examine Phonetic and Phonologic Evaluation Records. Hillsdale, N. J.: Laurence Erlbaum.

SHRIBERG, L. D. (1987). In search of the otitis media-speech connection. *Journal of the National Student Speech, Language, and Hearing Association, 15,* 56–67.

SHRIBERG, L., & KENT, R. (1982). *Clinical phonetics.* New York: Macmillan.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1980). *Procedures for natural process analysis (NPA) of continuous speech samples.* New York: Macmillan.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1982a). Phonological disorders I: A diagnostic classification system. *Journal of Speech and Hearing Disorders, 47,* 226–241.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1982b). Phonological disorders II: A conceptual framework for management. *Journal of Speech and Hearing Disorders, 47,* 242–255.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1982c). Phonological disorders III: A severity metric. *Journal of Speech and Hearing Disorders, 47,* 256–270.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1983). Computer-assisted natural process analysis (NPA): Recent issues and data. *Seminars in Speech, Language, and Hearing, 4,* 389–406.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1987). A retrospective study of spontaneous generalization in speech-delayed children. *Language, Speech, and Hearing Services in Schools, 18,* 144–157.

SHRIBERG, L. D., & KWIATKOWSKI, J. (1988). A follow-up study of 36 children with speech delays of unknown origin. *Journal of Speech and Hearing Disorders, 53,* 144–155.

SHRIBERG, L. D., KWIATKOWSKI, J., BEST, S., HENGST, J., & TERSELIC-WEBER, B. (1986). Characteristics of children with phonologic disorders of unknown origin. *Journal of Speech and Hearing Disorders, 51,* 140–161.

THIELKE, H. M., & SHRIBERG, L. D. (1987). *Speech-language sequelae of recurrent otitis media in Native American preschoolers.* Paper presented at the annual meeting of the American Speech-Language-Hearing Association, New Orleans.

THIELKE, H. M., & SHRIBERG, L. D., (1990). Effects of recurrent otitis media on language, speech, and educational achievement in Menominee Indian children. *Journal of American Indian Education, 29,* 25–35.

VAN KLEECK, A. (1982). The emergence of linguistic awareness: A cognitive framework. *Merrill-Palmer Quarterly, 28,* 237–265.

WARREN, S. F. (1988). A behavioral approach to language generalization. *Language, Speech, and Hearing Services in Schools, 19,* 292–303.

WEAVER-SPURLOCK, S., & BRASSEUR, J. (1988). The effects of simultaneous sound-position training on the generalization of [s]. *Language, Speech, and Hearing Services in Schools, 19,* 259–271.

WEINER, F., & OSTROWSKI, A. (1979). Effects of listener uncertainty on articulatory inconsistency. *Journal of Speech and Hearing Disorders, 44,* 487–493.

WILLIAMS, A. L., (1988). *Patterns of generalization associated with least phonological knowledge.* Paper presented at the annual convention of the American Speech-Language-Hearing Association, Boston.

WOLF, V. I., BLOCKER, S. D., & PRATER, N. J. (1988). Articulatory generalization in two word-medial, ambisyllabic contexts. *Language, Speech, and Hearing Services in Schools, 19,* 251–258.

ZHUROVA, L. YE (1973). The development of analysis of words into their sounds by preschool children. In C. A. Ferguson & D. I. Slobin (Eds.), *Studies in child language development.* New York: Holt, Rinehart & Winston.

ZIMMERMAN, I. L., STEINER, V. G., & POND, R. E. (1979). *Preschool Language Scale-Revised.* Columbus, OH: Charles E. Merrill.

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APPENDIX

The data in the following table describe the error patterns for all eight children. Data were obtained from combined initial baseline samples using procedures described in the text. The columns, from left to right, divide errors into classes termed *natural* and *non-natural*. (Shriberg & Kwiatkowski, 1980, 1983), and are further subdivided by consistency of error and by word position (I = Word initial; F = Word final). Non-natural process errors include initial singleton consonant deletions, substitutions not accounted for by eight natural processes, and distortions (with the exception of dental distortions of /s/ and /z/, which because of their prevalence in the eight children, were counted as correct). The format for error entries, subdivided into singleton and clusters and organized by manner features, shows the replacement consonant/the ambient form. Deletions are represented by "–". Inconsistent (>10% to <90%) natural and non-natural process errors were further analyzed using procedures for context/function variability analysis described in Shriberg and Kwiatkowski (1980, p. 69). In most cases, word position accounted for variability; other variables that were identified are listed in parentheses after the error entry.

Consistency in Error Production

	Natural Process Errors				*Non-Natural Process Errors*			
	>10%–<90%		*≥90%*		*>10%–<90%*		*≥90%*	
Child	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*
1								
Singleton		−/f,s,z	b/v,d/ð ^{t}s̪/tʃ, ^{d}z/dʒ w/r	b/v,t/θ d/ð,−/ʃ t/tʃ, ^{d}z̪/dʒ ^{ʋ}/l,r	h/θ		h/f,s,ʃ	
Cluster	hl/fl, sl (phonetic context)	−/s	−,h/s w/r	^{ʋ}/l,r				
2								
Singleton			d/ð t/tʃ w/l,r	d/ð, t/ʃ s/tʃ,z̪/dʒ ^{ʋ}/l,r			w/f,s,ʃ −/dʒ	
Cluster			−/s w/l,r	^{ʋ}/l,r				
3								
Singleton		d/z,s/ʃ ^{t}s/tʃ d/dʒ	p/f,θ d/ð, t/s t/tʃ j,w/l w/r	d/ð ^{ʋ}/l,r	^{d}z̪/z	s/θ	^{tʃ}/ʃ	
Cluster			−/s w/l,r	^{ʋ}/l,r				
4								
Singleton		t/s,d/z	p/f,θ d/ð, t/s j,w/l,r w/r	t/θ, d/ð d/dʒ ^{ʋ}/l,r	^{d}z/z	^{t}s/s	^{tʃ}/ʃ	^{tʃ}/ʃ
Cluster			−/s w/l,r	^{ʋ}/l,r				
5								
Singleton	b/v,t/θ	t/θ (lexical specific)	t/k,d/g d/ð t/tʃ,d/dʒ w/l,r	d/ð ʋ/l,r	w/f		w/s,z,ʃ	
Cluster			−/s w/l,r	^{ʋ}/l,r				
6								
Singleton	t/f,s d/dʒ	t/f,d/v t/s,d/z t/tʃ	t/θ,d/ð d/z,s/ʃ t/tʃ w/l,r	^{t}/θ,d/ð t/ʃ d/dʒ ʋ/l,r	^{v}w/f			
Cluster		t/s	−/s w/l,r	^{ʋ}/l,r				
7								
Singleton			t/k,d/g w/l,r	t/k,d/g s̪/ʃ ^{t}s̪/tʃ ^{d}z̪/dʒ ^{ʋ}/l,r				
Cluster	−/s or unmarked member (phonetic context)		w/l,r	^{ʋ}/l,r				
8								
Singleton	g/ð	d/g p/f,d/z	b/v k/θ,s k/tʃ d/dʒ j/l,w/r	t/θ ^{ʔ}/s,ʃ p/tʃ −/dʒ ^{ʋ}/l,r	k/t	^{ʔ}/t		^{ʔ}/f ʃ/ʃ
Cluster			−/s −/l,w/r	−, ^{ʔ}/s ^{ʋ}/l,r				