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Syllable structure development of toddlers with expressive specific language impairment

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ABSTRACT
A total of 35 children – 20 with expressive specific language impairment (SLI-E) and 15 typically developing (TD) peers – were compared longitudinally from 24 to 36 months with respect to their production of syllable shapes in 10-minute spontaneous speech samples. SLI-E 24-month-olds predominantly produced earlier developing syllable shapes containing vowels, liquids, and glides. TD 24-month-olds and SLI-E 36-month-olds produced approximately the same proportion of syllable types, with the exception of consonant clusters, where TD 24-month-olds produced more than SLI-E 36-month-olds. TD children at 36 months showed the greatest use of syllable shapes containing two different consonants and consonant clusters. Detailed analyses revealed that SLI-E children produced fewer syllable shapes containing final consonants, more than one consonant type, and consonant clusters. Furthermore, the children with SLI-E were found to vocalize less often than their TD peers. The possible relationships between these findings, SLI-E children's concomitant deficits in morphology and syntax, and the implications for diagnosis and remediation are discussed.

A focus of research in recent years has been on the development of a group of toddlers known as "late talkers." Late talkers are typically identified as those children who fail to produce at least 50 vocabulary words or any two-word combinations by age 2 (Rescorla, 1989; Rescorla & Schwartz, 1990; Scarborough & Dobrich, 1990), yet who do not demonstrate deficits in hearing, intelligence, or receptive language ability. It is currently estimated that the prevalence of expressive language delay at 24 months is as high as 15% in children from low-income families and 7% in children from middle-class families (Rescorla, 1984). Despite the valuable insight this population may provide into the development of specific language impairment, it has not been particularly well studied. The shortage of data is largely due to the unavailability of assessment tools for toddlers. The relatively recent development of parental checklists, such as the Language Development Survey (Rescorla, 1989) and the MacArthur Com-

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municative Development Inventory (CDI) (Fenson et al., 1993), has assisted researchers and clinicians in the early identification of 2-year-old late talkers.

Overall, researchers have demonstrated that at least half of late talkers identified by age 2 will be considered language-disordered by age 3 or older (Fischel, Whitehurst, Caulfield, & De Baryshe, 1989; Paul, 1989; Rescorla, Roberts, & Dahlsgaard, 1997; Rescorla & Schwartz, 1990). Some of these children will be diagnosed with expressive specific language impairment (SLI-E). However, the proportion of late-talking children who continue to perform at below-average levels at age 3 differs from study to study and varies based on which outcome measure is used (Rescorla et al., 1997). Typically, at age 3 late talkers have made rapid gains in the areas of lexical development and the ability to explain and describe, but continue to demonstrate persistent and more evident delays in morphology and syntax (Rescorla et al., 1997). Researchers who have examined long-term recovery rates for late-talking toddlers have reported that the majority of these children move into the normal range on all standardized tests by first or second grade (Bishop & Adams, 1990; Paul, 1996; Rescorla, 1993; Whitehurst & Fischel, 1994). Nevertheless, as a group late talkers continue to perform more poorly than their peers, with persistent difficulty in the areas of verbal short-term memory, sentence formulation, word retrieval, auditory processing of complex information, and elaborated verbal expression (Rescorla, 1993). Furthermore, not all children with a history of expressive language delay recover. Paul (1996), for example, reported a recovery rate of only 74% by first grade. Consequently, investigators have attempted to define more clearly the factors that may identify late talkers who will present with persistent difficulties later in life. Most research to date has focused on late talkers' failure to develop lexical, morphological, syntactic, gestural, and social skills at a rate similar to normally developing peers. Surprisingly few studies have systematically evaluated the phonetic development of these children, although several researchers have noted that articulation development may fall below age expectations (Fischel et al., 1989; Rescorla & Schwartz, 1990; Scarborough & Dobrich, 1990).

Phonetic development of late talkers: Current research

Over the past decade, a large number of studies of speech-sound development in late-talking and language-disordered children have been published. For ease of discussion, Table 1 provides a summary regarding subject characteristics, assessment protocols, and primary findings. Taken together, the studies cited here collectively found that, when compared to normally developing children, SLI-E children between the ages of 2 and 3 years exhibit reduced phonetic inventories, simpler syllable shapes, and reduced pronunciation accuracy. Unfortunately, the phonetic development of this population has not yet been selectively examined in a longitudinal investigation between the typical age of early diagnosis (24 months) and the age at which more formal testing generally occurs (36 months). The literature to date is characterized by some limitations that indicate further study in this area is warranted: (a) cross-sectional rather than longitudinal design (Paul & Jennings, 1992; Thal et al., 1995); (b) small sample size, with regard to number of subjects and quantity of speech analyzed (Paul &

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Jennings, 1992; Scarborough & Dobrich, 1990; Stoel-Gammon, 1989); and (c) global rather than specific descriptions of phonological performance (Rescorla & Schwartz, 1990; Whitehurst, Smith et al., 1991).

For several years, researchers have noted the uncertain relationships among delayed expressive language, reduced phonetic inventory, and production of simpler syllable shapes (Mirak & Rescorla, 1998; Paul & Jennings, 1992, Rescorla & Ratner, 1996; Stoel-Gammon, 1989; Thal et al., 1995; Whitehurst, Smith et al., 1991). The driving force behind these developmental deficits is as yet unknown, although speculation has led to theories of limited information-processing abilities (Leonard, Sabbadini, Volterra, & Leonard, 1988), symbolic capacity (Terrell & Schwartz, 1988), and memory capacity (Kirchner & Klatzky, 1985). However, the continued observation that many SLI-E children display concomitant phonological delays raises interesting questions about the role of phonology in the development of other domains, such as the lexicon and bound morphology. Only intensive and careful research into the precursors of persistent language difficulty will provide clinicians with the tools and information they require to make informed decisions regarding the early identification of, and appropriate intervention for, 2-year-old late talkers. Thus, we posed the following questions: (1) What patterns of syllable structure development do children with SLI-E display between the ages of 2 and 3 years? (2) How do children with SLI-E compare to normally developing agemates during this period of development?

METHOD

Subjects

The subjects in this study were a subset of Rescorla's longitudinal cohort of late talkers (Rescorla & Schwartz, 1990) and included many of the same children studied in Mirak and Rescorla (1998), Rescorla and Ratner (1996), and Roberts, Rescorla, Giroux, and Stevens (1998). Of the larger group, subjects were excluded from the current analysis on the basis of age greater or equal to 30 months ($n = 7$), audio samples unsuitable for phonetic transcription ($n = 3$), or missing data at 24 or 36 months ($n = 4$).

A total of 35 children – 20 with SLI-E, who were between 24 and 27 months at the time of intake, and 15 typically developing (TD) peers – participated in this study. Children in both groups were matched on gender (one girl in each group), age, and socioeconomic status (Hollingshead, 1975). All subjects were required at the time of intake to display normal nonverbal cognitive abilities and age-adequate receptive language skills, as determined by a minimum MDI score of 85 on the Bayley Scales of Infant Development (Bayley, 1969) and a score within 3 months of chronological age on the Reynell Receptive Language Scale (Reynell, 1977). Admission to the cohort of children identified as SLI-E necessitated a score at least 6 months below chronological age on the Reynell Expressive Language Scale (Reynell, 1977) and an expressive vocabulary of fewer than 50 words or no word combinations, as measured by parental report

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Table 1. *Summary of past studies examining speech sound development in children with SLI and late-talking children*

Study	Subject population	Sampling conditions	Primary findings
Stoel-Gammon (1990)	2 late-talking children from a larger cohort, followed from 9 to 24 months	Prespeech utterances	More limited repertoires, simpler syllable shapes, and smaller expressive lexicons
Scarborough & Dobrich (1990)	4 children, followed from 2 to 8 years	First 100 successive identifiable words	Significant differences between delayed children and TD peers in total consonant errors at 30, 36, and 42 months
Whitehurst, Smith et al. (1991)	37 children, assessed at ages 2;0 and 2;5	Babble from 1- to 12-minute spontaneous speech samples	Number of words, rate of consonantal or vowel babble, and frequency of behavioral problems at intake were correlated with language outcomes 5 months later
Paul & Jennings (1992)	9 18- to 23-month-old and 19 24- to 34-month-old SLI-E children and 25 TD comparison children	Spontaneous speech samples	Children with SLI-E demonstrated significantly depressed phonetic inventories, syllable shape complexity, and pronunciation accuracy
Paul (1993)	37 late talkers and 32 comparison children, followed from ages 3 to 4	Single word articulation test; subjective intelligibility of spontaneous speech	Significantly depressed performance by late-talking children on single-word articulation and intelligibility at both ages
Thal, Oroz, & McCaw (1995)	17 late talkers, ages 18 to 33 months, matched to 17 LA and 17 CA controls	Spontaneous language	At meaningful speech stage, significantly lower variety of word-final consonants in late talkers' speech and less complex syllable structure; at premeaningful speech stage, significantly lower number of intelligible utterances and variety of word-initial and word-final consonants and reduced syllable structure in babble

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Paul (1996)	23 children with histories of ELD, 8 with current ELD, and 27 TD peers	Word articulation and intelligibility in spontaneous speech	In kindergarten and first grade, children with persistent ELD scored more poorly than TD peers on the TOLD-P expressive quotient and Percent Consonants Correct (PCC) and were rated more poorly on intelligibility
Rescorla & Ratner (1996)	30 SLI-E children (ages 24–31 months); 30 CA-matched peers	Spontaneous speech	Children with SLI-E produced fewer vocalizations and displayed reduced phonetic inventories and syllable structure patterns
Mirak & Rescorla (1998)	37 children with SLI-E (ages 2 to 3); 20 CA-matched peers	Speech samples from testing and free play	Children with SLI-E used significantly fewer consonant types and tokens and more open syllable shapes; outcome at age 3 was not predicted by variables studied at age 2
Roberts, Rescorla, Giroux, & Stevens (1998)	29 children with SLI-E (age 36 months); 19 CA-matched peers	Spontaneous speech	Children with SLI-E had significantly smaller phonetic inventories, lowered intelligibility, and lowered PCC, but not significantly lower vocalization or phonological process rates

Table 2. *Means and standard deviations of demographic information and test scores for SLI-E and TD children*

	SLI-E		TD	
Intake data	*M*	*SD*	*M*	*SD*
Age in months	24.9	1.37	24.73	.46
Hollingshead total	53.30	13.61	53.87	8.36
Language Development Survey*	15.45	9.34	231.60	5.43
Bayley Nonverbal items	12.70	3.15	12.60	3.89
Reynell Receptive *Z* score*	0.13	0.57	0.95	0.59
Reynell Expressive *Z* score*	−1.54	0.24	0.40	0.44

*$p < .001$

on the Language Development Survey (Rescorla, 1989). Test scores and demographic data for SLI-E and TD children are summarized in Table 2.

A series of unpaired, two-tailed *t* tests revealed that there were no significant differences between SLI-E and TD children in age, socioeconomic status, or nonverbal cognitive skills. However, a significant difference was found with regard to receptive language. Although the children from both groups scored within normal limits on the Reynell Receptive Language Scale (Reynell, 1977), TD children showed advanced receptive language skills for their age. As expected, significant group differences were present for expressive language, as measured by the Reynell Expressive Language Scale (Reynell, 1977) and the Language Development Survey (Rescorla, 1989).

Data collection

Children were observed at 24 and 36 months. Unstructured 10-minute play sessions provided the spontaneous speech samples used in this study. All testing and play sessions were conducted in a carpeted lab room and were videotaped for subsequent analysis. A wall-mounted free-field microphone served as the audio input for the videotape recorder. Play materials provided for each mother–child pair were age-appropriate and were the same for each child within the same chronological age group or across diagnostic categories. Mothers were instructed to "play as you normally would at home."

Transcription

The vocalizations of all subjects were transcribed directly from the videotapes containing the mother–child play sessions. The first author served as the transcriber and remained unaware of the subjects' diagnostic assignments until all transcription activities had been completed. Each 10-minute play session was transcribed in its entirety, using broad phonetic transcription in Unibet. The

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following guidelines, similar to those used by Stoel-Gammon (1989) and Paul and Jennings (1992), were employed during the transcription process:

1. A vocalization was defined as a minimum of a voiced vocalic element or a voiced syllabic consonant that occurred on an egressive airstream.
2. Vocalizations that could not be confidently transcribed after five repetitions or were inaudible (e.g., concurrent with maternal speech or toy noise) were eliminated.
3. Screams, cries, coughs, and any other vegetative sounds were excluded.
4. Babbled and noninterpretable utterances were bounded by 1 second of silence, a breath, a noise, or maternal speech.
5. Intonational contours were used to determine the utterance boundary.

Completed transcriptions were entered into individual CHAT files (Codes for the Human Analysis of Transcripts; MacWhinney, 1995) for subsequent analysis using CLAN software (MacWhinney, 1997). Final transcripts represented a mix of standard words (lexically recognizable forms rendered in phonetic transcription), babble (defined as transcribable sounds without interpretable referents), and unintelligible sequences (sound strings for which no agreed-upon phonetic transcription could be reached). For the purpose of analysis, no distinction was made between standard words and babble as long as the vocalization could be transcribed. Unintelligible (i.e., nontranscribable) utterances characterized 3.61% at 24 months and 2.06% at 36 months of the speech for TD children. For SLI-E children, only 2.08% at 24 months and 1.52% at 36 months were characterized as nontranscribable.

Transcription of syllable shapes was governed by a number of operational principles. We recognized that it is difficult to make a priori decisions about whether a "multisyllabic" babble string represents a unitary form or the child's attempt to output a series of monosyllabic words for which listeners could not reference targets. When bracketing out known lexical targets, where intonation contour and pausal phenomena were not sufficient to distinguish these choices, the default was to use "maximal bracketing" to create the largest possible remaining unit. Thus, for example, two successive syllables for which no clear target adult form could be determined were treated as a CVCV or VCVC sequence. This coding strategy maximized the children's potential for achieving credit for more advanced syllabic shapes.

Data reduction

Each child's CHAT file contained one main tier and three dependent tiers. The three dependent tiers consisted of a phonetic tier in Unibet (%pho:) containing the phonetic transcription of each child's speech; a syllable shape tier (%syl:) containing the syllable shapes represented in the phonetic transcription; and a syllable structure tier (%lev:) containing the assigned levels of each syllable shape. In accordance with the procedure outlined by Paul and Jennings (1992) and Thal et al. (1995), syllable shapes were assigned to syllable structure levels based on the following guidelines:

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Level 1: vocalizations containing a vowel (e.g., [a]), a syllabic consonant (e.g., [s]), or a CV syllable in which the only consonant type is a glottal stop (e.g., [ʔu]) or glide (e.g., [wi]);
Level 2: vocalizations containing true consonants with a single consonant (e.g., [ba], [$^{\wedge}$p]) or identical consonants (e.g., [mam], [dædi]) not represented in Level 1;
Level 3: vocalizations containing two or more different consonants, not including consonant clusters (e.g., [dOgi], [k$^{\wedge}$p], [fInI‘]), and vocalizations containing consonants that differed solely in voicing (e.g., [p$^{\wedge}$b$^{\wedge}$]);
Level 4: vocalizations containing consonant clusters (e.g., [br$^{\wedge}$‘], [El{f$^{\wedge}$nt]).

The percentage of production of each syllable structure level was calculated on a per-child basis. Mean syllable structure level, as per Paul and Jennings (1992), was also calculated, with SSL4s scored as SSL3s. Finally, the frequency of each syllable shape was tallied for descriptive purposes.

Reliability

Reliability of phonetic transcription was assessed through the retranscription of approximately 13% of the sample. Two groups of children – 4 24-month-olds and 4 36-month-olds – were randomly selected for this purpose. Each age group contained 2 SLI-E and 2 TD children. Four students, trained in phonetic transcription, served as the additional transcribers. A method of occurrence reliability (McReynolds & Kearns, 1983) was utilized. Briefly, occurrence reliability differs from the more common point-to-point method by including only those vocalizations that both observers agree are able to be accurately transcribed. For TD children, 92% of vocalizations were judged to be transcribable by both judges, while only 70% of vocalizations from SLI-E children met this criterion. Interrater agreement percentages for the transcription of identical syllable shapes ranged from 72% to 90% ($M = 81.75\%$, $SD = 6.17$). More specifically, reliability percentages were 72% and 82% for 24-month-old SLI-E children; 82% and 83% for 24-month-old TD children; 74% and 83% for 36-month-old SLI-E children; and 88% and 90% for 36-month-old TD children. As expected, transcribers experienced greater disagreement on the transcription of the speech of younger children and children with SLI-E. The greater sources of disagreement were the transcription of identical CV syllables as a reduplicated CVCV shape and the presence of final consonants and final consonant clusters. To maintain consistency within the data, only the first author’s transcriptions were used for the final data analysis.

RESULTS

Spontaneous speech samples ranged in length from 8:32 to 10:00 minutes (M = 9:51, $SD = 0.016$) for SLI-E children and from 8:38 to 10:00 minutes ($M = 9:51$, $SD = 0.013$) for TD children. Unpaired t tests revealed no significant differences between groups at either age. Samples were shortened when children refused to participate further in the play activity. Conversely, when play sessions lasted

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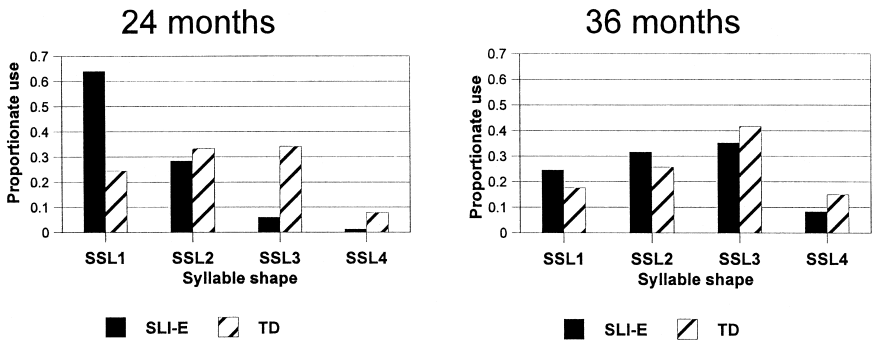


Figure 1. Proportion of each syllable structure level produced by SLI-E and TD children at 24 and 36 months.

longer than the designated time, only the first 10 minutes were included in the final data analysis. In spite of similar sampling times between groups, vocalization rates differed greatly. At 24 months, SLI-E children vocalized at a mean rate of 98.85 vocalizations (range = 29–301, $SD = 56.98$), compared to TD children's mean rate of 192.07 vocalizations (range = 66–338, $SD = 74.84$). When the cohort reached 36 months, SLI-E children vocalized at a mean rate of 230.65 vocalizations (range = 71–479, $SD = 113.64$), compared to TD children's mean rate of 342.20 vocalizations (range = 95–585, $SD = 141.62$). Unpaired t tests revealed significant differences between SLI-E and TD children at both 24 and 36 months. Because of the significant differences in vocalization rate, all data were proportioned on a per-child basis.

Syllable structure levels

A series of Mann–Whitney U tests, adjusted to yield Z scores, were performed to evaluate between-group differences at each syllable structure level for each age examined. Figure 1 illustrates the findings of this analysis.

Syllable structure level 1. At 24 months, SLI-E children produced a significantly greater proportion of SSL1 vocalizations than age-matched TD children ($Z = 4.0667$, $p < .0000$). At 36 months, SLI-E children continued to produce a significantly greater proportion of SSL1 utterances, although the magnitude of the difference was not as great ($Z = 2.7667$, $p < .0057$). Examples of SSL1 vocalizations include: *I* [aI], *we* [wi], *yeah* [j@], and *sh* [‘].

Syllable structure level 2. At 24 months, TD children produced a slightly greater proportion of SSL2 vocalizations than SLI-E children, but this difference was not significant ($Z = .9666$, *ns*). At 36 months, however, a between-group difference was significant, with SLI-E children producing a greater proportion of SSL2 vocalizations than TD children ($Z = 2.5333$, $p < .0113$). Examples of SSL2 vocalizations include: *dada* [d@d@], *mom* [mam], *is* [Iz], and *go* [go].

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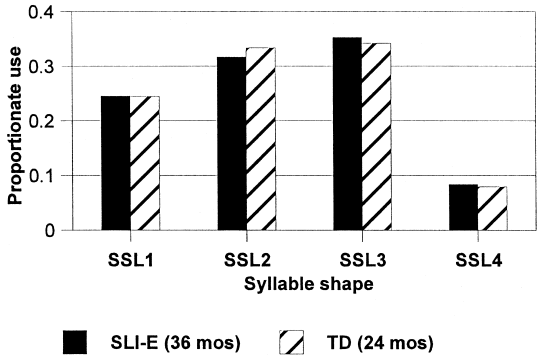


Figure 2. Comparison of SLI-E 36-month-olds and TD 24-month-olds on proportion of each syllable structure level produced.

Syllable structure level 3. At 24 months, TD children produced a significantly greater proportion of SSL3 vocalizations than SLI-E children ($Z = 4.5667$, $p > .0000$). At 36 months, TD children continued to produce a significantly greater proportion of SSL3 vocalizations than SLI-E children, but the magnitude of the difference was not as large ($Z = 2.8333$, $p < .0046$). Examples of SSL3 vocalizations include: *here* [hir], *gonna* [g^n{], *ladder* [l@d5], and *only* [onli].

Syllable structure level 4. At 24 months, both groups produced relatively few vocalizations containing consonant clusters, but TD children produced a significantly greater proportion than SLI-E children ($Z = 4.3667$, $p < .0000$). At 36 months, TD children continued to produce a significantly greater proportion of consonant clusters than SLI-E children ($Z = 3.3667$, $p < .0008$). Examples of SSL4 vocalizations include: *trip* [trIp], *lights* [laIts], *scream* [skrim], and *asked* [@skt].

Mean syllable structure level. Mean syllable structure level was calculated for each group at each age. At 24 months, SLI-E children produced a mean syllable structure level of 1.432 ($SD = 0.295$, range = 1.027–2.035), and TD children produced a mean syllable structure level of 2.176 ($SD = 0.212$, range = 1.825–2.500). At 36 months, SLI-E children produced a mean syllable structure level of 2.191 ($SD = 0.134$, range = 1.923–2.324), and TD children produced a mean syllable structure level of 2.391 ($SD = 0.096$, range = 2.186–2.505). Unpaired *t* tests revealed significant differences between SLI-E and TD children at both 24 and 36 months. No significant difference was found between 36-month-old SLI-E children and 24-month-old TD children. As seen in Figure 2, group profiles for 36-month-old SLI-E children and 24-month-old TD children were strikingly similar across all four syllable structure levels. Finally, paired *t* tests revealed that both SLI-E and TD children demonstrated significant increases in mean syllable structure level from 24 to 36 months.

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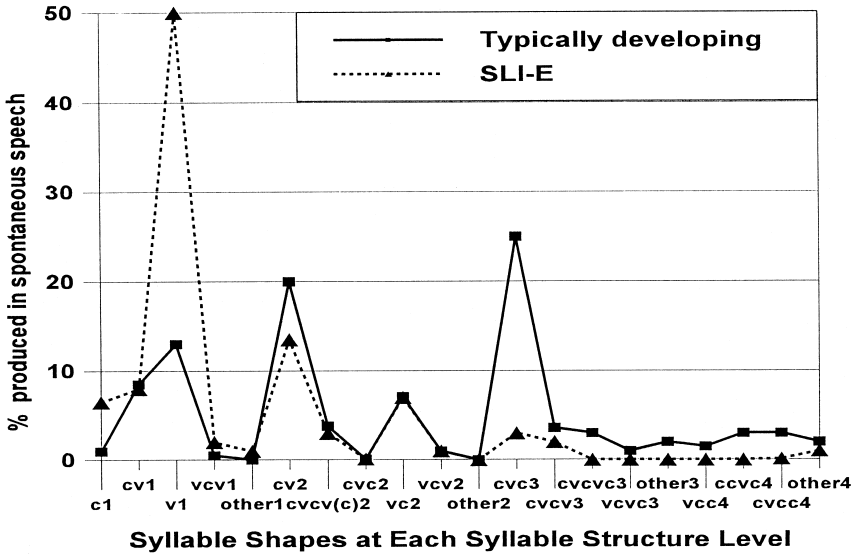


Figure 3. Syllable shape use of SLI-E and TD children at 24 months.

Syllable shape preferences

Figures 3 and 4 present a more detailed picture of which syllable shapes were produced at the various syllable structure levels. These data were not subjected to statistical analyses, but nonetheless they assist in illustrating some of the differences in the production of specific syllable shapes. Figure 3 graphs the proportional use of all syllable shapes produced by SLI-E and TD children at 24 months. Figure 4 displays the same data for the children at 36 months.

The data presented in Figure 4 are consistent with the results of the Mann–Whitney *U* tests, which revealed a statistically different pattern of production of syllable shapes by 24-month-old SLI-E children. These children followed a pattern of production similar to that of their TD peers for many of the syllable shapes across levels; the most dramatic differences appeared with SLI-E children's increased proportional usage of (SSL1) vowel-shaped (V1) vocalizations (e.g., [a]) and their decreased usage of vocalizations classified as the closed (SSL3) CVC shape (e.g., [maIn]). Other points of difference between SLI-E and TD children were noted. In particular, SLI-E children produced a proportionately larger number of vocalizations classified as syllabic consonants (C1) (e.g., [ˈ]); showed a lower rate of utilization of the open syllable shape containing consonants other than glides or glottal stops (CV2) (e.g., [d@]); and produced a few vocalizations with consonant clusters (SSL4) (e.g., [grin]).

At 36 months (see Figure 4), SLI-E children increased the diversity of their syllable shapes to what appeared to be nearly equal to that of TD children. However, they continued to diverge from TD children on their frequency of production of various syllable shapes. SLI-E children consistently produced a

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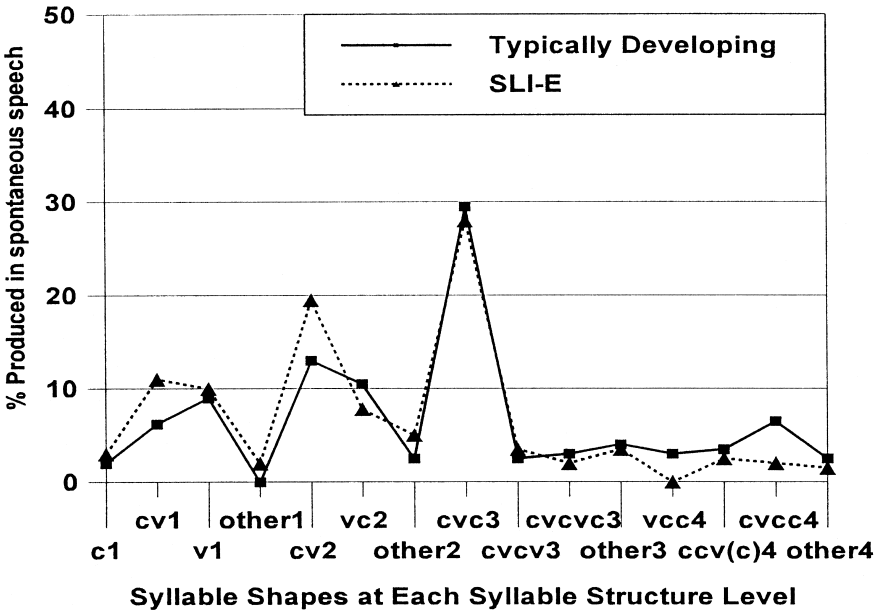


Figure 4. Syllable shape use of SLI-E and TD children at 36 months.

higher proportion of all SSL1 shapes and most of the SSL2 shapes, with the exception of the vowel initial vocalization (VC2) (e.g., [^p]). Conversely, TD children produced a higher proportion of all SSL4 shapes and all but one of the SSL3 shapes. The exception was the open syllable (CVCV3) (e.g., [g^n{]). Moreover, SLI-E children were more likely to produce a vocalization with an open syllable shape, especially CV1 (e.g., [j@]) and CV2 (e.g., [ma]), whereas TD children were more likely to produce vocalizations with a closed syllable shape, especially those ending with consonant clusters (e.g., [dont]). Thus, an important differentiating factor between the two groups at 36 months is that TD children tended to produce a higher proportion of the more advanced, closed syllable shapes.

DISCUSSION

SLI-E children at both 24 and 36 months produced fewer of the more advanced syllable shapes. As the children matured, the diversity of their shapes increased, and they became more like those of their TD peers. However, at 36 months SLI-E children continued to display deficits in consonant cluster production and closed syllable shapes, in spite of their similar patterns across the less advanced syllable structures. This overall pattern appears to represent a model of delayed development that is not qualitatively different from that of younger TD children.

The overall findings of this investigation are consistent with those reported

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by Mirak and Rescorla (1998), Paul and Jennings (1992), Rescorla and Ratner (1996), Roberts et al. (1998), and Thal et al. (1995). Children up to 3 years of age who are diagnosed with SLI-E display a significantly different pattern of syllable structure production from their TD agemates. While this and other studies have found significant differences in the comparison of diagnostic groups, the present study extends previous findings by more clearly delineating the source of the differences across a wider age range and in a more homogeneous group of children. At 24 months, SLI-E children produced significantly more of the earlier developing syllable shapes (SSL1), whereas TD children produced more of the later developing structures (SSL3 and SSL4). At 36 months, SLI-E children's vocalizations appeared more like those of TD children, but significant differences remained with regard to the more advanced syllable shapes.

Paul and Jennings's (1992) finding of no significant difference in mean syllable structure level between younger and older subgroups of either SLI-E or normally developing children is not supported by the present study. The present study revealed significant developmental changes for both SLI-E and TD children such that, as both groups matured from age 2 to 3 years, the mean structural complexity of their vocalizations increased. Although the mean syllable structure level was shown to increase from younger to older subgroups in Paul and Jennings (1992), this increase was not significant. Several factors may explain the reason for this incongruity. Children in the present study were an average of 8 months older than the oldest group of children examined in Paul and Jennings (1992). Furthermore, the highest level structures examined by Paul and Jennings (1992) were already present in significant numbers in the speech of the younger (18-month-old) subgroup, thereby reducing the chance of finding a significant difference.

The findings of the present investigation partially support those of Thal et al. (1995), who found a significant effect for developmental stage and a significant difference between prelinguistic late talkers and their age-matched peers. Unlike the present investigation, however, Thal et al. did not find a significant difference between late talkers using meaningful speech and age-matched controls. However, Thal et al. examined development as a factor of developmental stage rather than chronological age, and thus this lack of agreement is not surprising as 13 months separate Thal et al.'s late talkers from the present study's 36-month-old SLI-E children.

While Roberts et al. (1998) did not find a significant difference between groups on a measure of volubility, the present study revealed a significant finding. Possible reasons for this difference include partially different subgroups from the original Rescorla cohort (Rescorla et al., 1997; Rescorla & Schwartz, 1990), different sample sizes, and different transcription criteria. However, in spite of these differences, the overall trend showing increased levels of volubility in the SLI-E group at age 3 remained constant between studies.

A potential concern in the present study is the inclusion of babbled utterances. Current research into the continuity between babble and meaningful speech indicates that the two are closely related and co-occur for a period of 4 to 5 months as the transition from babble to first words takes place (Cruttenden, 1970; Elbers, 1982; Labov & Labov, 1978; Leopold, 1947; Olmsted, 1971; Vihman &

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Miller, 1988). Children's early words often display patterns found during the later stages of babbling. Both consonants and syllable shapes follow this continuity (Vihman & Miller, 1988), whereas vowels typically do not (Davis & MacNeilage, 1990). In addition, researchers have found evidence that an infant's individual phonetic and syllable shape preferences cross over from late babble to first words (Vihman, Ferguson, & Elbert, 1986). Development has been shown to decrease this individuality as each child moves toward using sounds and syllable shapes that more closely resemble those of the adult system. Thus, based on current findings, it would appear that the sounds most easily produced by infants at the conclusion of the prespeech period would be the same sounds that appear in their first words.

Only one study has been designed specifically to address the issue of continuity in the population of children identified as SLI-E. Whitehurst, Smith et al. (1991) showed a strong correlation between the complexity of babble and the expressive language skills observed 5 months later in a sample of 37 28-month-old children with expressive language disorder. Although continuity was not examined in the traditional manner, these results support a theory of continuity between late babble and meaningful speech in the SLI-E population.

Most of the research to date supports a theory of delayed development in the population of children diagnosed with SLI-E. The present investigation is no exception. The results reported here strongly support the theory that SLI-E children develop speech and language skills at a slower rate than their TD peers. The reason for this apparent delay is still unknown. Findings of reduced rates of vocalization have led some researchers (Mirak & Rescorla, 1998; Paul & Jennings, 1992; Rescorla & Ratner, 1996) to postulate that limited vocal practice may be integral to the phonetic delay observed in the SLI-E population. Differences in vocalization rate between SLI-E and TD children also appeared in the present study's cohort. Consistent with Rescorla and Ratner (1996), 2-year-old SLI-E children as a group vocalized at a mean rate of almost half that of TD children during a 10-minute spontaneous speech sample. At 3 years, SLI-E children showed some improvement, increasing their mean vocalization rate to approximately 75% of the rate observed in their TD agemates. This increase in overall vocalization rate is compatible with the advancement in phonological abilities displayed by 3-year-old SLI-E children.

Recent research has intimated the existence of a positive correlation between volubility and subsequent speech and language ability (Camp, Burgess, Morgan, & Zerbe, 1987; Sullivan & Ratner, 1991), such that volubility facilitates the active process of development. With each vocalization, the child creates an opportunity for articulatory practice and auditory feedback, both of which are considered necessary for learning the speech sounds and syllable types that serve as the building blocks for lexical acquisition (Locke & Pearson, 1992; Stoel-Gammon, 1992). Volubility also has been positively correlated with an increase in caregiver interaction, which in turn stimulates further vocalization by the child. Findings by Veneziano (1988) suggest that the active process of language development relies on the mutual engagement of both child and caregiver as each strives to meet the other in language knowledge. It would then follow that the child who talks more would be more likely to produce a phonetic sequence

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from which the caregiver could interpret meaning. Thus, the caregiver would engage the child in subsequent interactions during which valuable feedback would be provided. In fact, rapid progress in early lexical development has been linked to a mother's belief that her child's early vocalizations represent word attempts (Murphy, Menyuk, Liebergott, & Schultz, 1983).

The ancillary finding that reliability of transcription was lower for the SLI-E samples may have interesting consequences for these children's interactions with adult speakers and their opportunities for language growth. A significant positive correlation was found between intelligibility and maternal use of recasts with SLI-E children (Conti-Ramsden, 1990). The more intelligible children provided their mothers with a greater number of opportunities, and therefore their mothers used the greatest number of simple recasts. Unintelligibility appears to interfere with the parent's responsiveness to the child. Along with parental inability to attach meaning to the phonetic sequences uttered by the child, it is not particularly surprising that researchers have encountered similar difficulties in agreeing on the structure and sound sequences of some of these utterances. Although the relationship between intelligibility and phonetic transcription reliability has not been examined in the SLI-E population, it is apparent that they are related and may have important consequences for these children's language-learning opportunities.

Research findings on the linguistic characteristics of maternal input to late talkers have been contradictory. Paul and Elwood (1991) found that mothers of late-talking children did not differ significantly from those with normally developing children in the proportion of utterances containing expansions and extensions relative to the child's rate of vocalization. However, because the late talkers vocalized less, a significant difference in the overall number of extensions and expansions provided by the mothers was noted. On the other hand, Whitehurst, Fischel et al. (1988) reported significant differences between mothers of speech-delayed children and those of children matched for receptive language or chronological age in the variety of pragmatic categories utilized. Because the frequency of use of expansions and extensions in child-directed speech has been linked to a heightening of children's language abilities (Barnes, Gutfreund, Satterly, & Wells, 1983), a clarification of these differences would be useful, both from a clinical and a research standpoint. The findings appear to suggest that children who vocalize less often may deprive themselves of opportunities to improve their language ability, as a result of reduced vocal practice and decreased caregiver interaction. Thus, children's reticence may serve to perpetuate their delay, not only in phonology but also in the acquisition of vocabulary and syntax.

The developmental relationship between phonology and later stages of language development has long been recognized (Panagos, 1982), and estimates of children with delays in phonology who exhibit concomitant delays in syntax reach 80% in the literature on childhood speech and language disorders (Paul & Shriberg, 1982; Shriberg & Kwiatkowski, 1988). Subsequent research has identified the reciprocal nature of delays in phonology and syntax (Menyuk, 1964; Panagos & Prelock, 1982; Shriner, Holloway, & Daniloff, 1969). It has been found that increased syntactic complexity produces an increase in phonological

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errors (Panagos, Quine, & Klich, 1979), and that increased phonological complexity causes an increase in syntactic errors (Panagos & Prelock, 1982). Concomitant delays in phonology and syntax have also been examined in the population of children with SLI-E (Mirak & Rescorla, 1998; Paul, 1993; Thal et al., 1995), although researchers have not yet attempted to demonstrate a causal relationship in this population. Paul and Shriberg (1982), however, uncovered a link between speech-delayed children's use of phonological simplifying processes and their productive use of grammatical morphemes determined to be phonetically complex. The processes of final consonant deletion and cluster reduction were found to interfere with the speech-delayed child's production of the following grammatical morphophonemes: plural, possessive, regular past tense, and regular third-person singular. In their sample of 30 children with mild–moderate to severely delayed speech, Paul and Shriberg (1982) found that approximately 50% had phonological delays that adversely affected their productive syntax. Given the paucity of production of final consonants and consonant clusters in the speech of the children in the present study, as well as their apparent delays in syntax, an analysis such as that conducted by Paul and Shriberg (1982) on samples from the study children at older ages may not only provide additional evidence for a causal link in some types of syntactic delay, but also prove fruitful in determining which SLI-E children are at greater risk for continued difficulties. Even at 36 months, the children in both groups studied here did not produce enough phonetically complex bound inflections to permit meaningful analysis.

Given that phonological delays are observed in even the earliest productions of children diagnosed with SLI-E, there is a possibility that expressive language delay is intrinsically based in phonological insufficiency. Partial support for this hypothesis is provided by the relatively low numbers of children in past longitudinal SLI-E studies who demonstrate persistent linguistic delays. In fact, it may well be that the selection of children at such early ages caused an overselection or inappropriate selection of children for the SLI-E diagnostic category. That is, by selecting children at a presyntactic stage of language development and for non-syntactic reasons, we may overselect for the later syntactic delay that accompanies some, but not all, vocabulary deficits, or we may miss children whose later deficits are unrelated to the compilation of the expressive lexicon.

Recent discussion has focused on whether SLI-E as observed in preschool children may be classified as a true disorder or as a risk factor for later learning difficulty. The studies cited earlier clearly show that the majority of SLI-E children move into the normal range by school age. The phonological development of this population is reportedly "essentially normal" as measured by standardized tests, although performance of the group as a whole falls within the low–normal range. Naturalistic data on the phonological profiles for this population at school age have not been reported. Thus, the exact implications of a delay in the development of syllable structure occurring between the ages of 2 and 3 are not clear. However, persistent and pervasive delays in syllable structure development have been noted in the population diagnosed with SLI (Fee, 1995; Haynes & Naidoo, 1991).

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Clinical implications

What should the clinician do when confronted with a 2-year-old child who is slow to talk? At the present time, it is not possible to state conclusively whether treatment is warranted or even beneficial. Researchers studying this population currently remain divided on the issue. The results of early outcome data show that the majority of these late talkers spontaneously recover to levels within the low end of the normal range. However, the question of which children recover and which continue to present with later learning difficulties cannot yet be answered. Nevertheless, some important clinical implications may be drawn from this research.

If a child is performing below the group mean reported for the SLI-E children on syllable structure production, therapy may well be warranted. Paul (1996) advocated a policy of "watch and see" and suggested that therapy be initiated if a series of conditions are not met. For phonological development, the condition is: "The child's speech can be understood by family, friends, and peers after the third birthday" (Paul, 1996, p. 16). Perceptually, this roughly corresponds to the available normative data on phonological acquisition. Clinicians who decide to address the issue of treatment in this population may want to consider incorporating a goal which specifically targets syllable shape production. Following a developmental sequence, the expansion of the child's phonetic inventory to include sounds other than the most elementary glides, in addition to the production of more than one sound per syllable shape, would be recommended for the younger child. For a child of 3 or older, highlighting the closure of open syllable shapes and presenting a wider range of syllable types would be suggested. An introduction of the earliest appearing consonant clusters also may prove beneficial, specifically in final position, to facilitate morphological marking. Although consonant cluster reduction is a phonological process which typically persists after age 3 (Bankson & Bernthal, 1990; Kahn & Lewis, 1986; Roberts, Burchinal, & Footo, 1990; Stoel-Gammon, 1985), all of the TD children in the present study were using consonant clusters by age 2. Continued research on the SLI-E population is crucial so that clinicians and parents alike may arrive at well-informed decisions on what course of action is best for the preschool child diagnosed with SLI-E.

Research into the effects of intervention on the developing phonological skills of late talkers is quite limited. Whitehurst, Fischel et al. (1991) found no significant difference on a single-word test of articulation between expressive language-delayed children who had received language intervention and those who had not. Using a pretreatment–posttreatment design, Girolametto, Pearce, and Weitzman (1997) examined the effects of lexical intervention on the phonology of late talkers. They found significant posttreatment differences between the experimental and control groups, such that the experimental group produced a greater number of sounds in both initial and final positions and a greater variety of complex syllable shapes. However, differences between groups were not significant for percentage of consonants produced correctly, number of different vocalizations produced, and production of syllable shapes containing a single

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consonant type. Thus, training vocabulary in SLI-E toddlers was seen to have some beneficial effects on their phonology. The opposite strategy, using phonological intervention to affect lexicon size, was not assessed, and so the relative merits of targeting lexicon or phonology first when both are impaired cannot be evaluated. Collectively, these studies demonstrate the need for further research into the relationship among phonological, lexical, and syntactic development in children who are slow to talk.

CONCLUSION

The SLI-E child's development of complex syllable shapes appears to represent a slowed-down version of that of TD peers. Characteristic differences include the SLI-E child's higher proportional use of a restricted variety of simpler, less advanced syllable shapes. Over time, SLI-E children demonstrate a significant increase in syllabic complexity and show the potential for narrowing the extant gap between themselves and their TD agemates. However, even at age 3, significant differences continue to be present, which suggest that a 3-year-old SLI-E child is performing at the level of a 2-year-old TD child. These results correspond well to previous research, which has found that phonological deficits may persist in the SLI-E population until age 5 or beyond (Paul, 1993; Whitehurst, Fischel et al., 1991). Given the recent evidence of the inability of SLI adults to master the structural complexity of the English language (Fee, 1995), a measure of syllable structure complexity may serve as a predictor of later language outcome and thus prove useful in the diagnosis and preferred remediation strategy for toddlers with SLI-E.

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