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Speech patterns in Cypriot-Greek late talkers

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ABSTRACT
The investigation longitudinally examined the phonetic skills of Cypriot-Greek children with late onset of expressive vocabulary. The rate of phonological development within short time increments and the identification of possible speech constraints motivating slow development of expressive language were examined. Participants were seven Cypriot-Greek children identified as late talkers, and seven age-matched normally developing counterparts. Phonetic skills were examined at ages 30, 33, and 36 months for both groups based on spontaneous language samples. Phonological analyses focused on the construction of all subjects' phonetic inventories over time. Both groups exhibited an increase of specific phoneme use over time. Late talkers had significantly poorer phonetic inventories when compared to the control group. Within the experimental group the analysis revealed the persistent omission of word-initial consonants. Results are discussed in terms of language-specific phonological constraints and their relation to slow development of speech.

Research on early detection of language problems revealed that approximately 15% of middle class preschool children in the United States present with late onset of expressive language (Rescorla, 1989). These children are usually referred to as late talkers (LTs). In these youngsters, early expressive language delay is diagnosed on the bases of restricted expressive vocabulary (usually less than 50 words) and lack of 2-word combinations around the age of 24 months, despite normal cognitive and emotional development.

However, LT children do not necessarily develop a language delay, and significant variability exists regarding longitudinal language outcomes. Recovery rates have been estimated to be around 50%, suggesting that some children will eventually "grow out" of early language delay (Paul, Looney, & Dahm, 1991; Rescorla & Schwartz, 1990). Studies examining language skills at age 3 years revealed that some LT children achieved age-appropriate scores on standardized batteries while others continued to lag behind on a number of language milestones (Ellis-Weismer, Murray-Branch, & Miller, 1994; Fischel, Whitehurst, Caulfield, & DeBaryshe, 1989; Paul et al., 1991; Rescorla & Schwartz, 1990; Thal, Tobias, & Morrison, 1991). Notably, by age 3 years, significant progress for lexical development may occur in relation to depressed morphological, phonological, and syntactic skills (Rescorla, Roberts, & Dahlsgaard, 1997; Rescorla & Schwartz, 1990); however, lexical progress at 3 years, 0 months (3;0) is predicted by vocabulary size from ages 2;2; to 2;4 (Rescorla, Mirak, & Singh, 2000). At 4 years of age, reported language outcomes referred to grammatical difficulties (Paul & Alforde, 1993) as well as difficulty in narrative skills (Paul & Smith, 1993).

Taken together, the research findings suggest that some children with a late onset of expressive language may be at risk for long-term linguistic deficits, learning disabilities, and academic difficulties (Aram, Eckelman, & Nation, 1984; Aram & Nation, 1980; Bishop & Edmudson, 1987; Scarborough & Dobrich, 1990; Silva, Williams, & MacGee, 1987).

Apart from a cluster of other factors such as family history (Ellis-Weismer et al., 1994) and receptive language level (Mirak & Rescorla, 1998; Rescorla & Schwartz, 1990), it has been suggested that the phonological skills of LT populations may be a major contributing factor to the late onset of expressive language. This stems from studies that investigated the phonological skills of LTs (Rescorla & Ratner, 1996; Roberts, Rescorla, Giroux, & Stevens, 1998; Stoel-Gammon, 1989; Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). However, it is also supported by a large body of evidence attesting that development, lexical organization, and processing capacity of language are linked with phonological ability (Beckman & Edwards, 2000; Coady & Aslin, 2003; Edwards, Beckman, & Munson, 2004; Gerken, Murphy, & Aslin, 1995; Menn, 1978; Schwartz & Leonard, 1984; Storkel, 2001; Storkel & Rogers, 2000).

Several studies have found that, from the earliest stages, the phonological skills of LTs lag behind normal development. Stoel-Gammon (1989) examined retrospectively the babbling patterns of two LTs between the ages 9 and 24 months, and reported a positive relationship between size of expressive vocabulary and diversity of phonetic inventory. Phonological limitations included atypical sound preferences and limited use of canonical babbles characterized by absence of consonants. Similarly, simple syllable structure, small consonantal and vowel inventories, small ratios of consonant to vowel targets and reduced frequency of vocalizations were reported by subsequent studies for LTs aged from 24 to 31 months (Rescorla & Ratner, 1996; Whitehurst et al., 1991). It has been suggested that the proportion of consonant to vowel at 24 months strongly predicted the persistence of language delay at the 5-month follow-up visit. Follow-up data at age 36 months showed that approximately half of LTs continued to lag behind on certain phonological parameters, including mastery of phonemes such as stops and glides (Roberts et al., 1998).

In older LT populations, one study by Ellis-Weismer et al. (1994) reported no phonological deficits in their LT subjects. However, converging evidence on phonological skills in older children with a history of delayed onset of expressive speech supports the persistence of phonological delays (Mirak & Rescorla, 1998; Paul & Jennings, 1992; Rescorla & Ratner, 1996; Rescorla & Schwartz, 1990). Findings generally lend support to a delayed rather than a deviant developmental pattern because phonetic inventories and syllable structures used by LT children resembled the patterns exhibited by younger normally developing children (Mirak & Rescorla, 1998; Paul & Jennings, 1992; Rescorla & Ratner, 1996; Thal, Oroz, & McCaw, 1995).

The above findings reveal a strong relationship between phonological skills and language development early on. It can be hypothesized that the child's limited phonological or speech motor skills may rob him/her from communicative chances to practice the ambient language early on (Stoel-Gammon, 1989; Whitehurst et al., 1991). In contrast, one may not rule out the possibility that slow language learning due to other language factors, including lexical factors such as word familiarity, word frequency, neighborhood frequency, precipitate decreased phonemic awareness, thus arresting phonological development (Dollaghan, 1994; Lindblom, 1992).

Further recent work on the interactions among language levels illuminates new aspects on the role of phonological ability in relation to lexical development. Pertinent studies have shown that phonological representation skills may affect lexical growth, as well as processing capacity and production accuracy of words (Edwards et al., 2004; Gerken et al., 1995). As children (and adults) store more words in mental lexicon they organize them in neighborhoods based on their phonetic similarity, a phenomenon addressed as the neighborhood density effect (Charles-Luce & Luce, 1990; Coady & Aslin, 2003; Logan, 1992). In addition, Schwartz and Leonard (1984) have shown that an early developmental mechanism of lexical acquisition, that is, prior to the 50-word stage, is that children acquire more IN words than OUT words, basing their decision on phonological grounds tied in to their productive phonological repertoire. Thus, dense neighborhoods are formed early on and their formation facilitates rapid vocabulary growth. Neighborhood density also leads to further phonetic refinement as recognition of incoming words will be depended upon the child's ability to distinguish among similar phonetic forms, that is, among the phonetically similar words in the neighborhood.

Conversely, early formation of phonological representations may affect word learning. It has been found that children (and adults but to a lesser degree) process new words faster when they have a high phonotactic probability (Storkel, 2001). Finally, Edwards et al. (2004) have shown that receptive and expressive vocabulary size was related to phonological factors such as phonotactic probability and articulatory skill, apart from lexical factors such as word frequency.

Because there is growing evidence in the developmental literature that speech sounds are considered to be the "building blocks" for lexical acquisition it appears important to examine the phonetic skills in LT children at any language as they might be considered a precipitating factor for subsequent delays in vocabulary growth.

However, some studies (Treiman & Baron, 1981) dispute the above developmental account and indicate that normally developing children are using holistic processing even after the vocabulary spurt, and only later on do they start processing language based on phonological categories. This idea, coupled with recent findings that indicate that phonologically delayed (PD) children do not process words in ways similar to their normally developing peers but rather divert to different strategies for word selection that do not require sharp phonological skills (Storkel, 2004), diminishes the role of phonological ability, indicating that phonology may not be the sole determinant of vocabulary growth.

On par with the notion of an unformed phonological skill is the widely accepted theoretical framework (Ferguson, 1986; Ferguson & Farwell, 1975; Macken, 1979; Menn, 1983; Menyuk, Menn, & Silber, 1986;Vihman, 1992; Waterson, 1971) according to which phonemic awareness does not occur until later in language development and in early stages children process holistic forms. In explicit terms, the particular ways via which normally developing children simplify the motoric output depend on gross characteristics of phonological patterning, that is, word structure.

Because children first learn to recognize word forms (Ferguson & Farwell, 1975), one might expect that children's output phonological patterns in different languages will be affected by language particular characteristics. Indeed, developmental studies in other languages such as Finnish (Savinaimen-Makkonen, 2000), German (Berg, 1992), and Italian (Bortolini & Leonard, 1991), in addition to French (Ingram, 1986) and Brazilian Portuguese for the case of liquids (Yavas & Lamprecht, 1988), indicate that children use initial consonant deletion (ICD) in their word productions, a finding not noted in English (Ferguson & Farwell, 1975; Kiparsky & Menn, 1977; Mirak & Rescorla, 1998; Paul & Jennings, 1992; Rescorla & Ratner, 1996).

Based not only on the above but also on preliminary findings that LT patterns are delayed rather than deviant, it should be interesting to investigate the phonological patterns of LTs in another language. To date, the existing literature on the phonetic skills of LT populations, although informative, has only focused on English-speaking children. Therefore, the impact of language particular characteristics in shaping atypical phonological development remains largely unexplored. Moreover, results from another language may throw some light on the issue of holistic versus segmental patterning at the early stages of language development, because the topic of processing strategy has been shown to be a crucial one for formulating valid (or even universal) accounts on lexical development. The language of interest in which LTs were examined is the Cypriot-Greek dialect (CYG).

THE CYG

CYG is spoken on the island of Cyprus, which is located in the southeastern Mediterranean Sea. It is considered a southeastern dialect of Standard Modern Greek (Mackridge, 1987; Newton, 1972). CYG consists of 27 consonants defined according to features of place and manner of articulation. There are bilabial, labiodental, dental/alveolar, palatal, and velar phonemes. Regarding manner of articulation there are stops, fricatives, affricates, nasals, liquids, and glides. The liquid segment /r/ is trilled. In CYG voiced stops are prenasalized, with voiceless cognates being either unreleased or aspirated. The [n] and [s] may also occur in word final position. According to Newton (1972) several phonological phenomena that pertain to CYG include the palatalization of the consonants /x/ and /k/ when these surface before the front vowels /i/ and /ɛ/ ([ˈçɛri], *hand* and [ˈcɛʻri] *candle*), respectively. The palatal-alveolar fricative [ʃ] is the allophone of the palatal fricative [ç] (i.e., [ˈçɛri] also produced as [ˈʃɛri]). In addition, intervocalic voiced fricatives including the segments /v/, /ð/ and /γ/ might be deleted (/ˈliγo/, *some* also pronounced as [ˈlio]).

Currently, there are no published data regarding the syllable structure of CYG. Thus, for the purposes of the current investigations the authors analyzed the syllable structure of 600 target word items found in the Cypriot-Greek Lexical Acquisition List (CYLEX; Petinou, Hadzigeorgiou, & Minaidou, 1999). A detailed description of the CYLEX is provided in the Methods section. Percentages of syllable structure occurrences from the 600 uninflected words were as follows: consonant–vowel–consonant–vowel (CVCV; 28%), CVCVCV (22%), CVCVCVCV (10%), CCVCV (8%), CVCCV (6%), and VCV (6%). The rest of the word targets (20%) consisted of variable monosyllabic, trisyllabic, and multisyllabic structures. Based on these observations it was concluded that the predominant syllable structure one might encounter in CYG was the disyllabic CVCV and trisyllabic CVCVCV. Stress pattern analysis was also performed and results revealed 10 monosyllables, 285 disyllables (183 trochees [65%] and 102 [35%] iambs), 208 trisyllables (28 targets stressed on the ultimate, 120 targets on the penultimate, 60 on the antepenultimate), and 97 multisyllables.

PURPOSE OF THE STUDY

The current investigation had three goals. The first goal was to examine the development of phonetic skills of Cypriot-Greek LTs and expand the current cross-linguistic database. The second goal was to observe whether the phonological patterns of young Cypriot-Greek speaking children with late onset of expressive language maybe affected by language-specific characteristics. The third goal was to relate the findings on phonological patterns of LTs with existing accounts of phonological and lexical development.

METHOD

Participants

Participants for this study were seven Cypriot-Greek toddlers identified as LTs between the ages of 24 and 28 months and seven peers with normal course of language development (NLD) who formed the control group. The two groups were matched on the bases of gender, age, and socioeconomic status (Cyprus Ministry of Internal Affairs, Department of Statistics and Research; Republic of Cyprus Health Survey, 1989). All children were recruited from a cohort of 66 subjects currently participating in an ongoing project on language development of Cypriot-Greek preschoolers.

The large cohort study yielded 27 children identified as LTs and 39 children with normal language development. In the current study, however, the group of the seven LTs included only the children whose caregiver was willing to participate in the phonological study at ages 30, 33, and 36 months.

All participants had unremarkable developmental and medical history, as reported on developmental questionnaires filled by each child’s primary caregiver. Subjects came from monolingual CYG-speaking environments with mothers as the primary caregivers, and had hearing within normal limits based on results from audiometric screenings performed by each child's family otolaryngologist or from pure tone screenings performed at intake using a GSI-38 portable audiometer. They all had normal nonverbal abilities based on informal cognitive assessment in the form of checklist performed by a developmental psychologist as part of the cohort testing protocol.

Materials

Size of expressive vocabulary and instances of word combinations were measured with the CYLEX administered to all subjects as part of the cohort testing protocol. The CYLEX is a vocabulary list consisting of 600 words usually found in children's early words, and has been designed based on the MacArthur Communicative Development Inventory (Fenson et al., 1993). The results from the list were based on parental reports regarding the child's comprehension and production of target lexical items. The list included both content and function words in the following order: onomatopoetic words, animal sounds, animal names, clothes, actions, places, foods, toys, tools, colors, numbers, definite articles, prepositions, conjunctions, and basic concepts. In addition, the list contained a section for 14 gestures that might be used by youngsters and a section on which caregivers could provide examples of phrases and short sentences used by their child.

Cognitive ability of the cohort population was assessed based on clinical observations and checklist adapted from the Bayley Scales of Mental Development administered at the time of intake. A "pass" or "fail" score was based on the child's performance on 18 nonverbal tasks within the age bracket of 23–28 months. Eighty percent (correct performance of 14 out of the 18 items) was used as the cutoff point required for a passing profile.

Receptive and expressive language skills in both groups were assessed at intake and at age 30 months using an adaptation of the Preschool Language Scale—3 (PLS-3; Zimmerman, Steiner, & Evatt-Pond, 1992). The PLS-3 was used as a guide to formal expressive and receptive language assessment procedures used as part of the cohort testing protocol. Certain items from the PLS-3 were adapted to fit child language characteristics and parameters of CYG. It should be noted that most of the adaptations were performed in the expressive domain of the test, and included the linguistic parameters of phonology, plural inflections, definite and nondefinite articles, grammatical agreement, and the correct use of clitics (Petinou & Terzi, 2002).

At age 30 months language assessment was repeated using the PLS-3 and the CYLEX to determine any linguistic changes in LTs that would disqualify them from the study (i.e., recovery from language delay). Additional language measures included mean length of utterance in words (MLUW).

Selection criteria for the LT group included the reduced size of expressive vocabulary as measured by the CYLEX, lack of 2-word combinations in the child's speech, as well as age-appropriate cognitive abilities as indicated at the time of intake. The cutoff criterion regarding size of expressive vocabulary at intake for the identification of LTs was calculated to be 50 words. The 50-word cutoff criterion was derived after z-score transformation of the raw vocabulary data from all 66 children and corresponded to the 10th percentile. The mean expressive vocabulary used by the 66 children of the larger cohort ranged from 18 to 600 ($M = 228$, $SD = 173$), and it included both LT and NLD children. Word count reliability was performed for 10% (seven children) of the CYLEX lists collected at intake. Counting reliability was performed between two research assistants and results indicated 100% agreement.

Procedures

Each child was seen for a total of three experimental sessions at ages 30, 33, and 36 months. Each session lasted approximately 45 min and was conducted in a carpeted room at a speech language clinic in Nicosia, Cyprus. Children's phonological abilities were examined through naturalistic observations and through a spontaneous language sample collected during child–mother and child–examiner communicative interaction. Play materials included plastic food items, dolls, plastic cups and plates, books, puzzles, and pictures. The toys were held constant across all children and across all sessions. Pictures depicting objects and actions were also used to elicit additional speech samples. Each session was audio recorded using a Marantz PMD-222 tape recorder and an Audio-Technico flat unidirectional microphone placed on the experimental table in front of the child.

Recorded speech samples were transcribed using the International Phonetic Alphabet. Broad phonetic transcriptions were performed for each recorded session including all consecutive different words or wordlike targets produced by each child. To be included in the analysis, each sample needed to include at least 30 consecutive glossable utterances. The analyses included both spontaneous and imitated targets. Nonspeech vocalizations including laughs, grunts, cries, coughs, as well as ill-recorded tokens (e.g., a vocalization co-occurring with noise or the adult's production) were excluded from the analysis. Boundaries for utterances were defined on the bases of pauses occurring between utterances (usually 1-s pause bounding each utterance), the recognizable onset of a real word, and a falling intonation contour indicating the offset of an utterance (Stoel-Gammon, 1992; Stoel-Gammon & Dunn, 1985). Phonetic coding was performed based on guidelines from the Language Production Checklist (Olswang, Stoel-Gammon, Goggins, & Carpenter, 1987), as well as procedures suggested by Rescorla and Ratner (1996), Roberts et al. (1998), and Stoel-Gammon and Dunn (1985). The elicitation of all possible target consonants was attempted through the presentation of pictures presented to the child during the experimental session. If the child did not attempt to spontaneously produce the target, the examiner prompted for delayed imitation. In cases where the child was not responsive even after several prompts, the examiner attempted the elicitation of direct imitations.

An independent phonetic analysis was employed for constructing the consonant inventory of each child. According to Stoel-Gammon and Dunn (1985), an independent analysis of a child's productions includes all phoneme tokens produced, regardless of the adult target. The particular consonant types used by each child were identified, and tokens of each type of consonant were counted. Established or stable productive consonantal targets were considered those that occurred at least two times in two different words in initial, medial, and final word position. The dependent variable was the mean number of consonant types across each age level for each child. If during multiple productions of the same word target the child used an allophone he/she was scored with productivity for both segments (i.e., the target [ç] in the word [ˈçεri] "hand" and its allophone [ʃ] in [ˈʃεri] "hand").

In addition to each child's inventory, established consonants per group were calculated including types that were consistently used by 60% of the children within each group (e.g., four of seven children; Rescorla & Ratner, 1996).

Transcription reliability

Four transcriptions (10% of samples) from four different children (two within each group) were randomly selected for the purposes of transcription reliability. The samples were phonetically transcribed by the first author and were checked against comparable coding from an independent transcriber (a speech-language pathologist trained in phonetic transcription) who was unfamiliar with the purpose of the investigation. Reliability on the relevant phonetic categories was based on the number of agreements divided by agreements plus disagreements after the two transcribers had jointly listened to the tapes and had compared their transcriptions with regard to place and manner of articulation. Interrater transcription reliability for manner and place of articulation were approximately 90 and 84%, respectively.

RESULTS

Language characteristics in LTs and NLDs at intake

At intake size of expressive vocabulary in the LT group ranged from 18 to 48 words ($M = 30$, $SD = 11$), and was significantly smaller when compared to the size of the expressive vocabulary in the NLD group with a range of 178 to 300 words ($M = 223$, $SD = 62$), t (12) = 8, $p < .05$. Standard scores for receptive and expressive skills in the LT group ranged from 77 to 89 ($M = 85$, $SD = 4.9$) and 72 to 83 ($M = 77$, $SD = 5.2$), respectively. Comparable standard scores for the NLD group ranged from 85 to 109 ($M = 95.2$, $SD = 7.6$) for receptive language and 87 to 103 ($M = 95$, $SD = 6.8$) for expressive language. When compared to the LT group children in the NLD group had significantly higher PLS-3 standard scores on both the receptive and expressive parts, t (12) = 3.27, $p < .05$, and t (12) = 4.62, $p < .05$, respectively. All children had passing scores on the cognitive tasks. Table 1 provides information on language measures in both groups at intake.

Language characteristics in LTs and NLDs at 30 months

At age 30 months size of expressive vocabulary in the LT group ranged from 39 to 150 words ($M = 83$, $SD = 40$). In the NLD group, expressive vocabulary ranged from 290 to 500 words ($M = 396$, $SD = 73$). Despite an increase in the expressive vocabularies within the LT group, significantly more words were produced by NLDs versus LTs, t (12) = 9.87, $p < .05$.

Table 1. *Language measures at intake*

Group	Size of Expressive Vocab.	PLS-3 Standard RC	Scores for EC
LT			
1	48	89	77
2	43	89	83
3	33	85	74
4	20	77	72
5	18	79	72
6	22	89	83
7	28	85	83
Mean	31	84.7	77.7
NLD			
1	237	97	100
2	178	97	100
3	290	109	100
4	128	89	87
5	247	93	91
6	300	97	103
7	185	85	97
Mean	223	95.2	95.4

Note: RC, receptive communication; EC, expressive communication. Subject numbers 6 and 7 in each group correspond to the female participants.

PLS-3 standard scores for receptive and expressive skills in the LT group ranged from 74 to 93 ($M = 84$, $SD = 7.44$) and 72 to 83 ($M = 78$, $SD = 4.2$), respectively. Comparable standard scores for the NLD group ranged from 97 to 127 ($M = 108$, $SD = 10.7$) for receptive language and 87 to 116 ($M = 100$, $SD = 10.9$) for expressive language. When compared to the LT group children in the NLD group had significantly higher PLS-3 standard scores on both the receptive and expressive parts, $t\ (12) = 4.82$, $p < .05$, and $t\ (12) = 5.15$, $p < .05$, respectively. In the LT group MLUW was significantly lower ($M = 1.05$, $SD = .18$) than MLUW in the control group ($M = 1.96$, $SD = .31$), $t\ (12) = 5.62$, $p < .05$. The measures at 30 months indicated that all of our LT subjects continued to be language delayed. Table 2 provides information about language measures at age 30 months.

Mean number of consonant types

This analysis compared the mean number of established consonants produced by each child in every group. A two-way analysis of variance with group as the between-subject variable (NLD vs. LT) and age level as the within-subject variable (30, 33, and 36 months) compared the mean number of consonant types between the two groups. The results revealed a group main effect, $F\ (1, 12) = 93.2$, $p < .001$, suggesting that the NLD group used significantly more consonants ($M = 24$, $SD = 3.9$) than the LT group ($M = 8$, $SD = 2.7$). The age main effect was also significant, $F\ (2, 24) = 27$, $p < .001$. Post hoc Tukey analysis

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Table 2. *Language measures at 30 months*

Group	Size of Expressive Vocab.	PLS-3 Standard RC	Scores for EC	MLUW
LT				
1	122	89	80	1.10
2	150	93	80	1.16
3	58	85	80	1.02
4	48	74	72	0.90
5	39	74	72	0.78
6	78	89	83	1.28
7	92	85	74	1.23
Mean	82	84	78	1.05
NLD				
1	425	112	116	1.72
2	363	97	89	1.88
3	500	109	112	2.87
4	327	97	87	1.77
5	450	101	100	1.83
6	422	127	105	2.11
7	290	113	97	1.60
Mean	396	108	101	1.96

Note: Subject numbers 6 and 7 in each group correspond to the female participants.

revealed significant differences between ages 30 and 33 months, between 30 and 36 months, and between 33 and 36 months ($p < .05$). The age main effect suggested that regardless of group, mean number of established consonants increased as a function of age (at 30 months, $M = 12$, $SD = 8.4$; at 33 months, $M = 16$, $SD = 8.8$; and at 36 months, $M = 18$, $SD = 8.11$). The interaction was not significant, $F\ (2, 24) = .53$, $p > .001$. Mean number of established consonant types used by each participant within each group is reported in Table 3. Based on the means in Table 3, approximately two new consonants per age level were established within each group, suggesting parallel developmental profiles in the rate of segmental acquisition.

Phonetic profiles as a function of word position

This analysis examined the use of consonant types primarily at word-initial and word-medial positions. Word final position was examined only for final /s/.[1] Following the procedures described by Rescorla and Ratner (1996) an "established" group phoneme was the one used by at least 60% of the children within each group (four of seven children).

Appendix A reports group phonetic profiles for LT and NLD children at each word position. Established segments in the NLD group were the following: at 30 months, 19 phonemes produced in initial and 21 in medial position; at 33 months, 23 phonemes produced in initial and 23 in medial position, and at 36 months, 24 phonemes produced in initial position and 25 in medial position. Word final [s] was consistently used from age 30 months. Comparable data from

Table 3. *Mean number of types of consonants as a function of group and age level*

Group	30 Months	33 Months	36 Months
LT			
1	7	8	9
2	9	14	15
3	7	8	9
4	3	5	9
5	6	8	9
6	6	8	10
7	5	5	8
Mean	6	8	10
NLD			
1	24	27	27
2	22	25	25
3	15	19	24
4	25	26	26
5	16	18	23
6	27	27	27
7	18	25	26
Mean	22	24	26

the LT group revealed the following: at 30 months, 2 phonemes produced in initial and 6 in medial position; at 33 months, 3 phonemes produced in initial and 8 in medial position; at 36 months, 7 phonemes produced in initial and 11 in medial position. Realization of word final [s] was not observed.

A total of four t tests ($p < .01$ after Bonferroni correction) were conducted in all cases where raw differences of consonants at initial versus medial positions were noted. Three of the four tests examined the differences in the number of phonemes at initial versus medial positions across all age levels within the LT group. One of the four tests examined the observed raw difference in the NLD group regarding the number of phonemes at initial versus medial positions at age 30 months. Within the LT group all comparisons reached statistical significance, $t\ (6) < 3.5$, $p = .0009$, suggesting that more consonants were produced at medial than at initial position across age levels. However, no significant differences were revealed within the NLD group.

A post hoc analysis focused on the percentage of ICD exhibited by the two groups. ICD was calculated only from disyllabic targets. Percentage of ICD was calculated by dividing the total occurrence of ICD over total number of disyllabic tokens. Initial consonants were deleted more often by the LTs (86, 66, and 58% at the three respective age levels) compared to the NLD group data, suggesting minimal percentages of initial consonant omission (8, 2, and 1%, at the three respective age levels).

Overall, the patterns in the LT group indicated that consonants in word-initial position were more difficult to master when compared to medial position counterparts. However, remarkable progress regarding acquisition of word-initial consonants was noted to occur from 33 to 36 months as production of initial consonants increased from 3 to 11.

It appears from the above data that NLD children, as a group, had mastered the majority of singleton consonants by age 33 months at all word positions. It was also noted that a remarkable developmental trend in favor of word-initial position occurred between the ages of 30 and 33 months when the number of target consonants increased from 19 to 23. The NLD group's phonetic inventories consisted of stops, fricatives, affricates, nasals, and glides at all places of articulation. On the other hand, the established consonants observed in the LT group consisted of bilabial and alveolar stops [b/p] and [d/t], respectively, the glide [l] and the bilabial and alveolar nasals [m] and [n], respectively. The velars [k/g] did not appear until age 36 months.

DISCUSSION

The current investigation examined longitudinally the phonetic skills of seven Cypriot-Greek LT children in relation to peers. At age 30 months the CYG-speaking LT children in our sample exhibited depressed receptive and expressive language skills, reduced size of expressive vocabulary, and possessed a smaller number of consonants in their phonetic repertoire. Two of the LT subjects presented with receptive language delay as indicated by the PLS-3 standard score results. Furthermore, these children had identical standard scores because they missed the same number of testing items on the PLS-3. Further, investigation of phonetic skills of both LTs and controls during the 6-month time span of the study (30–36 months) indicated that both groups manifested production of new phonemic categories with similar rates of segmental acquisition, approximately two new phonemes at each consecutive time interval. However, the NLD children overall produced triple the number of consonants, hence presenting with more diverse phonetic inventories when compared to their LT counterparts. This finding implies that the NLD children came into the investigation with more phonetic "foundations" and achieved greater phonological gain at the end of the study.

The phonetic inventories of LT children consisted of segments such as /p/, /t/, /m/, and /n/ mainly produced in word-medial position. The fricative /s/ and the velars /k/ and /g/ did not appear in LT phonetic inventories until the age of 36 months. Furthermore, production preferences for nasals and stops in the LT group was compared, and was found similar to segmental production of CYG-speaking infants reported by Petinou and Minaidou (1999) for the purposes of a different investigation. The findings are consistent with reports from a number of investigations on English-speaking LTs and lends support to the notion of a delayed rather than atypical phonological development (Mirak & Rescorla, 1998; Paul & Jennings, 1992; Rescorla & Ratner, 1996). Based then on a segmental framework of phonological analysis, the overall difference between LT toddlers and their normally developing peers appears to be quantitative in nature.

Furthermore, certain consistent phonological patterns were noted in the speech output of LTs including unstressed syllable deletion and ICD followed by regressive assimilation (i.e., target [ˈmilo] (apple)->[ˈilo]->[ˈlilo]). On the contrary, the NLD children exhibited mastery of phonemes at both initial and medial positions. Their early trend for more consonants at the medial than the initial position at age 30 months was not significant and did not occur in subsequent age levels. By contrast, LT children at age 30 months produced significantly more phonemes at the word-medial position than at the word-initial position, and continued to do so during acquisition of new consonant targets at later stages.

Our finding contrasts with those obtained for English-speaking LTs (and normally developing English-speaking children), who acquire consonants first at initial and then at medial and final positions (Ferguson & Farwell, 1975; Kiparsky & Menn, 1977; Mirak & Rescorla, 1998; Paul & Jennings, 1992; Rescorla & Ratner, 1996). Developmental data from five normally developing CYG infants followed during the ages 20 to 24 months revealed that ICD was the predominant phonological pattern at age 20 months (Petinou & Minaidou, 1999), but it resolved around the child's second birthday. Our speculations about the developmental patterns of CYG are only preliminary, and future data employing language-matched controls is needed to validate the delayed versus disordered phonological pattern. Nevertheless, data from other languages seem to verify the developmental nature of initial consonant omission, as suggested earlier in this paper (Amayreh & Dyson, 1998; Berg, 1992; Bortolini & Leonard, 1991; Ingram, 1986; Linell & Jennische, 1980; Savinaimen-Makkonen, 2000).

A plausible explanation for the occurrence of ICD may be related to the stress patterns of words. Research on normally developing English-speaking children has suggested that initial syllables or their nested segments were omitted in iambic but not in trochaic word types because the former are unstressed (Echols & Newport, 1992; Gerken, 1991; Schwartz & Goffman, 1995). In an effort to examine any stress-driven bias on our LT subjects' productions we calculated the frequency of bisyllabic trochaic versus iambic targets in CYLEX list, the only early language database available at the time in CYG. Based on 330 bisyllables found in CYLEX, the distribution of iambs was 102 (35%), and the distribution of trochees was 183 (65%). The greater occurrence of trochees indicates that ICD is not related to stress factors per se. Moreover, examination of word targets produced by the CYG children from our LT corpus showed that initial consonant omissions occurred regardless of stress. For example, initial targets such as [m] in [ˈmilo] (apple) versus [miˈlo] (I speak),were uniformly omitted resulting in isomorphic realizations of word structure, namely, [ˈilo] and [iˈlo].

It is highly possible, then, that the particular ways of simplifying the motoric output may depend on gross characteristics of phonological patterning, such as word structure. It can be noted that the simplified word structures in English-speaking children, that is, CV forms (Paul & Jennings, 1992; Stoel-Gammon, 1989) differed from the ones observed in CYG-speaking children (i.e., VCV forms). Obviously, the "simplicity rule" escapes universal uniformity. Yet, a common choice across English-speaking and CYG-speaking children is that both syllabic patterns (CV, VCV) contain only one consonant constriction. Of interest, CYG children choose to produce the intervening consonant, thereby maintaining a disyllabic structure in the VCV pattern. On the same end, one occasion where English-speaking children's simplified output was VCVs was when they attempted to simplify production of multisyllabic words (Studdert-Kennedy & Goodell, 1993).

In CYG, word structures typically involve more than one syllable and are often multisyllabic (Newton, 1972). In addition, Drachman (1973) reports that most early words on CYG baby talk are disyllabic and trisyllabic. This characteristic is in contrast with English where there is a plethora of monosyllabic words (CV or CVC structure), many of which are also found in child-directed speech (Ferguson, 1977; Fernald, 1983). Thus, one prevailing hypothesis is that CYG-speaking children are likely to target VCV structures early on because they are urged to maintain a minimal form of the typically occurring word structures of their language. The above interpretation fits well with the well-accepted theoretical framework (Ferguson, 1986; Ferguson & Farwell, 1975; Macken, 1979; Menn, 1983; Menyuk et al.,1986; Vihman, 1992; Waterson, 1971) stating that children's input–output speech unit is the word.

Alternatively, other language-specific prosodic characteristics within a word may come into play and impose a segmental bias leading to ICD. Hence, it is possible that LTs, as they transition into attempts to segment the word form into smaller units, place their focus on the middle part of the word, thereby dropping the initial consonant. Savinainen-Makkonen (2000) suggested that ICD by Finnish-speaking children might be related to a special focus they pay on the medial part of disyllabic words, due to the frequent occurrence of geminates in that particular position. She argued that the prolonged phonemic consonant length in the case of geminate production might be a salient prosodic cue within words. Furthermore, children's focus at medial position occurred, despite the fact that the Finnish language always carries the stress at initial position. In regard to CYG, the occurrence of geminates in the medial position is a common phonological phenomenon (Newton, 1972). Furthermore, recent work on the acoustic characteristics of CYG (Arvaniti, 2001; Tserdanelis & Arvaniti, 1999) suggested that word-medial position geminate targets of CYG were significantly longer in duration when compared to their nongeminate counterparts, regardless of stress. Consequently, such temporal/prosodic salience might act as an attractor of the child's attention to the middle part of the word and create a more systematic perceptual bias even for words without geminates in middle position. At this point it should be noted that apart from the language differences stressed previously, incidental interlanguage commonalities, such as the above, provide another indication that cross-linguistic factors are pertinent to the development of phonology. Although this latter account seems less likely because geminates do not occur in all CYG words, more data, including calculation of geminate percentage, are needed to support such alternative hypotheses.

A final theoretical concern is how the given phonological constraints affect expressive language development and vocabulary growth in particular. A prevailing notion is that children's vastly expanding lexicon, at stages past the early word acquisition, is restructured on the basis of the initial phoneme or syllable of the word (Branigan, 1979; Donahue, 1986; Marslen-Wilson, 1993; Menn, 1983;

Storkel, 2002). Thus, initial word position affects word recognition (Swingley, Pinto, & Fernald, 1999) as well as identification of phonological similarity (Walley, Smith, & Jusczyk, 1986), possibly even prior to vocabulary expansion (Jusczyk, Goodman, & Baumann, 1999). Inevitably, then, children showing ICD might be trapped in processing forms that make them less capable of storing vast amounts of lexical items in long-term memory.

However, counterevidence suggests that even after the onset of naming explosion children do not recognize that spoken words are composed of smaller units; therefore, they continue to engage on holistic processing (Charles-Luce & Luce, 1990, 1995; Treiman & Baron, 1981). Accommodation of holistic processing is further achieved by altering lexical acquisition strategy; after the vocabulary spurt children pay more attention to OUT words as these may be distinguished with ease from words that are already in their vocabulary (Schwartz, 1988). With reference to PD children, recent evidence validates the above account (Storkel, 2004). PD children seem to resort to that strategy early on, thus avoiding the initial stage of developing dense neighborhoods composed of phonetically similar words. In this way, they adopt alternative mechanisms that do not rely on acoustic–phonetic refinement, thereby managing to expand their lexicon.

Taken together, the findings of the present study denote that if CYG-speaking LTs produce word forms in a holistic way their lexical growth will be depended on the alternate strategy stated above. However, LTs may lose the chance to acquire the skill for phonetic refinement early because this appears to emerge from the formation of dense neighborhoods. In contrast, even if LTs merely focus on certain parts of the word (middle), their lack of attention to the initial part of the word will alter the phonotactic probabilities for given sounds, thereby arresting one of the primary mechanisms for vocabulary growth. In addition, the density relations will probably be altered as well. Further research on speech processing of LTs is necessary to substantiate either of the above speculations. Interestingly, neighborhood density diminishes in languages with greater word length (Vitevitch & Rodriguez, 2005).

There are certain limitations of this study that should be addressed here. First, the present study employed a small sample; thus, replication with a larger sample size is needed to validate its findings. Second, as the preference of consonant use in medial than initial position diminished at 36 months in our sample, a systematic investigation of a wider range of phonological processes might shed light on transitive issues related to holistic versus segregated processing.

To summarize, the current study provided some evidence from another language regarding the intimate relationship between late onset of expressive language and phonological delay. A specific phonological pattern (i.e., ICD) was prominently used by CYG-speaking LTs and was tentatively characterized as a typical developmental process for this language. The existence of language-specific phonological constraints so far has thrown relatively more support to nonsegmental accounts of speech processing and organization by children with delayed onset of speech. Moreover, the interplay between language-specific phonological factors and language delay was addressed and should be further investigated to provide fuller accounts of typical and atypical phonological development.

APPENDIX A

Group phonetic profiles as a function of age level and word position

	30 Months			33 Months			36 Months		
Group	Initial	Medial	Final	Initial	Medial	Final	Initial	Medial	Final
LTs									
Stops	t, d	t, d, p, b		t, d, **p**	t, d, p, b		t, d, p, **b**	t, d, b, p, **g**, **k**	
Fric.					**s**			s, **j**	
Affric.									
Nasals		m, n			m, n		**m, n**	m n	
Glides					l		l	l	
NLD									
Stops	p, t, k, c, b, d, g	p, t, k, c, b, d, g		p, t, k, c, b, d, g	p, t, k, c, b, d, g		p, t, k, c, b, d, g	p, t, k, c, b, d, g	
Fric.	f, θ, s, x, ç, ð, v, γ, j	f, θ, s, x, ç, ð, v, γ, j	s	f, θ, s, **z**, v, x, ç, ð, γ, j, ʃ	f, θ, s, **z** v, x, ç, ð, γ j, ʃ	S	f, θ, s, z, v, x, ç, ð, γ, j, ?	f, θ, s, z, v, x, ç, ð, γ j, ʃ	s
Affric.		ʧ		ʤ	ʧ		ʧ ʤ	ʧ, ʤ	
Nasals	m, n	m, n		m, n	m, n		m, n	m, n, ŋ	
Glides	l	l, **r**		l, r	l, r,		l, r	l, r	

Note: Underlined type indicates the addition of a consonant in the groups' repertoire.

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NOTE

1. In our language sample only one of the two final consonants (/s/, /n/) of CYG was observed to be used by NLD children.

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