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Leslie Rescorla
Bryn Mawr College, lrescorl@brynmawr.edu

Katherine Dahlsgaard

Julie Roberts

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Late-talking toddlers: MLU and IPSyn outcomes at 3;0 and 4;0*

LESLIE RESCORLA
Bryn Mawr College

KATHERINE DAHLSGAARD
University of Pennsylvania

JULIE ROBERTS
University of Vermont

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ABSTRACT

Expressive language outcomes measured by MLU and the Index of Productive Syntax (IPSyn) at ages 3;0 and 4;0 were investigated in 34 late talkers with normal receptive language identified between 2;0 to 2;7 and 16 typically developing comparison children matched on age, SES, and nonverbal ability. Late talkers made greater gains than comparison children between 3;0 and 4;0 in both MLU and IPSyn raw score. However, when age-standardized *z*-scores were analysed, the late talkers were about 2·5 standard deviations below comparison children on both measures at both ages. At 3;0, 41% of the late talkers had MLUs above the 10th percentile based on Scarborough's (1990) benchmark sample; by 4;0, 71% did so. Using the IPSyn, a more stringent measure, 34% scored above the 10th percentile at 3;0 and only 29% did so at 4;0. MLU was significantly correlated with the IPSyn at both ages for the late talkers, but only at 3;0 for the comparison children. A converging set of regression analyses indicated no group differences in the predictive relationship between MLU and IPSyn, suggesting that the late talkers were delayed on both measures but not deviant in their development.

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INTRODUCTION

This paper examines the expressive language outcomes at ages 3;0 and 4;0 of a sample of late-talking toddlers. The children studied were identified as language delayed between 2;0 and 2;7 and all had normal nonverbal ability, age-adequate receptive language, and at least a six month delay in expressive language.

Toddlers who are slow to talk have been the focus of research by several investigators in the last decade (Fischel, Whitehurst, Caulfield & DeBaryshe, 1989; Rescorla & Schwartz, 1990; Thal, Tobias & Morrison, 1991; Paul, 1993; Paul & Alforde, 1993; Paul, Murray, Clancy & Andrews, 1997; Rescorla, Roberts & Dahlsgaard, 1997). Reviews of the literature on late talkers suggest that late talkers typically improve in vocabulary from 2;0 to 3;0, that many continue to show grammatical delays in the preschool years, and that most have roughly normal language skills by the time they are age 5 or 6 (Whitehurst & Fischel, 1994; Paul, 1996; Rescorla & Lee, 1999). Research has also demonstrated that late talkers generally perform in the normal range on most language measures once they are in school, but that they continue to have lower scores on such measures than children with typical language histories (Rescorla, 1993; Rescorla & Dahlsgaard, 1995; Paul, 1996; Rescorla, 1999). Late talkers followed up through age 13 have demonstrated reading skills within the normal range but significantly below the mean for their comparison peers (Rescorla, 1999).

An important question being addressed in the language delay literature recently is whether late-talking toddlers are distinguishable from preschool children with specific language impairment (SLI) in the nature and outcome of their language problem (Whitehurst & Fischel, 1994; Paul, 1996; Rescorla & Lee, 1999). Many children diagnosed with SLI as preschoolers seem to have a persistent language impairment that continues through the school years and is manifested in a high rate of learning problems (Hall & Tomblin, 1978; Aram, Ekelman & Nation, 1984; Tallal, 1988; Bishop & Adams, 1990; Catts, Hu, Larrivee & Swank, 1994), as well as behavioural/emotional disorders (Baker & Cantwell, 1982). In these respects, they seem to differ from late talkers, most of whom perform in the normal range on language tests by age 5 and few of whom develop learning disabilities. This suggests that late talkers and children with SLI represent two quite different populations of children (Paul, 1996).

Despite the fact that late talkers have a generally positive prognosis, as a group they continue to have significantly lower scores on many language and reading measures than children with typical language histories (Paul, 1996; Rescorla, 1999). This suggests that late talkers are the less impaired subset of a larger pool of children, all of whom have compromised or weak language systems in the presence of normal nonverbal abilities. As we will argue at the

conclusion of this paper, language-delayed toddlers are a heterogeneous group: those mildly impaired youngsters who are speaking in the normal range by age 3 or 4 we call late talkers, whereas those with more severe impairments who continue to be language-delayed at age 4 are diagnosed with SLI.

There are only a few studies that have tracked the language development of late talkers, and the measures used in previous research have generally been quite old and rather unfamiliar to researchers who study normal language acquisition. For example, Whitehurst & Fischel's (1994) primary outcome measure for grammar was the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy & Kirk, 1968). Using this measure, they found that 74% of their late talkers with pure expressive delay were in the normal range by age 3 and 86% were in the normal range by age 4. Similarly, Paul's (1996) main language outcome measure was the Developmental Sentence Score (DSS) (Lee, 1974). Paul reported that 41% of her late talkers (about 25% of whom also had receptive delays) were below the 10th percentile on DSS at age 3 and 57% scored at this level at age 4. The DSS is based on 50 utterances, all of which must contain both a noun and a verb, making it of limited utility for children not yet producing many sentences. Criticism of the DSS can be found in Nippold & Schwartz (1996).

Paul (Paul & Alforde, 1993) also employed suppliance of grammatical morphemes (Brown, 1973) as an outcome measure for her late talkers at age 4;0. Late talkers were sub-classified as normal ('late bloomers') or 'continued delay' on the basis of MLU. Late bloomers had mastery of fewer advanced morphemes than normal controls, and the continued delay group had significantly fewer morphemes than would be expected given their MLU, based on Brown (1973) and Miller (1981). This finding is consistent with an extensive literature on children with specific language impairment (SLI) indicating poorer morphological skills than would be predicted based on MLU, a finding that has been reported in many languages (Johnston & Schery, 1976; Johnston & Kamhi, 1984; Leonard, Sabbadini, Volterra & Leonard, 1988; Clahsen, 1989; Leonard, Bortolini, Caselli, McGregor & Sabbadini, 1992; Dromi, Leonard & Shteiman, 1993; Rice & Oetting, 1993; Crago & Gopnik, 1994; Leonard, 1998). However, the high rate of variability demonstrated by typically developing children in grammatical morpheme use has cast doubts on its utility as a measure for language impairment (Lahey, Liebergott, Chesnick, Menyuk & Adams, 1992; Lahey, 1994). Furthermore, late talkers in the preschool years who have very limited language skills rarely present enough obligatory contexts for most morphemes to calculate an accurate picture of their suppliance.

Rescorla *et al*. (1997) used four expressive language measures to evaluate age 3;0 outcomes for a cohort of late talkers identified between the ages of

2;0 to 2;7. The percentage of late talkers performing within one standard deviation of average at age 3;0 varied widely as a function of the measure used: 79% on the Expressive One-Word Picture Vocabulary Test (Gardner, 1981); 58% on the Reynell Expressive Language Scale (Reynell, 1977); 35% on MLU (Brown, 1973); and 24% on the Index of Productive Syntax (IPSyn) (Scarborough, 1990).

The study presented here reports the expressive language outcomes at ages 3;0 and 4;0 of the 34 late talkers studied in Rescorla *et al.* (1997). The present study used mean length of utterance (MLU) and the Index of Productive Syntax (IPSyn) (Scarborough, 1990) as measures of grammatical development. These measures have several advantages. First, they are widely used and well-regarded in the field of typical language acquisition. Second, they can be used to measure expressive language development from the earliest stages of syntax, namely two-word combinations. Third, these measures provide general, aggregated indices of the maturity of a child's speech in terms of length and complexity of sentences, development of sentence constituents, use of grammatical morphemes, and mastery of variants of sentence structure.

Because MLU and IPSyn are broad, aggregated measures, they are not suitable for the in-depth investigation of a particular syntactic structure or morphological inflection. In the same way, an IQ score provides an excellent index of the child's general mental ability but is not a useful measure of any very specific cognitive skill. However, MLU and IPSyn seem ideal for the purpose of this study, which was to track the development of a group of late-talking toddlers to age 4;0 and to compare their expressive language skills to those of typically developing comparison children over time. In addition, careful examination of the properties of MLU and IPSyn raw scores versus *z*-scores as well as investigation of the interrelationships between MLU and IPSyn for the two groups of children over time may be informative for a broader understanding of both typical and atypical early language development and their measurement.

Mean length of utterance (MLU) (Brown, 1973) has a long tradition of use as a general index of linguistic maturity level in young children. As would be expected given the fact that MLU is based on both the number of words and the number of grammatical inflections present in a child's corpus of utterances, there is a strong association in normally developing children between MLU and other indices of grammatical proficiency, such as mastery of morphological inflections (Klima & Bellugi, 1966; Brown, 1973; de Villiers & de Villiers, 1973; Miller, 1981).

The Index of Productive Syntax (IPSyn) (Scarborough, 1990), an emergent syntax measure, consists of 56 syntactic and morphological forms that are coded for a 100-utterance speech sample. Sub-scores in four areas of grammatical development (noun phrase, verb phrase, questions/negations,

and sentence structure) and an overall syntactic proficiency score are computed. Many of the IPSyn's items are morphemic in nature (e.g. articles, prepositions, plural -s, third person -s, past -ed, auxiliary and copular forms), but others refer to syntactic constructions (e.g. relative clause, propositional complement, auxiliary inversion), and still others are lexical (e.g. use of adverb, adjectives, adverbial conjunctions, etc.)

In Scarborough's (1990) original report based on data for 15 children studied longitudinally from 2;0 to 4;0, MLU and IPSyn were correlated 0·94, with the correlation much higher at younger ages (e.g. 0·91 at 2;0, 0·60 at 3;0, and 0·44 at 4;0) and at lower MLU levels (e.g. 0·93 for MLUs below 3·0 and 0·55 for MLUs above 3·0). This is due in large measure to the fact that MLU grew rather little from 3;0 to 4;0 (3·41 to 3·80). In contrast, the IPSyn continued to reflect grammatical development during this same period, as indicated by an increase from 73·87 at 3;0 to 85·80 at 4;0. Finally, Scarborough (1990) reported that multiple regression analysis yielded a curvilinear relation between MLU and IPSyn, with the regression containing a significant quadratic term.

Scarborough, Rescorla, Tager-Flusberg, Fowler & Sudhalter (1991) reported on the relationship between MLU and the IPSyn for a cohort of 30 typically developing preschoolers studied cross-sectionally. Data from this typically developing sample confirmed the findings of Scarborough (1990). Specifically, MLU and IPSyn were correlated at 0·92, with the correlation higher when MLUs were below 3·0 (e.g. 0·93 for MLUs below 3·0 and 0·58 for MLUs above 3·0). Once again, multiple regression indicated a curvilinear relationship between MLU and IPSyn, with a significant quadratic component. Using the regression equation derived from the longitudinal sample in Scarborough (1990), there was a very good fit between expected and observed IPSyn scores in this cross-sectional sample, with an average discrepancy of less than one point on the IPSyn.

Scarborough *et al*. (1991) also reported MLU and IPSyn data for two samples of late talkers. The first sample consisted of five language-delayed youngsters studied longitudinally by Scarborough in her research on the antecedents of reading disability (Scarborough, 1989). These five youngsters, who were seen at 3;0, 3;6, and 4;0, exhibited a mean correlation of 0·92 between MLU and IPSyn. The regression curve of IPSyn on MLU for the normally developing children in Scarborough's (1990) longitudinal sample was used to predict IPSyn based on MLU for the five language-delayed youngsters. Results indicated that the language-delayed children's IPSyn scores relative to their own MLUs deviated from those predicted by the normal children's regression equation by only −2·3 IPSyn points, a very small deviation.

The second language-delayed sample described in Scarborough *et al*. (1991) consisted of 15 boys from Rescorla's (Rescorla *et al*., 1997) sample of

late talkers identified between the ages of 2;0 to 2;7. These 15 children, who constituted a cross-sectional sample, were early recruits in the Rescorla cohort and they ranged in age at follow-up from 3;0 to 4;0. Correlation between MLU and IPSyn was 0·94 for this sample of 15 late talkers. The mean prediction error in IPSyn from MLU, based on the regression line for Scarborough's 15 typically developing children, was −4·1 IPSyn points. In both the longitudinal sample ($N = 5$) and the cross-sectional sample ($N = 15$), errors of prediction tended to be larger when MLUs were above 3·0 (−4·8 and −9·1 respectively) than when MLUs were below 3·0 (−0·5 and −1·6 respectively).

In summary, the present study extended the follow-up research reported in Rescorla *et al*. (1997). We traced expressive language outcomes to age 4;0 in the same late-talking toddlers and in a subset of the typically developing comparison group whose outcomes to 3;0 were reported in Rescorla *et al*. 1997). In the study reported here, MLU and the IPSyn were used as measures of expressive language outcome at ages 3;0 and 4;0. Furthermore, the research built on the cross-sectional study of late talkers reported in Scarborough *et al*. (1991) by examining the relationship between MLU and IPSyn in a larger group of late talkers seen at two age points.

METHOD

Participants

Participants for the study included 34 late talkers (33 boys and 1 girl) who were aged 2;0 to 2;7 at the time of intake and an age-matched comparison group of 16 toddlers (15 boys and 1 girl) with normal language. The late talkers whose MLU and IPSyn data were analysed in this study consisted of all subjects in Rescorla's (Rescorla *et al*., 1997) Pennsylvania sample of 40 late-talking toddlers for whom 3;0 and 4;0 naturalistic speech samples were collected during mother–child play with the Fisher Price Village. The six excluded late talkers were among the first participants recruited into the sample, and they had either played with different toys ($N = 5$) or had defective tapes ($N = 1$) at age 3. Eleven of the 15 late talkers from the cross-sectional sample in the Scarborough *et al*.(1991) study of MLU and IPSyn were part of the cohort of 34 for the present study. The 16 normally developing children whose MLU and IPSyn data were analysed for this report consisted of all typically developing participants who participated in the Rescorla *et al*. (1997) age 3;0 follow-up (21 youngsters) who also had speech sample tapes at age 4;0.

Late talkers had been recruited through newspaper advertisements, notices to pediatricians, and a local infant lab. All but one of the children in the study

came from a two-parent, middle- to upper-middle class white family (the mother of one late talker was divorced). All the late talkers had normal nonverbal abilities and age-adequate receptive language but significant delays in expressive speech. They had to have an MDI score of greater than 85 on the Bayley Mental Development Scale (Bayley, 1969). Additional selection criteria were a score within 3 months of chronological age on the Reynell Receptive Language Scale (Reynell, 1977) and a score at least 6 months below CA on the Reynell Expressive Language Scale. During the two year period of this study, about one-third of the late talkers received some individual or group speech/language therapy. This was solely at the discretion of the parents, and therefore intervention was not systematically controlled nor analysed for this study.

Comparison children were recruited in the same fashion as late talkers, had the same Bayley and Reynell Receptive Language Scale criteria, and also had to have a Reynell Expressive Language Scale score within 3 months of CA. Age 3;0 outcome data for the 16 comparison children in the present study were included in the report on 21 typically developing children reported in Rescorla *et al*. (1997).

All participants in both groups met these group selection criteria except for three late talkers whose receptive language skills were 4 rather than 3 months delayed, one late talker whose Bayley MDI was 84, and one comparison child who had an expressive language age of 4 months below CA. Because none of these deviations was sufficient to place the participant into the contrasting group and the results of the study were unchanged when these children were excluded, they were included in their respective groups for all analyses.

Demographic information and test scores for the two participant groups appear in Table 1. As can be seen, the late talkers and the comparison children were essentially identical in age and Hollingshead SES score.

The two groups were also fully comparable in their total scores on the 19 nonverbal Bayley items above the basal level for all children (e.g. towering blocks, doing puzzles, drawing, and inserting pegs). As can be seen in Table 1, the groups were significantly different in receptive language as measured by the Reynell Receptive Language Scale *z*-score, although the late talkers had fully normal receptive skills for their age. Of course, there was a striking difference in Reynell Expressive Language Scale *z*-score between the two groups, with the late talkers on average at the 1;5 age level in expressive language (a lag of more than 9 months). All late talkers were at least 1·2 *S.D.*s below age expectations, and 26 of the 34 were 1·5 *S.D.*s or more below age level on the Reynell Expressive Language Scale. Finally, the late talkers had a mean reported vocabulary on Rescorla's (1989) Language Development Survey (LDS) of 20 words, in contrast to a vocabulary of 236 words for the comparison children. All late talkers met Rescorla's (1989) criterion of fewer than 50 words or no word combinations.

TABLE 1. *Intake and outcome measures by group*

	Late talkers (LT)	Typically developing (TD)
INTAKE MEASURES		
Intake age	2;2·26 (2·4)	2;1·63 (2·2)
Hollingshead total	52·59 (13·2)	52·50 (11·0)
Bayley nonverbal items	13·62 (3·1)	14·25 (2·6)
Reynell receptive *z*-score	0·16 (0·6)	0·94 (0·6)***
Reynell expressive *z*-score	−1·72 (0·5)	0·36 (0·5)***
LDS Vocabulary*	20·26 (22·0)	235·75 (70·9)***
OUTCOME MEASURES		
MLU-3;0	2·46 (0·9)	4·13 (0·7)***
MLU-3;0 *z*	−1·51 (1·5)	1·15 (1·1)***
IPSyn-3;0	48·26 (18·5)	78·25 (7·9)***
IPSyn-3;0 *z*	−2·21 (1·6)	·44 (0·7)***
MLU-4;0	3·78 (0·7)	4·66 (0·9)***
MLU-4;0 *z*	−·05 (2·0)	2·69 (2·6)***
IPSyn-4;0	74·74 (9·5)	85·25 (4·7)***
IPSyn-4;0 *z*	−2·64 (2·3)	−·13 (1·13)***

* LDS = Language Development Survey (Rescorla, 1989)
*** $p < .001$ by independent means *t*-test

PROCEDURE

All participants were seen for follow-up at age 3;0 and age 4;0 in the company of their mothers. The MLU and IPSyn data analysed for this study were based on a naturalistic speech sample collected while each child played with his or her mother for approximately 30 minutes using the Fisher Price Village, a toy that contains a wide variety of environments and equipment conducive to pretend play (e.g. a fire engine, a garage, a barber shop, a post office, and many toy figures, vehicles, and other assorted props). This play session was both videotaped and audiotaped. In addition, a speech-language pathologist present in the room during the play session took running notes of all utterances.

Transcript preparation

Transcripts from these 30-minute play sessions were prepared from the tapes, with every utterance and action of the children and mothers recorded using conventions established by the CHILDES consortium (MacWhinney, 1991). A variety of undergraduate and graduate student transcribers did the basic transcript preparation from audiotape, then checked all utterances on the videotape and added all actions, gestures, and relevant contextual information. The first author then checked the transcripts against the tapes and the running session notes that had been made by the speech-language

pathologist. Every transcript was then checked against the tapes by the third author, a certified speech-language pathologist. If the first and third author did not agree on an utterance, they listened together to that portion of the audio and videotape several times and came to consensus. If consensus could not be reached, that utterance was not included in the 100-utterance sample. This elaborate checking and re-checking procedure was necessary because a large number of people did the initial transcription over a period of several years and because many of the late talkers had quite poor intelligibility. For the same reasons, it was not feasible to calculate interrater reliability using independent transcriptions of the speech samples.

We examined a sample of 15 transcripts from both groups (9 late talkers and 6 comparison children, taken in alphabetical order by name within group) to estimate how many utterances were excluded because they were not fully intelligible or because raters could not agree on what was said. Excluded utterances ranged from 0 to 10 for 14 of the 15 children, with a mean of 5·8 utterances. The fifteenth child, a late talker, whispered during much of the session, so 26 utterances could not be accurately transcribed; however, 100 audible and intelligible utterances could be transcribed even from this speech sample.

Measures

When the transcripts had been fully checked and corrected, CLAN procedures (MacWhinney, 1991) were used to identify a corpus of the first 100 complete utterances, after imitations, immediate self-repetitions, memorized songs/rhymes, and unintelligible utterances had been eliminated from the corpus, as is standard practice. Because of their very high frequency in many subjects, we also eliminated single word 'yes' and 'no' responses to questions before calculating MLU, unlike Brown (1973), Miller & Chapman (1981), or Scarborough (1990). The CLAN MLU program was then run on this 100-utterance corpus.

Finally, each 100 utterance corpus was coded using the IPSyn (Scarborough, 1990) Fifty of the 55 age 3;0 transcripts used in this study were IPSyn-coded independently by the first and second authors. Mean interrater percent agreement across all IPSyn items was 96%, with agreement across the four IPSyn domains all above 95%. Interrater reliability for the 30 age 4;0 IPSyns coded by both raters was also 96%.

Data analysis

Data analysis first involved comparing the late talker and age-matched comparison group children on MLU and IPSyn at ages 3;0 and 4;0 by means of (2) group × (2) age ANOVAs on MLU and IPSyn raw scores. Second, we derived MLU and IPSyn *z*-scores for each child, based on Scarborough's (1990) benchmark mean and standard deviation values for

normally-developing children. This procedure provided a single, typically developing, external referent group against which both our late talker and comparison groups could be compared in terms of effect size. Third, MLU and IPSyn *z*-scores were used to classify late talkers at 3;0 and 4;0 into 'continuing delayed' or 'recovered' subgroups. Fourth, the basic relationship between MLU and IPSyn by group at each age was examined by means of Pearson correlation. Fifth, the regression curve of IPSyn on MLU for the normally developing children in Scarborough's (1990) longitudinal sample was used to predict IPSyn based on MLU for the 34 late talkers in this sample at ages 3;0 and 4;0 as well as for the 16 comparison children at age 3;0. In addition, multiple regression was used to predict IPSyn from MLU at ages 3;0 and 4;0 with the late talker and typically developing groups combined. Finally, using an MLU-match design, we compared the late talkers at age 4;0 to the normally developing youngsters at age 3;0 by means of regression discrepancy analysis based on the comparison children's regression line.

RESULTS

Group and age differences in MLU and IPSyn raw scores

MLU and IPSyn data at ages 3;0 and 4;0 for late talkers and comparison children are presented in Table 1. The 2 × 2 ANOVA on MLU raw scores, which yielded significant main effects for group ($F(1, 48) = 34{\cdot}96$, $p < 0{\cdot}001$) and age ($F(1, 48) = 67{\cdot}72$, $p < 0{\cdot}001$), resulted in a significant group by age interaction ($F(1,48) = 12{\cdot}73$, $p < 0{\cdot}001$). Thus, the late talkers made greater gains between age 3;0 and age 4;0 than the comparison children in MLU raw score. However, *t*-tests indicated that the late talker (LT) and typically developing (TD) groups differed at both age 3;0 and age 4;0 (MLU at 3;0, $t(37{\cdot}96) = -6{\cdot}96$, $p < 0{\cdot}000$; MLU at 4;0, $t(23{\cdot}24) = -3{\cdot}61$, $p < 0{\cdot}001$), as seen in Figure 1.

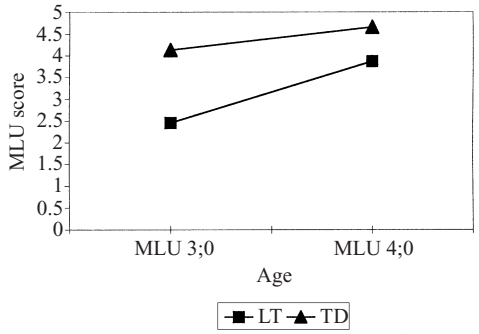

Fig. 1. MLU by group and age.

A similar pattern was found when IPSyn raw scores were examined, with significant effects for group (F (1,48) = 40·04, $p < 0·001$), for age (F (1,48) = 61·13, $p < 0·001$), and the group by age interaction (F (1,48) = 20·69, $p < 0·001$). Thus, as can be seen in Figure 2, the late talkers (LT group) made

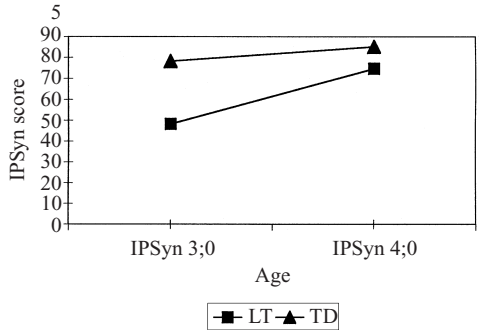

Fig. 2. IPSyn Score by group and age.

larger gains in IPSyn raw score between age 3;0 and age 4;0 than the typically developing (TD) comparison children, although both groups increased over time. There were significant group differences in IPSyn score at both ages: IPSyn at 3;0, t (47·73) = −8·04, $p < 0·000$; IPSyn at 4;0, t (47·71) = −5·24, $p < 0·000$.

Group and age differences in MLU and IPSyn z-scores

When the MLU and IPSyn data were analysed in terms of z-scores, a rather different picture emerged. Figure 3 shows that the effect size for group (LT

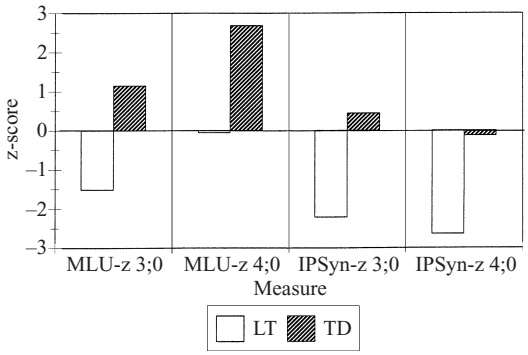

Fig. 3. MLU and IPSyn z-scores. by group and age.

vs. TD) for both MLU and IPSyn *z*-score was 2·5 *S.D.*s or more at both age 3;0 and age 4;0. This means that although in raw score terms the late talkers appeared to be catching up to their comparison peers, in fact the gap between them was not closing in terms of age-standardized expectations. In other words, when scores were used that incorporated age expectations of normal development, it is clear that the late talkers were as far behind their comparison peers in MLU and IPSyn at age 4;0 as they had been at age 3;0. Because standardizing MLU and IPSyn by age norms removes age effects, group differences for these *z*-score data were analysed by *t*-tests rather than ANOVAs. All four group comparisons were highly significant (MLU-*z* at 3;0, t (37·96) = −6·95, $p < 0{\cdot}000$; MLU-*z* at 4;0, t (23·23) = −3·61, $p < 0{\cdot}001$; IPSyn-*z* at 3;0, t (47·99) = -8·15, $p < 0{\cdot}000$; IPSyn-*z* at 4;0, t (47·73) = −5·26, $p < 0{\cdot}000$).

The reason that late talkers appeared to be closing the gap in raw scores but not in *z*-scores is due to developmental changes in the variance of MLU and IPSyn in typically developing children between 3;0 and 4;0. In Scarborough's (1990) normally developing sample, MLU and IPSyn increased from 3;0 to 4;0, but variability decreased even more in both measures as children's morphosyntactic skills increased over time. For example, IPSyn increased from 73·87 at age 3;0 to 85·80 at age 4;0, but the *S.D.* decreased from 10·95 to 4·21 between these same age points. Thus, the 10·5 IPSyn raw score difference between our late talkers and comparison children at age 4;0 was about 2·5 *S.D.*s, comparable to what it had been at age 3;0 when the raw score difference had been 30 IPSyn points. A similar pattern was found for MLU.

Classification of late talkers at 3;0 and 4;0

At age 3;0, only 35% of the late talkers scored within −1 *S.D.* of average in MLU and only 24% scored in this range on the IPSyn. By age 4;0, 68% of the late talkers had MLU *z*-scores at −1 *S.D.* or higher, but only 21% had IPSyn scores in this range. These findings suggest that the IPSyn was a more sensitive and/or stringent measure than MLU for characterizing the outcomes of the late talkers in this study.

In the next analyses, MLU and IPSyn *z*-scores were used to classify the 34 late talkers into 'continuing delayed' vs. 'recovered' subgroups. For purposes of this analysis, two different levels of severity were used; these were a *z*-score cut-off of −1·25, which falls at about the 10th percentile, and a *z*-score cut-off of −1·50, which corresponds to the 6th percentile. These data, which appear in Table 2, further indicate that the IPSyn was a more stringent criterion at both ages, regardless of whether the −1·25 and −1·50 cut-off was used. However, this pattern was most marked at 4;0, where roughly twice as many late talkers were classified as language-delayed by the IPSyn than by MLU.

TABLE 2. *Classification of late talkers into outcome groups at* 3;0 *and* 4;0

Cut-off measure	Outcome groups	
	Continuing delayed	Recovered
Age 3;0		
MLU z-score $< -1{\cdot}25$	20 (59%)	14 (41%)
MLU z-score $< -1{\cdot}50$	18 (53%)	16 (47%)
IPSyn z-score $< -1{\cdot}25$	25 (66%)	9 (34%)
IPSyn z-score $< -1{\cdot}50$	20 (59%)	14 (41%)
Age 4;0		
MLU z-score $< -1{\cdot}25$	10 (29%)	24 (71%)
MLU z-score $< -1{\cdot}50$	10 (29%)	24 (71%)
IPSyn z-score $< -1{\cdot}25$	24 (71%)	10 (29%)
IPSyn z-score $< -1{\cdot}50$	21 (62%)	13 (38%)

At age 3;0, more than half of the 34 late talkers were still delayed in expressive language, with the percentage ranging from 53% to 66% depending on which MLU or IPSyn cut-off was applied. By 4;0, using either MLU cut-off, only 29% of the late talkers were still delayed. The IPSyn overall percentages suggested that about the same percentage of late talkers was delayed at 4;0 as at 3;0, roughly 60-to-70%.

Although these overall figures are informative with regard to the percentage of late talkers who were 'recovered' at each age using each criterion, it is necessary to investigate the scores of individual children at both ages to get a picture of trajectories of recovery over time. When the $-1{\cdot}25$ MLU cut-off was used to examine trajectories of individual children, it emerged that 11 of the 20 late talkers who were delayed at 3;0 had moved into the 'recovered' category (55%) by 4;0, whereas one late talker who was in the average range at 3;0 scored below the $-1{\cdot}25$ MLU cut-off at 4;0. Using the $-1{\cdot}50$ MLU cut-off, 9 out of 18 children delayed at 3;0 had 'recovered' by 4;0 (50%), and one out of 16 late talkers had moved from the 'normal' into the 'delayed' range. When the $-1{\cdot}25$ IPSyn cut-off was employed, 8 of 25 of those delayed at 3;0 (32%) were in the 'recovered' range by 4;0, but 7 of the 9 youngsters scoring above the $-1{\cdot}25$ cut-off at 3;0 obtained IPSyn z-scores below that point by 4;0. When the IPSyn $-1{\cdot}50$ cut-off was used, 6 out of 20 late talkers had moved above the cut-off by age 4;0 (30%), but 50% of those above the cut-off at 3;0 had moved below it by 4;0 (7 children).

Correlational analysis

The next set of analyses involved Pearson correlations between MLU and IPSyn for both groups at ages 3;0 and 4;0. For the late talkers, MLU and IPSyn were highly correlated at both ages: $r = 0{\cdot}83$ at 3;0 and 0·87 at 4;0, both $p < 0{\cdot}001$. The age 3;0 correlation was slightly higher than the

correlation of 0·75 that Scarborough (1990) found at 2;6, when her typically developing children had a mean MLU and mean IPSyn score slightly higher than these late talkers (e.g. MLU of 2·63 vs. 2·46; IPSyn of 58·80 vs. 48·26). When the late talkers were 4;0, their MLUs and IPSyn were roughly comparable to those of Scarborough's typically developing children at 3;6 (i.e. late talkers 3·78 and 74·74 vs. 3·74 and 79·43), but the MLU–IPSyn correlation was higher (0·87 vs. 0·60). For the comparison sample in this study, the MLU–IPSyn correlation at age 3;0 was 0·76 ($p < 0·001$), slightly lower than Scarborough's (1990) age 3;0 correlation of 0·82, probably due to the fact that the comparison children in the present study had higher MLUs. However, by age 4;0, when the comparison children had very high MLUs and were near ceiling on the IPSyn, the correlation between MLU and IPSyn was a non-significant 0·44, which is the same value Scarborough (1990) obtained for her age 4;0 normally developing children.

When the 50 children in the combined late talker and typically developing samples were subdivided by an MLU 3·0 cut-off, results confirming Scarborough (1990) and Scarborough *et al*. (1991) were found. Specifically, the correlation between MLU and IPSyn was 0·90 for the 28 subjects with MLUs at or below 3·0, in contrast to a correlation of 0·64 for the 22 children with MLUs above 3·0.

Regression analysis

Several converging regression analyses were used to examine the prediction of IPSyn from MLU for the children in this study. First, using the procedure followed in Scarborough *et al*., (1991), we used the regression equation from the subjects in Scarborough (1990) to predict IPSyn from MLU for the 34 late talkers at 3;0 and 4;0 and the 16 typically developing comparison children at age 3;0. (This first regression analysis was not done for the comparison children at 4;0 because MLU and IPSyn were not significantly correlated at that age). Next, the mean discrepancy between obtained and predicted IPSyn values was calculated for both groups at 3;0 and for the late talkers at 4;0.

Results of this first regression analysis indicated a mean discrepancy in IPSyn points of −4·93 for the late talkers and a highly similar −4·78 for the typically developing children. These mean residual scores were not significantly different from each other. The mean discrepancy for the late talkers at 4;0 was in this same range (i.e. −5·14). Parallel to findings in Scarborough *et al*., (1991), the mean discrepancy was −1·89 for the 28 children with MLUs at or below 3·0, but −8·69 for the 22 children with MLUs greater than 3·0. It appears that mean discrepancies were slightly higher in this study than in Scarborough *et al*. (1991) because the present study's elimination of 'yes/no' responses from the corpora resulted in MLUs that were somewhat higher relative to IPSyn score.

In the next analysis, the 34 late talkers and the 16 typically developing children were combined into a single sample and the relationship between MLU and IPSyn at 3;0 and 4;0 was explored using multiple regression. Consistent with Scarborough *et al.* (1991), a quadratic equation explained more of the variance than a simple linear fit. Variance explained was 86% (3;0) and 74% (4;0). The equations appear below, with regression lines (plus 95% confidence bands) shown in Figures 4 and 5.

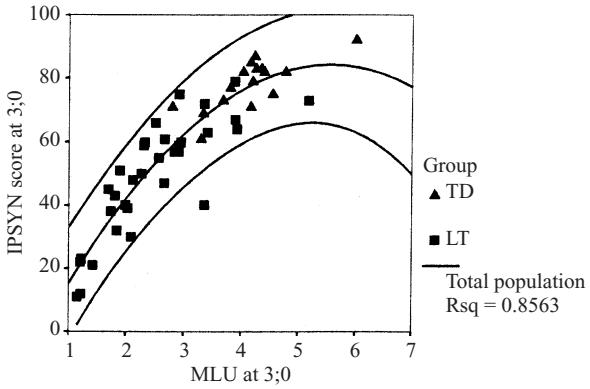

Fig. 4. Regression of IPSyn on MLU at 3;0. pooled groups at 3;0.

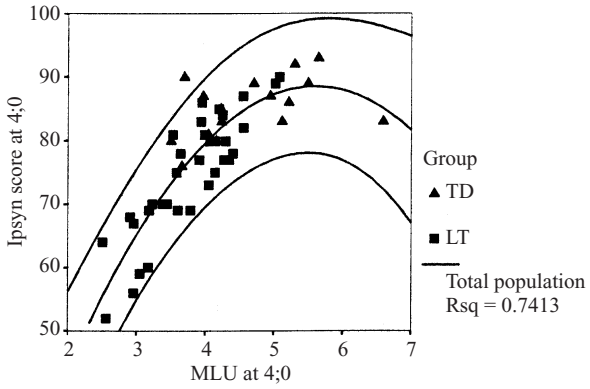

Fig. 5. Regression of IPSYN on MLU at 4;0. pooled groups at 4;0.

3;0: IPSyn = 36·998(MLU)- 3·338(MLU^2)- 18·55
4;0: IPSyn = 38·879(MLU)- 3·475(MLU^2)- 20·20

It is evident in the figures for both age 3;0 and 4;0 that the late talkers and typically developing children are best viewed as constituting a single group

sharing a mildly quadratic relationship between MLU and IPSyn. As the figures show, the typically developing children had progressed further along this common trajectory at both ages.

There was no significant group difference in mean discrepancy from the regression line at 3;0, at which time the late talkers were an average of −1·09 IPSyn points below the curve and the typically developing children were 2·32 points above. Virtually the same values in mean discrepancy (−1·02 vs. 2·16 IPSyn points) at age 4;0 yielded a significant difference, t (30·662) = −2·28, $p < 0·05$. This is due to the fact that the standard deviations in mean discrepancy for both groups were roughly half as large at 4;0 as they had been at 3;0. Not surprising in light of the high variance accounted for by the regression model (R-squared values of 0·86 at 3;0 and 0·74 at 4;0), there were only a few children at either age who obtained IPSyn scores that were markedly discrepant from the predicted value (i.e. one late talker fell outside the 95% confidence band at 3;0 and one comparison child was above this band at 4;0).

The final regression analysis involved a cross-age match design in which the age 4;0 late talkers were compared to the typically developing children at 3;0. As can be seen in Table 1, MLUs were quite comparable when the late talkers at 4;0 were compared with the normally developing peers one year earlier (MLU: 3·78 vs. 4·13); thus, this cross-age match design constitutes a form of MLU matching. As can be seen in Table 1, the age 4;0 late talkers and age 3;0 comparison children were also very similar in their IPSyn scores (74·74 vs. 78·25). Comparison of these MLU and IPSyn values using t-tests indicated no significant group effects.

In this cross-age match analysis, the age 3;0 regression equation for the comparison children was used to predict age 4;0 IPSyn scores for the late talkers based on their age 4;0 MLUs. When separate regression lines were calculated for each group, the quadratic curves provided no better fit to the data than the linear equations, hence the linear regression equation for the typically developing children was used to derive the predicted and residual IPSyn scores for the late talkers. The mean discrepancy between late talkers' obtained and predicted IPSyn score was minimal (i.e. −0·59 IPSyn points). In other words, when the regression equation for the age 3;0 typically developing children was used to predict IPSyn scores for the MLU-matched age 4;0 late talkers, there was no discrepancy for the late talkers between their predicted and obtained IPSyn scores.

Figure 6 contains the scatter plot of MLU and IPSyn for the MLU-matched groups (late talkers at 3;0 and typically developing at children at 4;0), as well as the linear regression line for each group.

For this cross-age match, when the two groups were indistinguishable in terms of MLU and IPSyn, the regression lines relating these two variables were quite similar across groups. Although the comparison children's line

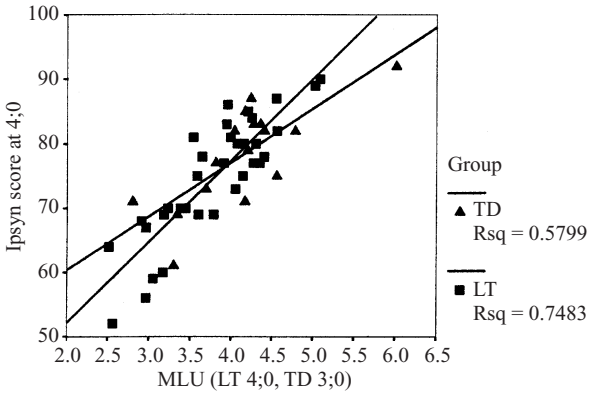

Fig. 6. Regression of IPSYN on MLU. cross-age match.

had a higher intercept (43·70 vs. 26·88) and a lower slope (8·36 vs. 12·65) than the late talkers' line, there was minimal discrepancy when the comparison children's line was used to predict IPSyn for the late talkers.

DISCUSSION

This study used MLU and IPSyn to track the course of expressive language development through age 4;0 for 34 late-talking toddlers and 16 children with normal language histories with whom they had been matched at 2;0 to 2;7 on age, SES, and nonverbal cognitive ability. Although both groups increased in MLU and IPSyn between 3;0 and 4;0 and the late talkers made larger gains during this period than comparison children, late talkers had significantly lower MLUs and IPSyn scores at both ages. Furthermore, when age-standardized z -scores were used, the gap between the late talkers and the comparison children was about 2·5 *S.D.*s at 3;0 and 4;0 on both MLU and IPSyn. At age 3;0, 59% of the 34 late talkers scored below the 10th percentile on MLU and 66% did so on the IPSyn. By 4;0, only 29% of the late talkers were below the 10th percentile in MLU, but 71% were below this cut-off on the IPSyn.

Late talkers looked very similar to the typically developing children in the relationship between MLU and IPSyn. The correlation between MLU and IPSyn at 3;0 was high and significant for both groups. At 4;0, MLU and IPSyn were only intercorrelated for the late talkers, consistent with Scarborough (1990). Also consistent with Scarborough (1990), the MLU–IPSyn correlation was much higher for children with MLUs at or below 3·0 than for those whose MLUs exceeded 3·0.

Regression analyses also supported the similarity between late talkers and typically developing children in the MLU–IPSyn relationship. When differences were computed between obtained IPSyn scores and those predicted from the regression equation in Scarborough *et al*. (1991), mean discrepancy in IPSyn score at 3;0 did not differ by group. As in Scarborough *et al*. (1991), discrepancies were lower for those with lower MLUs, regardless of group. When the late talker and comparison groups were merged, the quadratic regression equation explained much of the variance in IPSyn score and there were no group differences in mean residual score, despite the fact that the late talkers occupied a lower position on the common regression line. Finally, in the MLU-match, cross-age analysis, discrepancies in IPSyn calculated for the 4;0 late talkers from the 3;0 comparison's children's regression line were minimal.

Overall, the findings from this study suggest that the late talkers in this study, 71% of whom scored in the normal range on MLU at age 4;0, may not have been as selectively impaired in their morphological development relative to their MLU as older children with SLI who have been studied in the literature (Leonard, 1998). Of course, as the IPSyn is not a pure grammatical morphology measure, it would be interesting to do a cross-age match grammatical morpheme analysis with these late talker and comparison children.

As stated in the introduction to this paper, an important question in the language disorders field is whether late talkers and preschoolers with SLI are fundamentally different categories of children. Because late talkers have a relatively good outcome, they do not appear to be as 'disordered' as preschoolers with SLI whose language problems continue for many years (Whitehurst & Fischel, 1994). Thus, late talkers are assumed to have no true pathology, whereas children with SLI are postulated to have some fundamental disorder that results in continuing difficulties with language into adulthood (Tallal, 1988; Gopnik & Crago, 1991; Rice & Wexler, 1996).

In contrast to this categorical view, we propose a continuum account. We suggest that both late talkers and children with SLI have less optimal endowment for language than children with typical language histories. According to this account, late talkers occupy a position on a hypothesized language ability continuum that is closer to average than the position of children with SLI. The current proposal is therefore consistent with Leonard (1991), who suggested that specific language impairment was a 'weakness' in the linguistic faculty rather than a true pathology.

If late talkers and preschool children with SLI are at the lower end of the normal distribution in language skills, one would expect both groups to manifest both slower development and poorer asymptotic performance. The data from the present study are consistent with this hypothesis, as are other recent findings in the literature.

The recovery data presented here and elsewhere indicate that about half of late-talking toddlers identified between 2;0 and 2;7 scored in the normal range in expressive language by 3;0 in terms of MLU (Rescorla *et al.*, 1997). In the present study, about half of those still delayed in MLU at 3;0 had roughly normal MLUS by age 4;0. About half of late talkers still delayed at 4;0 appear to recover by 5;0, as indicated by the fact that 75 to 85% of late talkers score in the normal range at 5;0 (Paul, 1996; Rescorla, 1999).

Very comparable recovery results have been reported for children diagnosed with SLI at age 4. Around half of the Bishop & Edmundson (1987) sample of four-year-olds with SLI scored in the normal range by age five. Those who were still delayed at age 5 continued to be delayed at age 8 (Bishop & Adams, 1990), whereas those who were in the normal range at age 5 continued in this range through age 8.

Considered together, these data suggest a rate of recovery of about 50% per year from age 2 to age 5, with comparable recovery rates demonstrated by late talkers and preschoolers with SLI. On the other hand, children still language-delayed at age 5 are likely to continue to manifest significant language problems for many years, with few moving into the average range.

Findings on asymptotic language performance also suggest that late talkers and preschoolers with SLI show comparable patterns. Although the vast majority of late talkers perform in the average range on most language tests by age 5, they appear as a group to have continuing weaknesses in their language systems that result in consistently poorer performance than that of matched comparison children on a wide range of language and reading tasks well into adolescence (Paul, 1996; Rescorla, 1999). Similarly, the preschoolers with SLI in Bishop's longitudinal sample (Bishop & Edmundson, 1987; Bishop & Adams, 1990) who performed in the average range at ages 5 and 8 scored below typically developing comparison children on several language and reading measures at age 15, despite the fact that their scores were still roughly in the normal range (Stothard, Snowling, Bishop, Chipchase & Kaplan, 1998).

Taken together, the results of this study call into question the categorical distinction between late talkers and preschoolers with SLI. Rather, we propose that young children who are significantly delayed in expressive language after age 2;0 have a diathesis for weak language abilities. The most mildly impaired outgrow their delay by age 4, those with an intermediate level of SLI recover by age 5, and those most severely impaired continue to have language problems for many years. All the children on this SLI continuum have slower language development than comparison children from the same backgrounds. Perhaps most importantly, both late talkers and preschoolers with SLI who move into the average range in language by age 5 continue to manifest significantly lower asymptotic performance across a wide variety of language and reading measures than comparison children

with normal language histories who had comparable nonverbal abilities and SES backgrounds at intake.

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