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Vocabulary growth in late talkers: lexical development from 2;0 to 3;0*

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ABSTRACT

Vocabulary growth from 2;0 to 3;0 was studied in 28 late talkers using expressive vocabulary inventories reported bimonthly on the Language Development Survey (LDS). Group milestones were 18 words at 2;0, 89 words at 2;6, and 195 words at 3;0. A sub-group of 11 children (Group 1) showed a rapid vocabulary spurt between 2;2 and 2;8, reached the 150–180 word mark by 2;6, and attained the LDS ceiling of about 300 words by 2;10. In contrast, the 17 children in Group 2 still had a mean vocabulary of fewer than 30 words at 2;6, had less of a vocabulary spurt when they did start acquiring words, and attained the 150–180 vocabulary mark at 3;0. All 3;0 language outcome measures were significantly predicted by LDS vocabulary size from 2;2 to 2;4.

INTRODUCTION

A well-established milestone for normally developing toddlers is a minimum 50-word vocabulary by 2;0. Children who fail to meet this milestone fall in approximately the lowest 15% of toddlers their age in terms of expressive language skills (Rescorla, 1989). The majority of toddlers with slow vocabulary development but normal nonverbal ability and age-adequate receptive language catch up to the normal range in vocabulary by age 3;0 or

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4;0 (Whitehurst & Fischel, 1994; Paul, 1996; Rescorla & Lee, 1999). For example, reporting on a sample of 34 late talkers with an average vocabulary of about 20 words between 2;0 and 2;7, Rescorla, Roberts & Dahlsgaard (1997) found that 78% were performing in the average range on the Expressive One-Word Picture Vocabulary Test (Gardner, 1981) at 3;0. However, that report did not examine the late talkers' actual course of vocabulary acquisition between 2;0 and 3;0, nor has this issue been addressed in any other study of late-talking toddlers.

Parental language diary studies have demonstrated that production of the first word occurs between 0;10 and 1;1 (Nelson 1973; Bates, Bretherton & Snyder, 1988). A period of slow, gradual development of the child's productive vocabulary, averaging roughly 10 words per month, lasts from about 1;0 to 1;6 (Nelson, 1973; Benedict, 1979; Rescorla, 1980). As the child approaches the 50-word mark, there is a sudden acceleration or 'vocabulary spurt'. During this period, normally from 1;6 to 1;9, a new word may be acquired after only one use and many new words may be acquired each day (Bloom, 1973; Nelson, 1973; Rescorla, 1980; Lieven, Pine & Dresner Barnes, 1992).

More recently, hierarchical linear model (HLM) growth curve analysis has been used to study vocabulary acquisition trajectories for individual children (Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991). Analysing vocabulary produced during mother–child play sessions collected periodically over roughly a one-year period terminating at 2;0 to 2;2, Huttenlocher *et al.* (1991) found that a one-parameter quadratic growth model provided a good fit to the vocabulary acquisition data. Individual differences in vocabulary acceleration across children were captured by the slope parameter for the quadratic term.

In the last decade or so, many studies of vocabulary development in toddlers have employed the methodology of parental report on a vocabulary checklist. Two such checklists were developed in the mid-1970s, the MacArthur Communicative Development Inventory (CDI) (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993) and the Language Development Survey (LDS) (Rescorla, 1989).

The MacArthur CDI: Toddlers, which contains a vocabulary checklist of 680 words, was normed on a cross-sectional sample of 1130 children, ranging in age from 1;4 to 2;6 (Bates, Marchman, Thal, Fenson, Dale, Reznick, Reilly & Hartung, 1994). Concurrent validity studies of the CDI: Toddlers (Dale, Bates, Reznick & Morisset, 1989) and of a short form of the CDI containing 123 words (Reznick & Goldsmith, 1989; Dunham & Dunham, 1992; Reznick & Goldfield, 1994; Corkum & Dunham, 1996) indicate high correlations with other expressive language measures.

The LDS (Rescorla, 1989), which consists of 310 words, has been used in numerous community samples of toddlers in the 2;0 age range. This research

has demonstrated that the LDS has excellent test–retest reliability and internal consistency (Rescorla, 1989), has high concurrent validity with object and picture naming on various standardized instruments (Rescorla, 1989; Rescorla, Hadicke-Wiley & Escarce, 1993), and has good sensitivity and specificity for the identification of language-delayed and normally developing toddlers (Rescorla, 1989).

Longitudinal studies using vocabulary checklists confirm that production of the first word occurs at around age 1;0. Early lexical development is characterized by a slow increase in word production, from fewer than 10 words at 1;0 to an average of 40 words at 1;4 months, according to the CDI: Infants and the CDI: Toddlers (Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994). Fenson *et al.* (1994) note that variance in vocabulary size is minimal until about 13 months of age, because few children have many words. However, starting at 13 months, a 'fan effect' emerges, deriving from the fact that some children begin to rapidly acquire words and others proceed more slowly.

Fenson and colleagues report that the lexicon grows steadily between 1;4 and 3;0, with a pattern of growth referred to as 'a smoothly accelerating exponential function' (Fenson *et al.*, 1994). Fenson *et al.* note that this growth function, which represents the central tendency of separate cross-sectional samples plotted over time, does not appear to manifest the sharp 'vocabulary spurt' noted so often in diary studies of individual children. However, they add that vocabulary growth curves of individual children need to be investigated in order to obtain a clearer picture of variation in lexical acquisition patterns (Fenson *et al.*, 1994).

At 2;0, mean vocabulary was 311 words on the CDI: Toddlers, based on the 2;0 norming sample of about 100 children (Bates *et al.*, 1994). Research using the LDS on multiple samples of children in the 2;0 age range (with a total sample size of more than 700 children) has indicated that mean vocabulary size is in the range of 150–180 words (Rescorla, 1989; Rescorla *et al.*, 1993).

Inspection of the individual words on the two checklists indicates that 280 of the 310 LDS words appear on the CDI; in addition, the CDI contains 400 other words not found on the shorter LDS. These additional words give the CDI a higher ceiling, allowing toddlers with large vocabularies to obtain high scores. This results in a higher mean vocabulary score than is possible on the LDS, which was developed primarily to identify language-delayed two-year-olds with vocabularies of fewer than 50 words. Despite these differences in length and purpose between the CDI and the LDS, word frequencies for the 280 words common to the CDI and the LDS are highly similar. Specifically, when word frequencies for these 280 words in the CDI 2;0 norming sample were compared with frequencies for the same words in four LDS samples, the four Q-correlations ranged from 0·76 to 0·85. Thus, for the words

common to the two checklists, the LDS and the CDI yield very congruent patterns of use.

In the language acquisition literature the vocabulary spurt is often referred to as a naming explosion, due to the predominance of object labels acquired by many English-speaking children. Nelson (1973) found that 57% of the first 50 words acquired in her longitudinal vocabulary study were nominals. Furthermore, she noted that the children who had higher proportions of nominals in their lexicons had larger vocabularies. Benedict (1979) and Rescorla (1980) also found that general nominals dominated word production up to the 75–100-word mark for the children in their samples. Goldfield & Reznick (1990) reported that 13 of their 18 subjects began rapid vocabulary growth at about 1;7 that was concentrated in nominal acquisition. However, five children had more gradual learning curves, added words at a slower pace, and had less nominal predominance than the 13 'spurters'.

Parent checklists appear to yield higher nominal concentrations than do speech samples. For example, Bates *et al.* (1988) found that 56% of words reported at 1;8 on an expressive vocabulary checklist consisted of common nouns, and proportion of nouns reported was positively correlated with total reported vocabulary. In contrast, only 46% of words used in a free speech sample at the same age were common nouns, and noun use in the speech sample was not correlated with total vocabulary size. Nelson, Hampson & Shaw (1993) found that 70% of the words reported on a vocabulary checklist at 1;8 were nouns, but that only 38% of words actually produced during a speech sample came from the noun category. Furthermore, Bloom, Tinker & Margulis (1993), who studied children from 0;9 to 2;0 by means of videotaped play sessions and maternal diaries, also reported that object names constituted only about 30–40% of total vocabularies, and that an increase in object words was not associated with a spurt in vocabulary.

Finally, Bates *et al.* (1994) examined vocabulary composition in about 1000 children who participated in the cross-sectional norming sample for the CDI:Toddlers. Results indicated that percentage of common nouns increased steadily as lexicons grew from 1 to 200 words, reaching a peak of 55% between 101 and 200 words; percentage of nouns declined thereafter, falling to 42% in lexicons of about 600 words. In contrast, predicates (action verbs and adjectives) and closed class words (modals, auxiliaries, articles, pronouns, prepositions, connectives and question words) became more frequent as lexicons began to exceed 200 words. Thus, Bates *et al* (1994) suggest that a nominal preference is associated with lexical growth only until about the 200-word mark, typically at 1;8 and 2;0.

In sum, for typically developing children there seems to be a clear association between early vocabulary growth and nominal acquisition when both are assessed by vocabulary checklists. That is, early in lexical development, toddlers who learn many nominals have rapid vocabulary growth

and toddlers whose vocabularies are growing more rapidly have higher nominal percentages. Thus, nominal acquisition seems to be the most common method by which toddlers add large numbers of words to their vocabularies in a relatively short period of time.

As this account indicates, the course of lexical acquisition has been extensively studied in normally developing children. However, there has been very little research on the growth of early vocabularies in late talkers. What research there has been in the area of vocabulary skills in late talkers has generally involved experimental studies with older language-impaired youngsters. For example, Leonard, Schwartz, Chapman, Rowan, Prelock, Terrell, Weiss & Messick (1982) reported that children with expressive language delays and language-matched children did not differ in their lexical acquisition patterns during an experimental task involving novel words.

Given that very little is known about vocabulary acquisition in late talkers except that they eventually acquire vocabulary and speak in sentences, the present study set out to address four questions: (1) How quickly do late talkers acquire vocabulary between 2;0 and 3;0? (2) Are there notable individual differences in rate of vocabulary growth among late talkers? (3) Is a focus on nominals associated with vocabulary growth in late talkers? and (4) Can late talkers' language outcome at 3;0 be predicted from vocabulary acquisition pattern from 2;0 to 2;6?

METHOD

Participants

Participants for this study consisted of 28 late talkers drawn from Rescorla's (Rescorla & Schwartz, 1990; Rescorla *et al.*, 1997) longitudinal sample of 40 toddlers diagnosed with expressive specific language impairment between 2;0 and 2;7. Twelve children from this cohort of late talkers were excluded from the present report because they had LDS vocabulary scores at fewer than two data points between 2;6 and 3;0.

All the late talkers had normal nonverbal cognitive ability and age-adequate receptive language, but substantial delays in expressive language development. Criteria for inclusion were a Bayley MENTAL DEVELOPMENT INDEX (MDI) above 85 (Bayley, 1969), a Reynell (Reynell, 1977) RECEPTIVE LANGUAGE AGE within three months of chronological age, and a Reynell EXPRESSIVE LANGUAGE AGE six months or more below CA. The late talkers had no evidence of significant emotional or behavioural disturbance, as assessed by the first author, a clinical child psychologist, based on parent report and 2–4 hours of direct observation. The late talkers also had no significant hearing loss, as assessed by their own pediatrician or by an audiologist affiliated with the project, although some had histories of otitis media and a

TABLE 1. *Intake measures for late talkers*

	Late talkers ($n = 28$)		
	Mean	S.D.	Range
Intake age	2;2.10	0;2.18	2;0–2;7
Hollingshead total	53·00	13·9	27–66
Bayley MDI	96·04	6·9	84–112
Reynell receptive age	2;2.21	0;3.24	1;8–2;9
Reynell receptive *z*	0·10	0·5	−0·7–1·4
Reynell expressive age	1;4.16	0;2.6	1;0–1;9
Reynell expressive *z*	−1·78	0·5	−3·1–1·2
LDS vocabulary	15·93	9·6	0–41

few had ear tubes. Two of the late talkers had a Reynell RLA four months below chronological age and one had a Bayley MDI of 84, but these deviations from the selection criteria were considered minor and therefore all 28 subjects were included in the present study.

Demographic and intake measures appear in Table 1. In all respects, these 28 children are representative of the full cohort of 40. These late talkers scored at age level on the Reynell Receptive language scale, but they manifested an average delay of 10 months below chronological age on the Reynell Expressive language scale. Intake expressive vocabulary size as reported by their mothers on the LANGUAGE DEVELOPMENT SURVEY (LDS) was 16 words, about one-tenth of the lexicon size of normally developing toddlers from the same backgrounds (Rescorla *et al.*, 1997).

Procedure

The primary data used in this study were from the LDS (Rescorla, 1989), a parent report vocabulary checklist. In addition, language outcome at 3;0 was assessed by performance on the Expressive One Word Picture Vocabulary Test (Gardner, 1981) and the Reynell Expressive Language Scale (Reynell, 1977), as well as by MLU and Index of Productive Syntax (IPSyn) (Scarborough, 1990) scores based on a speech sample collected during a mother–child play session.

The LDS is a one-page checklist containing 310 of the most frequently used words in children's early vocabularies. Parents are asked to check off words that their child uses spontaneously, to report use of two-word combinations, and to cite three of the child's longest sentences or phrases. The LDS consists of words belonging to fourteen general categories: actions, animals, body parts, clothes, food, household, modifiers, other, outdoors, people, personal, places, toys and vehicles. As reported above, the LDS has

demonstrated excellent reliability and validity in previous research (Rescorla, 1989; Rescorla *et al.*, 1993).

The LDS was administered bimonthly from age of intake (from 2;0 to 2;7) until 3;0, unless a subject had already approached the ceiling of the LDS (about 300 words). However, for the earliest subjects recruited, bimonthly visits were not part of the protocol and therefore fewer LDS data points were obtained. In addition, an occasional missed session or failure to administer the LDS also contributed to some missing data points for some subjects. To be included in the sample for this report, a subject had to have at least two LDS data points, with one at 2;6 and the other between 2;6 and 3;0. Twenty-two of the 28 subjects had at least four data points, four had three LDS forms, and two subjects had only two LDS data point

RESULTS

Vocabulary growth

As a first step in looking at vocabulary acquisition from 2;0 to 3;0 in this sample of 28 late talkers, we looked at mean reported vocabulary size for each bimonthly age point, based on all LDS forms collected at that age. As can be seen in Table 2, mean vocabulary size was 18 words at 2;0, 89 words at 2;6,

TABLE 2. *LDS vocabulary scores by age and group*

	Full sample	Group 1	Group 2
LDS 2;0	18·13 (9·67)[a] ($n = 15$)	20·54 (9·66) ($n = 11$)	11·50 (6·76) ($n = 4$)
LDS 2;2	33·00 (22·59) ($n = 18$)	44·36 (21·21) ($n = 11$)	15·14 (9·34) ($n = 7$)
LDS 2;4	79·17 (56·27) ($n = 18$)	114·09 (42·58) ($n = 11$)	24·29 (14·07) ($n = 7$)
LDS 2;6	89·04 (86·38) ($n = 28$)	183·82 (55·30) ($n = 11$)	27·71 (22·49) ($n = 17$)
LDS 2;8	149·75 (104·79) ($n = 20$)	267·00 (26·52) ($n = 8$)	71·58 (43·09) ($n = 12$)
LDS 2;10	180·33 (106·95) ($n = 18$)	281·17 (26·42) ($n = 6$)	129·58 (94·40) ($n = 12$)
LDS 3;0	194·82 (87·31) ($n = 11$)	288·00 (0) ($n = 1$)	185·50(86·08) ($n = 10$)

[a] Brackets contain S.D. of LDS total vocabulary at each data point.

and 195 words at 3;0. Thus, the 28 late talkers in this sample were, on average, about 12 months delayed in their lexical acquisition relative to community samples of unselected children aged 2;0, who have a mean LDS vocabulary of 150–180 words (Rescorla, 1989; Rescorla *et al.*, 1993). At intake, the range of LDS vocabulary size was relatively small, with all subjects manifesting severely limited vocabularies. However, the standard

deviation for LDS vocabulary doubled from 2;0 to 2;2 and from 2;2 to 2;4, reaching its maximum in the 2;8 to 2;10 period.

Subgroup analyses

As the next step in data analysis, we plotted LDS lexical growth curves for each subject at each data point. Data for the first 14 subjects appear in Figure 1 and those for the remaining 14 children appear in Figure 2. Visual

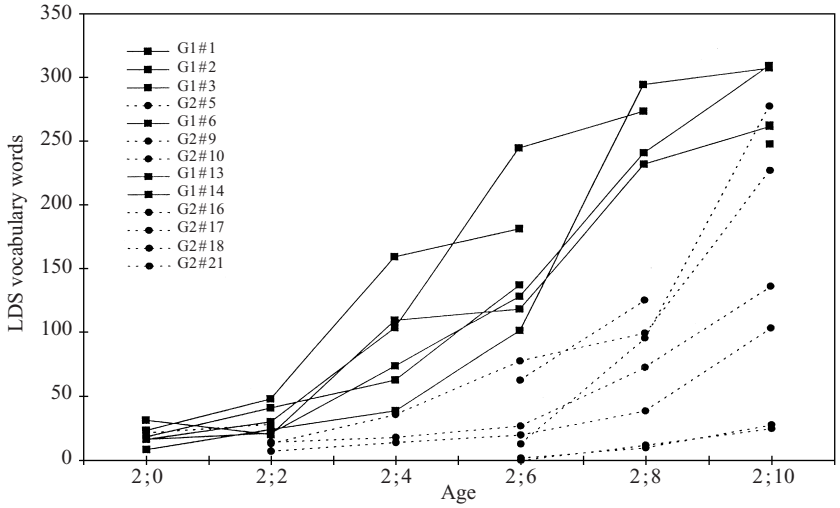

Fig. 1. Vocabulary growth with age: I.

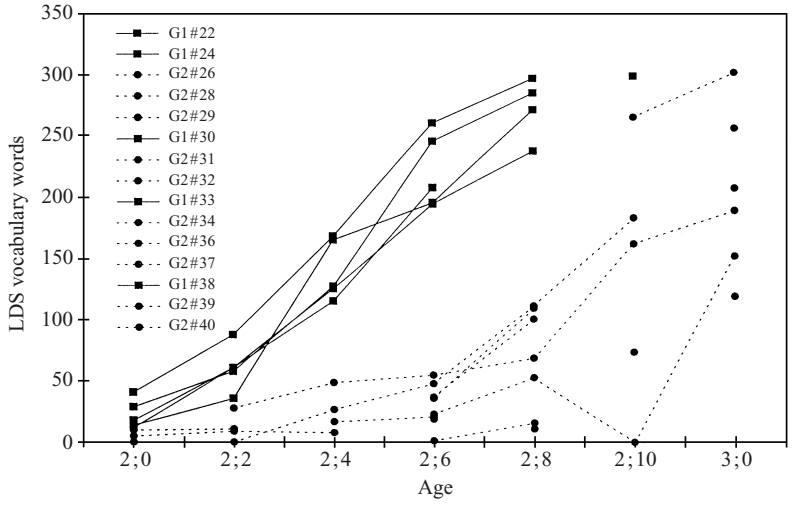

Fig. 2. Vocabulary growth with age: II.

inspection of these curves suggested the existence of two groups differentiable by the criterion of whether or not the child had a reported vocabulary of at least 100 words at 2;6, the midpoint between 2;0 and 3;0. The resultant two groups (Group 1, $n = 11$; Group 2, $n = 17$) are indicated on Figures 1 and 2 by solid and dashed lines respectively. Mean LDS vocabulary sizes across time for these two groups appear in Table 2, and each group's vocabulary sizes and S.D. over time are depicted in Figure 3.

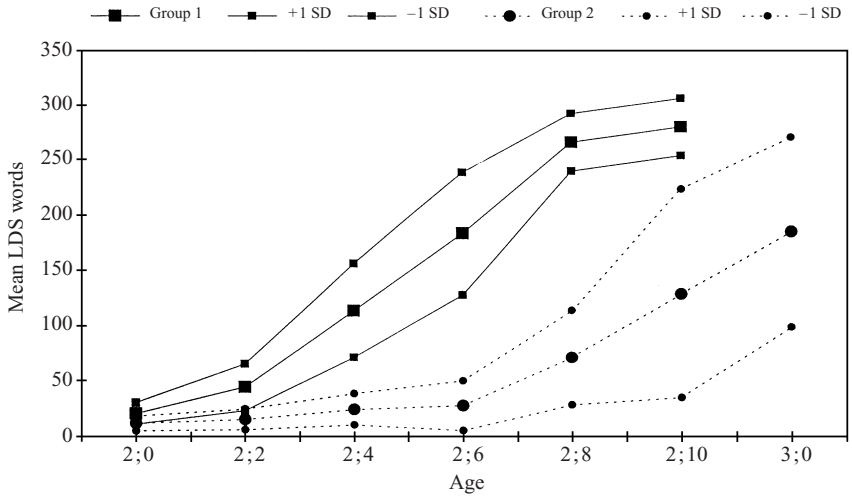

Fig. 3. Mean LDS vocabulary growth by group.

As can be seen in Table 2 and Figure 3, children in the first group ($n = 11$) demonstrated rapid lexical progress, had at least 100 words at 2;6, and were generally able to produce most if not all of the checklist items well before 3;0. These children had a dramatic vocabulary spurt starting at 2;2, adding 70–83 words per two-month period until 2;8, at which point they approached the ceiling of the 310-word LDS.

Mean LDS vocabulary scores from 2;0 to 3;0 for Group 2 also appear in Table 2. The 17 children in Group 2 showed relatively little change in vocabulary size until they had passed 2;6. At that point, they began to slowly add words to their lexicons. However, they showed less of a 'vocabulary spurt' than their Group 1 peers. That is, the mean number of words they acquired in their two-month period of greatest growth (2;8 to 2;10) was 58 words, much less than the maximum increment of 83 manifested by Group 1. At all data points from 2;2 to 2;10, *t*-tests indicated that the children in Group 2 had significantly smaller vocabularies than the children in Group 1 (with all p values $< 0{\cdot}001$). At 2;0 and 3;0, there were too few children in Group 2 and Group 1 respectively to permit statistical analysis.

It should be noted that these group differences from 2;2 to 2;10 were not only statistically significant, but they were of great magnitude as well. By 2;2, Group 1 children had vocabularies that were three times as large as those in Group 2. This rose to a sixfold difference at 2;6 (184 vs. 28 words), after which point the groups began to gradually move toward convergence on the LDS ceiling of 310 words. The final vocabulary size of Group 2, namely 185 words, had been reached by Group 1 six months earlier.

One of the most striking aspects of the vocabulary acquisition differences between Groups 1 and 2 can be seen in changes over time in their variance patterns. As can be seen in Figure 3, the children in Group 1 increased in variance up until 2;6, and then become less variable in their vocabulary size, as they all began to converge on the 310-word ceiling of the LDS. In contrast, the youngsters in Group 2 showed almost no variance in vocabulary size before 2;6, when they were at the floor of the LDS due to their very small vocabularies, but they then began to diverge sharply, showing their maximal variance at 2;10 and 3;0. *F*-tests comparing the variances in Group 1 and Group 2 were significant at 2;2, 2;4, and 2;6, with Group 1 having the higher variance (S.D. 21·21 vs. 9·34, 42·58 vs. 14·07, and 55·30 vs. 22·49, $p < 0{\cdot}05$, 0·05, and 0·01 respectively). Conversely, by 2;10, Group 2 had significantly higher variance than Group 1, due to the ceiling effect in vocabulary size in Group 1 (S.D. 27·21 vs. 94·40, $p < 0{\cdot}01$).

Additional inspection of variances in the two groups reveals that both groups showed a doubling of their standard deviations across two consecutive two-month periods, but that these doubling periods occurred six months later in Group 2. Specifically, in Group 1, the S.D. doubled from 2;0 to 2;2 and from 2;2 to 2;4, reaching its maximum of 55 at 2;6, when the mean vocabulary was 183·82 words. For Group 2, the S.D. doubled from 2;6 to 2;8 and from 2;8 to 2;10, when it reached its maximum of 94 at a mean vocabulary level of 129·58 words. It should also be noted that Group 2's maximum S.D. was almost double the maximum S.D. of Group 1, indicating that Group 2 was more heterogeneous in lexical acquisition pattern (i.e. some of the children in this group continued to be very slow in their vocabulary growth even after 2;6).

Growth curve analysis

To further explore the patterns of lexical growth displayed by the children in Group 1 and Group 2, growth curve analysis for these 28 subjects was conducted using the HLM 2-Level Model procedure (Bryk & Raudenbush, 1992). The Level 1 equation, which included linear, quadratic and cubic terms, appears below.

$$Y_{it} = B0_{0i} + B1_{1i}*(\text{Age\_}C)_{it} + B2_{2i}*(\text{Age\_}CQ)_{it} + B3_{3i}*(\text{Age\_}CC)_{it} + R_{it}.$$

In this equation, Y_{it} is the LDS vocabulary size for subject i at time t. Age_C is age-centred around the midpoint of t, namely 2;6, with values of -6, -4, -2, 0, $+2$, $+4$, $+6$ assigned to the respective values of t. Age_CQ and Age_CC are the quadratic and cubic contrast coefficients, each with its own set of weights set by the programme. $B0$ is the intercept, which represents the expected LDS vocabulary size of subject i at age 2;6. $B1$ is the linear effect of age on vocabulary size at age 2;6, whereas $B2$ and $B3$ represent the quadratic and cubic effects on vocabulary size. R_{it} is the random within-subject error of prediction for subject i at time t.

In the HLM procedure, a Level 2 model replaces $B0$, $B1$, $B2$, and $B3$ with equations based on the age-invariant predictor variable of group. For example,

$$B_{0i} = G_{00} + G_{01}*(\text{Group})_i + u_{01}$$
$$B_{1i} = G_{10} + G_{11}*(\text{Group})_i + u_{01}$$

In this Level 2 model, G_{00} is the expected LDS vocabulary size at age 2;6 for Group 2, and G_{01} is the mean difference in vocabulary size between Groups 1 and 2 at age 2;6. G_{10} is the expected rate of change in vocabulary size for Group 2 at age 2;6, and G_{11} is the mean difference in rate of change between Groups 1 and 2. The subscripts for the quadratic and cubic coefficients (not shown here) similarly denote the expected quadratic and cubic effects for Group 2, and the mean group difference in these effects). The terms u_{0i}, u_{1i}, and so forth represent the random effects for person i.

HLM analysis revealed significant intercept, slope, and quadratic effects; these coefficients are presented in Table 3. Group 1's intercept was roughly double that for Group 2. This is to be expected because the intercept value represents the estimated vocabulary size at the 'centred' age of 2;6, and the groups were defined based on their 2;6 vocabulary scores. Of more import

TABLE 3. *HLM growth curve analyses by group*

	Coefficient	*t*-ratio	*p* value
Intercept			
Group 1	137·88		
Group 2	70·06	5·58	$*p < 0{\cdot}001$
Linear slope			
Group 1	14·95		
Group 2	7·94	3·21	$*p < 0{\cdot}01$
Quadratic term			
Group 1	−10·51		
Group 2	3·92	−5·85	$*p < 0{\cdot}001$

* *p* value indicating significant difference between Group 1 and Group 2 on the HLM growth curve coefficient.

were the significant slope differences between the groups. Group 1's linear slope was roughly double that of Group 2, confirming their greater overall acceleration in vocabulary growth. The two groups also differed significantly in the quadratic term of the HLM equation, due to the ceiling effect in vocabulary size when the Group 1 children reached the 300-word mark in the period from 2;6 to 2;10.

To conclude, both groups of late talkers began with relatively small intake vocabularies. By 2;6, Group 1 had reached the vocabulary size typically found at 2;0 in normally developing samples, namely more than 150 words on the LDS (Rescorla, 1989). Group 2 did not reach this vocabulary size until 3;0. Therefore, there was a six-month time-lag between normally developing children and Group 1, as well as a six-months time-lag between Group 1 and Group 2 in terms of reaching a reported vocabulary of more than 100 words.

Correlational analyses

Cross-age correlations of total LDS vocabulary for the full sample of 28 children revealed that vocabulary size was significantly correlated across all six-month periods within this time frame, but that vocabulary was less predictable across wider time spans. For example, age 2;0 vocabulary significantly predicted vocabulary size to 2;6 ($r = 0{\cdot}64$, 0·64, 0·60), vocabulary size at 2;2 was significantly correlated with vocabulary size to 2;8 ($r = 0{\cdot}80$, 0·84, 0·67), and 2;4 vocabulary had significant correlations with later vocabulary through age 2;10 ($r = 0{\cdot}90$. 0·81, 0·66). Similarly, vocabulary size at 2;6 significantly predicted vocabulary size at the three subsequent data points ($r = 0{\cdot}90$, 0·72, 0·61), total vocabulary at 2;8 predicted vocabulary through 3;0 (0·87, 0·78), and vocabulary scores at 2;10 and 3;0 were highly intercorrelated (0·95). It should be noted that the strength, symmetry and regularity of these correlational patterns are especially striking given the fact that the sample shifted considerably in its composition across the seven data points.

Vocabulary composition analyses

Because of the well-established association between a vocabulary spurt and a focus on the acquisition of nominals, we next examined the proportion of nominals in each child's reported lexicon over time. For purposes of this analysis, we classified as nominals the words in all LDS semantic categories except Actions ('give', 'go', etc), Modifiers ('big', 'mine', 'this', etc), and Other (animal sounds, greetings and social phrases, numbers and letters, prepositions, and interrogative forms). When the LDS was developed, words that can be either nouns or verbs were categorized in accordance with impressions as to their most common form of use (e.g. 'kiss' and 'throw' were classed as Actions, whereas 'brush' and 'watch' were considered

nominals). According to this classification system, the LDS contains 191 nominals and 119 non-nominals, with nominals constituting 62% of total words on the LDS.

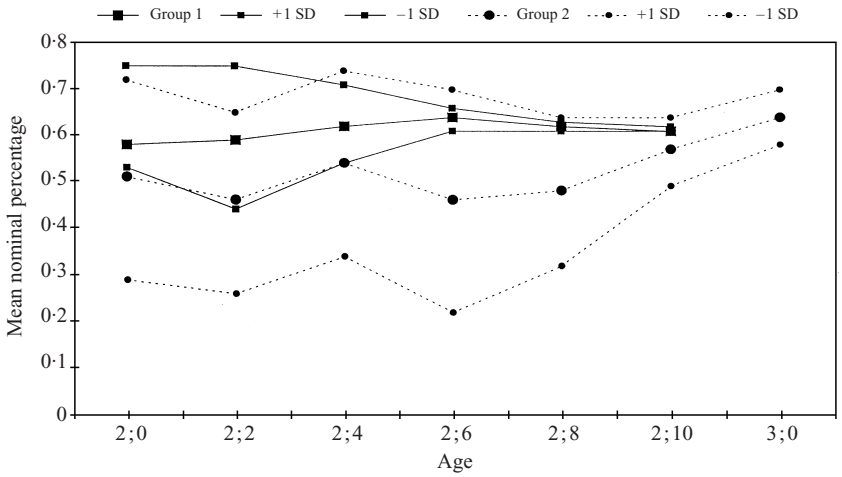

Fig. 4. Mean nominal percentage by group.

The data on percentage of nominals over time for Groups 1 and 2 are presented in Figure 4. Children in Group 1 started out with a nominal percentage of 58%. This rose to 62% by age 2;4 and stayed above 60% for the rest of the time period. It is also noteworthy that the children in Group 1 were fairly variable in their nominal percentage at the 2;0 and 2;2 points (S.D. of 0·17 and 0·16 respectively), but that this variability decreased sharply by 2;4, after which the S.D. for nominal percentage was minimal (S.D. of 0·08, 0·02, 0·01 and 0·01 respectively). In considering these nominal data, it is worth recalling that the children in Group 1 showed a strong vocabulary spurt at about 2;2 and had reached more than 100 words by 2;6 months.

The children in Group 2 showed quite a different pattern of nominal percentage over time. They hovered around the 50% nominal percentage mark to 2;8, a nominal percentage which is below what would be expected given the 62% nominal representation on the LDS itself. In addition, Group 2 children showed great variability in their nominal percentage through that period, with S.D. consistently at 0·20 or above to age 2;6. It was only in the last two months of the time period that nominal percentage for the children in Group 2 moved above 56% and showed the kind of low variability that had been displayed by Group 1 since age 2;4 (e.g. S.D. 0·08 and 0·06 respectively). It should be noted that the time period in which the children in Group 2 shifted substantially in their nominal percentage was also the time

TABLE 4. *Age 3;0 outcome measures for full sample and by group*

	Full sample	Group 1	Group 2
EOWPVT score	103·08 (20·2)[a]	113·36 (15·8)	94·38(19·9)**
Reynell expressive *z*	−0·65 (1·1)	−0·04 (0·8)	−1·08 (1·0)**
MLU	2·48 (1·0)	3·08 (0·9)	2·06 (0·8)
MLU *z*	−1·48 (1·57)	−0·52 (1·4)	2·14 (1·3)***
IPSyn	47·81 (20·4)	63·09 (11·5)	36·60 (18·2)
IPSyn *z*	−2·25 (1·7)	−0·99 (1·05)	−3·12 (1·5)***

[a] Brackets contain S.D. for each measure.
** $p < 0{\cdot}01$
*** $p < 0{\cdot}001$

period in which the largest numbers of new words were added to their lexicons.

Within the time frame from 2;0 to 3;0, nominal percentage tended to be highly correlated across a four-month period, but not over longer intervals. This was true at each data point, with correlation values ranging from 0·62 to 0·88. In addition, concurrent correlations between nominal percentage and vocabulary size were significant at all data points except 2·0 and 3;0 (correlations ranging from 0·43 to 0·68), and nominal percentage significantly predicted vocabulary size at the subsequent data point for all time periods after 2;4 (correlations of 0·48, 0·68, 0·90 and 0·91 respectively).

Prediction of age 3 outcome

All 28 participants were seen at 3;0 for outcome assessment. The Expressive One-Word Picture Vocabulary Test (EOWPVT) and the Reynell Expressive Language Scale (Reynell, 1977) were administered and MLU and the Index of Productive Syntax (IPSyn) (Scarborough, 1990) were derived from a 30-minute speech sample collected during free play with the mother. As reported in Rescorla *et al*. (1997), where follow-up data for 34 late talkers from this longitudinal cohort were presented, these four measures yielded quite different levels of 'recovery'. For example, the percentage of late talkers performing in the average range was 79% on the EOWPVT, a vocabulary measure, but 24% on the IPSyn, a syntax and morphology index.

The late talkers in Group 1 and Group 2, categorized based on vocabulary size at 2;6, differed significantly on all four outcome measures of expressive language at age 3;0. As can be seen in Table 4, the two groups differed by more than one S.D. on the EOWPVT and the Reynell Expressive Language Scale (t (21·93) = 2·60, $p < 0{\cdot}01$; t (21·00) − 3·41, $p < 0{\cdot}01$). Differences in MLU and the IPSyn were even larger (*z*-score difference of 1·5 S.D. and 2·0 based on Scarborough's (1990) benchmark figures, t (20·59) = 2·97, $p < 0{\cdot}01$; t (23·59) = 4·33, $p < 0{\cdot}001$).

Finally, these four outcome measures were all significantly correlated with vocabulary size as measured by the LDS checklist for these 28 late talkers from 2;0 to 3;0. LDS vocabulary from 2;4 significantly predicted 3;0 month EOWPVT scores, with correlations ranging from 0·56 to 0·85. Scores on the Reynell Expressive Language Scale were significantly predicted from 2;6 on (correlations ranging from 0·51 to 0·84). MLU at age 3;0 was significantly predicted by LDS vocabulary at 2;6, 2;8, and 2;10 ($r = 0{\cdot}48$–$0{\cdot}73$). Lastly, LDS vocabulary from 2;2 on significantly predicted age 3;0 expressive language outcome on the IPSyn, with correlations ranging from 0·67 to 0·86. The IPSyn, an aggregate measure of syntactic and morphological development, has been found in our previous research with this cohort to be the most sensitive index of language progress (Rescorla *et al.*, 1997).

DISCUSSION

For this group of 28 late talkers, vocabulary growth on the LDS from 2;0 to 3;0 was quite similar to the pattern shown by normally developing toddlers from 1;0 to 2;0 (i.e. a year earlier). That is, the late talkers had 18 words at 2;0, reached 89 words by 2;6, and acquired 195 words by 3;0. For the sample as a whole, the 50-word vocabulary mark was attained in the period from 2;2 to 2;4, about 10 months after normally developing toddlers (Nelson, 1973).

This aggregate pattern of vocabulary growth over time obscures the fact that these late talkers differed widely in their rate of vocabulary acquisition, with striking differences appearing in the group by age 2;2. As in the normally developing toddlers studied over time by Huttenlocher *et al.* (1991), there were wide individual differences in rate of acceleration in vocabulary growth in these 28 late talkers, producing the 'fan effect' described by Fenson *et al.* (1994).

Inspection of individual lexical growth curves suggested that the late talkers in this sample could be readily classified into two distinct groups based on whether or not they had attained 100 words at age 2;6. The 11 children in Group 1 showed a rapid vocabulary spurt between 2;2 and 2;8, reached the 150–180 word mark by age 2;6, and attained the LDS asymptote of about 300 words by 2;10. In contrast, the 17 children in Group 2 still had a mean vocabulary of fewer than 30 words at age 2;6, had less of a vocabulary spurt when they did start acquiring words, and attained the 150–180 word mark at 3;0. Thus, Group 1 children showed about a six-month lag in LDS vocabulary relative to normally developing children, whereas the youngsters in Group 2 were delayed by about twelve months.

HLM analysis indicated that Groups 1 and 2 differed significantly in both intercept and slope. As would be expected, Group 1's intercept was double that of Group 2 at the 2;6 age midpoint, reflective of their larger vocabularies at that time point. In addition, Group 1 had a much steeper linear slope than

Group 2, indicating faster vocabulary acquisition overall. Finally, Group 1 had a significantly stronger quadratic component to its growth function, due to the fact that these children reached the ceiling of the LDS by about 2;8 and thus decelerated in vocabulary growth by this measure.

Both Group 1 and Group 2 showed something of a vocabulary spurt close to the 50-word mark, but Group 1 showed the vocabulary spurt approximately four to six months before Group 2, and the magnitude of its 'spurt' was much greater (70–80 words vs. 58 words per two month period). The vocabulary spurt shown by the children in Group 1 appears to be at least as dramatic as the spurt shown by 13 of the subjects in Goldfield & Reznick's (1990) study, who had an estimated growth rate of 64 words per two-month period. The children in Group 2 were more similar to Goldfield & Reznick's (1990) 'non-spurters', who added words to their lexicons at approximately 40 words per two-month period.

For both groups of late talkers in this study, the vocabulary spurt appeared to be associated with a higher percentage of nominals in the vocabulary. Group 1 children showed a higher percentage of nominals for the first half of the acquisition period, when their vocabularies outstripped those of children in Group 2; however, at 2;8, the children in Group 2 crossed the 60% nominal percentage and began to show a spurt in their vocabularies. Thus, these late talkers performed similarly to previously studied typically-developing toddlers (Bates *et al.*, 1994) in that their parent-reported vocabularies grew more rapidly when their reported nominal percentages were higher.

Correlational data from this study indicated that vocabulary size at each data point was highly correlated with reported vocabulary at the subsequent three data points (i.e. over a 6-month period). Similarly, within the time frame from 2;0 to 3;0, nominal percentage tended to be highly correlated across a four month period. In addition, concurrent correlations between nominal percentage and vocabulary size were significant from 2;2 to 2;10 and nominal percentage was significantly correlated with vocabulary size at the subsequent data point throughout most of the time period studied. This pattern of results suggests that the progress these late talkers made in vocabulary acquisition between 2;0 and 3;0 was quite predictable well before age 2;6, with rapid vs. slow trajectories being readily identifiable in the 2;2 to 2;4 period. Moreover, it appears that children whose early LDS vocabularies increased most rapidly were adding more nominals to their lexicons relative to other words.

Finally, results of this study indicate that performance on all four age 3;0 outcome measures was well predicted by vocabulary progress in the period from 2;0 to 2;6. Groups identified by whether or not their 2;6 vocabulary size exceeded 100 words were strikingly different in their language outcomes by age 3;0, with the greatest differences being found on the most sensitive

measures, namely MLU and IPSyn. Moreover, LDS vocabulary at age 2;6 was significantly correlated with all four age 3;0 language outcome measures, and the most sensitive outcome measure – the IPSyn – was significantly correlated with LDS vocabulary from 2;2 on.

The results of this study must be considered in light of certain limitations inherent in the sample and the methods used for the research. First, these late talkers were all children with average or better nonverbal abilities, good receptive language, normal social-personality development, and middle- to upper-middle-class family backgrounds. In addition, the children were all identified as language delayed from 2;0 to 2;7, which is quite young relative to the ages of most children with language impairment discussed in the research literature. Thus, the rate of vocabulary progress made by these youngsters may not be typical of older late talkers, or of youngsters with other developmental delays in addition to expressive language, or of children from less economically advantaged families, all of whom might be expected to progress more slowly in vocabulary development.

The primary measure used in this research was the LDS, a parent report measure of vocabulary. This instrument has well-validated reliability and validity (Rescorla, 1989; Rescorla *et al.*, 1993), but it is not a direct measure of actual vocabulary production. If the data had been collected by means of repeated speech samples over a 12-month period, it seems likely, based on the existing literature, that rates of vocabulary growth would not have changed greatly but that nominal percentage would have been lower for all subjects. Had a longer checklist been used, such as the CDI:Toddlers (Fenson *et al.* (1994), vocabulary estimates might have been somewhat higher at the later data points, particularly for Group 1. Because the CDI has 400 words that are not on the LDS, children would not reach the ceiling on it as quickly as they did on the LDS. In addition, nominal percentages might have been lower had the CDI been used, because common nouns constitute 41 % of the CDI but 62 % of the LDS. However, the main findings reported here are quite compatible with results from research using the CDI:Toddlers, namely the wide range in individual differences in vocabulary growth with age and the association between nominal preference and vocabulary size early in the lexical acquisition period. The 'fan effect' described by Fenson *et al.* (1994) in their cross-sectional data was well documented in our individual lexical growth curve trajectories.

Finally, a limitation of this research is the fact that not all children had LDS forms at all data points. Because children entered the study at different ages, reached ceiling on the LDS at different time points, and occasionally had missing checklists, there was only one data point (2;6) for which all 28 children had data. Despite these caveats, the findings from these data appear to be very robust and are perhaps all the more convincing given that different children contributed to the patterns over time.

There are some important clinical implications that can be derived from this research. First, it is apparent that late talkers identified around their second birthday with specific expressive language delay do not all proceed to acquire vocabulary at the same rate between 2;0 and 3;0, consistent with Paul's (1996) account. Some late talkers began to make rapid progress shortly after their second birthdays, reached a vocabulary of more than 100 words by 2;6 months, and looked quite normal in their expressive language skills by age 3;0. In contrast, a larger number of late talkers continued to have very small vocabularies till about 2;6 months of age, at which time they began to gradually add words to their lexicons. Children still very delayed in vocabulary at age 2;6 were most likely to continue to manifest significant expressive language delays at age 3;0. Second, more rapid vocabulary growth in this study was associated with a relative predominance of nominal acquisition. This suggests that late talkers, like typically developing children, add to their vocabularies most quickly, according to parent report, when they acquire many object labels. Thus, intervention efforts with late talkers might do best to focus initially on noun acquisition.

Finally, the results of this study suggest that practitioners can feel relatively confident using age 2;6 vocabulary size to predict whether or not a late talker will have roughly normal language or will still be language-delayed at age 3;0. For example, at 2;6 there was a sixfold difference in LDS reported vocabulary size between those late talkers who were rapidly closing the gap in their vocabulary skills and those children whose expressive language delay was persisting. Although longer term follow-up studies with late talkers suggest that most will have normal language skills by age 5 (Whitehurst & Fischel, 1994; Paul, 1996; Rescorla & Lee, 1999;), it is also the case that language-delayed 3-year-olds are at higher risk for social, behavioural, and academic problems as they get older than youngsters with normal language histories (Silva, Williams & McGee, 1987). Thus, late talkers with specific expressive language delay at 2;6 may warrant focused intervention aimed at vocabulary building.

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