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LATE TALKERS: DO GOOD PREDICTORS OF OUTCOME EXIST?

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Both small-scale and epidemiological longitudinal studies of early language delay indicate that most late talkers attain language scores in the average range by age 5, 6, or 7. However, late talker groups typically obtain significantly lower scores than groups with typical language histories on most language measures into adolescence. These findings support a dimensional account of language delay, whereby late talkers and typically developing peers differ quantitatively on a hypothetical language ability spectrum. Variation in language ability is presumed to derive from variation in skills subserving language, such as auditory perception/processing, word retrieval, verbal working memory, motor planning, phonological discrimination, and grammatical rule learning. Expressive language screening at 18–35 months can serve an important public health function by identifying children whose expressive delay is secondary to autism spectrum disorder, intellectual disability, hearing impairment, receptive language delay, or demographic risk. Finally, the review suggests that demographic risk associated with low SES may become more important as a causal factor in language delay as children get older.
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A delay in expressive language is one of the most common reasons that young children are referred for evaluation [Whitehurst and Fischel, 1994; Rescorla and Lee, 2000]. As noted by the US Preventive Services Task Force [2006], "Speech and language delay affects 5% to 8% of preschool children, often persists into the school years, and may be associated with lowered school performance and psychosocial problems" (p. 497).

Because expressive language delay, like a fever, is a symptom found in many conditions, children who are slow to talk are a heterogeneous group. Expressive language delay is often secondary to another disorder [Whitehurst and Fischel, 1994; Rescorla and Lee, 2000]. Late talkers may have a vocal tract malformation or a hearing loss that interferes with language development. Other young children with delayed language may have a neurological disorder or general intellectual disability (ID). Still other children who are slow to talk have autism spectrum disorder (ASD), in which case delayed language is accompanied by deficits in social relatedness, play, and behavior. Children may also be slow to talk because they experience severe deprivation, neglect, or abuse. We henceforth use the term late talkers to refer to children 18- to 35-month-old who are slow to talk in the absence of any of these other conditions presumed to be primary. Some late talkers have an expressive delay only, whereas others are delayed in receptive language as well.

Although distinct diagnostic groups within the population of young children manifesting expressive language delay are easily delineated, their relative percentages are less well documented. One study that did address this issue was conducted by Buschmann et al. [2008], who studied 100 German 2-year-olds with delayed expressive language identified in pediatric practices. Of these 100 children (65% boys), 78 were late talkers, 18 had language delay associated with cognitive impairment, and four had autism. These three groups did not differ in gender, birth position, or maternal education. Family history of language impairment was reported for 40% of the language-delayed group but for only 4% of a typically developing group. Of the 78 late talkers, 61 had an expressive delay only, whereas 17 had receptive/expressive delay. The late talkers with receptive/expressive delay had lower nonverbal IQs than the typically developing children, whereas the late talkers with expressive delays only did not.

For children whose language delay is secondary to ASD or ID, developmental progress tends to be slow and language may never reach normal levels. Outcomes also vary among late talkers. The purpose of this article is to review the literature on outcomes of late talkers with the aim of determining what, if any, variables are reliable predictors of outcome. We will review two kinds of studies: (a) small-scale longitudinal studies of late talker and comparison samples and (b) large-scale epidemiological studies of young children. The review encompasses children identified with language delays between 18 and 35 months of age. In the small-scale studies, late talkers are typically a well-defined group that excludes children with hearing impairment, neurological disorders, ASD, and ID, and, in some studies, even children with receptive language delays. In the large-scale epidemiological studies, children whose language delay is secondary to a more primary condition may not be excluded or even differentiated.

OUTCOMES FROM SMALL-SCALE LONGITUDINAL STUDIES OF LATE TALKERS

Preschool Outcome Studies of Late Talkers

In one of the first studies of late talkers, Fischel et al. [1989] reported on 22 children identified with specific expressive

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language delay at 24–38 months. The late talkers scored more than two standard deviations (SDs) below average on the Expressive One-Word Picture Vocabulary Test [EOPVT; Gardner, 1981] and had mean vocabularies of <20 words. Five months later, 35% of the group had scores in the average range on the EOPVT (>85), with outcome predicted by vocabulary size and proportion of consonants to vowels at intake. By age 3½, 88% scored above 85 on the EOPVT; 95% were in this range by 5½ [Whitehurst et al., 1992].

Thal et al. [1991] reported that four of 10 late talkers identified at age 2 who were still delayed 1 year later (i.e., the "truly delayed") had also been delayed at age 2 in receptive language and recognitory gestures. In contrast, the six "late bloomers" had been comparable to typically developing comparison children in receptive language and had made extensive use of gestures to compensate for communication. For a different sample, Thal et al. [2005] reported age 4 outcomes of 20 children who scored <10th percentile in expressive vocabulary on the Communicative Development Inventory [CDI; Fenson et al., 1993] at 16 months. Although the late talker group scored in the normal range on language and cognitive tests, they scored significantly lower than a group of 44 comparison children with typical language (TL) histories. The late talkers also scored lower than the comparison children on a nonword repetition task, particularly for longer stimuli.

Feldman et al. [2005] reported sensitivity of only 50% and positive predictive value of only 64% when language delay at age 2 (CDI vocabulary scores < 10th percentile) was used to predict language delay at age 3 for 113 children (over 50% from low-income families). Thus, many children with delayed early vocabulary caught up by age 3 and many children with apparently normal development at age 2 were delayed by age 3. Vocabulary size at age 2 was a better predictor of outcome than utterance length or sentence complexity score.

Lyytinen et al. [2001] traced language skills using the CDI at 14, 24, 30, and 42 months in 200 Finnish children, 106 from dyslexic families (DR), and 94 from families with no dyslexia history (NDR). By age 2, the DR group had shorter maximum sentence length but not smaller vocabularies than the NDR group. By 42 months, the DR group had significantly lower scores on expressive vocabulary and inflectional morphology measures but not on receptive language measures. A subsample of 34 late talkers (20 DR and 14 NDR) was identified based on scores 1 SD below the mean on age 2 expressive language. By 42 months, only the DR late talkers were still delayed in expressive and receptive language. For the full sample of 200 children, parental education and history of dyslexia, symbolic play and vocabulary comprehension at 14 months, expressive language at 24 months, and receptive language at 30 months were all significant predictors of expressive language outcome at age 3½ years, explaining 48% of the total variance.

Rescorla et al. [2000] reported age 3 and age 4 outcomes for 34 late talkers with normal receptive language and nonverbal ability identified at 24–31 months. At age 3, 41% of the late talkers scored above the 10th percentile on MLU and 34% scored above the 10th percentile on the Index of Productive Syntax [IPSyn; Scarborough, 1990]. At age 4, the percentages were 71 and 29%. For the same 34 late talkers, Rescorla et al. [1997] reported that the percentage scoring in the normal range at age 3 (≥16th percentile) was 79% on the EOPVT, 58% on the Reynell Expressive Language Scale [Reynell, 1977], 35% on MLU, and 24% on the IPSyn. Thus, grammatical skills showed the most persistent delays.

Rescorla et al. [2000] used regression analyses to identify significant predictors of outcome. Expressive *z*-score accounted for 21–34% of the variance in the age 3 outcome measures, whereas Reynell Receptive z-scores [Reynell, 1977; Reynell et al., 1990] and nonverbal ability scores were not significant predictors. The 34 late talkers (age range, 24–31 months) had very similar raw scores on the Reynell Expressive Language Scale, but because Reynell *z*-scores are age-based, the older children had lower *z*-scores than the younger children [Rescorla et al., 1997]. Therefore, intake age was correlated at −0.76 with Reynell Expressive *z*-score, and both measures significantly predicted outcomes. Because expressive language skills in typically developing children improve so rapidly between 24 and 36 months, the older a late talker is within this time period, the more he is falling behind on a steeply accelerating curve, as noted by Rescorla et al. [1997].

Finally, Fernald and Marchman [2012] traced lexical development from 18 to 30 months in 36 late talkers who scored ≤20th percentile on the CDI at 18 months and 46 typically developing children who scored >20th percentile. Mean vocabulary scores were vastly different between the two groups at 18 months (20 vs. 121 words, $d = 1.9$), and still very different by 30 months (419 vs. 569 words, $d = 1.0$). By 30 months, 14 of the 36 late talkers still scored ≤20th percentile on the CDI (39% = delayed), whereas 22 scored above this cutoff (61% = late bloomers). Of the 18 children delayed at 30 months, 14 had been late talkers at 18 months and four had been typically developing (9% of the typical group were delayed at 30 months). These outcomes yielded sensitivity of 78%, specificity of 66%, positive predictive value of 39%, and negative predictive value of 88%.

Fernald and Marchman [2012] reported that 18-month-old late talkers had lower accuracy and speed scores than typically developing children on looking-while-listening (LWL), an online preferential looking lexical processing task in the child listens to sentences such as "where is the doggy?" while a picture of the named referent and a foil are flashed on a screen. Faster reaction time and greater accuracy predicted steeper acceleration in vocabulary growth in the late talker group from 18 to 30 months. Adding reaction time as a predictor increased positive predictive value to 55% versus 39% using CDI score alone. Vocabulary plus accuracy yielded a positive predictive value of 52%. Fernald and Marchman [2012] also noted that Marchman and Fernald [2008] had reported faster processing speed and larger vocabulary size at 18 months as predictive of better working memory at age 8. Although Fernald and Marchman [2012] acknowledged that their study could not address the degree to which endogenous versus experiential factors accounted for lexical processing ability, they cited a previous study [Hurtado et al., 2008] demonstrating that richness of maternal speech to the child at 18 months predicted both vocabulary size and lexical processing skill at 24 months.

Summary

Preschool outcomes from small-scale longitudinal studies of late talkers indicate that: (a) most children scored in the normal range on language tests by age 4 or 5; (b) grammatical delays tended to be more protracted than vocabulary delays; and (c) significant predictors of outcome, which varied across studies and left much variance unexplained, included receptive language, gestures/play skills, degree of

delay at 2, consonant repertoire, family history of reading problems, and lexical processing.

School-Age Outcome Studies of Late Talkers

Girolametto et al. [2001] reported age 5 outcomes for 21 late talkers identified at 24–33 months with scores below the 5th percentile on the CDI. The children participated in an 11-week parent-based intervention program at age 2, and 13 of the 21 had received subsequent speech-language services. At age 5 follow-up, most of the late talkers scored in the normal range on various language measures, but they scored significantly lower on most language measures at age 5 than children with TL histories, particularly on measures tapping more complex skills, such as narrating a story.

Paul et al. studied about 30 late talkers identified between 20 and 34 months and a matched comparison group [Paul, 1993, 1996; Paul et al., 1997]. Roughly 25% of the late talkers were delayed in receptive as well as expressive language. At age 3 and age 4, all of Paul's [1993] late talkers scored in the average range for receptive and expressive vocabulary and for receptive grammar. Paul [1996] used a criterion of >10th percentile in Developmental Sentence Score [DSS; Lee, 1974] to indicate recovery, which might be considered a rather minimal standard for normal functioning. By this criterion, recovery was achieved by 41% of the sample by age 3, 57% by age 4, 74% by kindergarten and first grade, and 84% by second grade [Paul, 1996; Paul et al., 1997]. However, the late talkers did more poorly than the typically developing comparison children at age 7 on the TOLD-P2 [Newcomer and Hammill, 1988] Expressive language scale, even if they were classified as recovered. The recovered children were not different from controls on receptive language, reading, spelling, IQ, or phonological skills at age 7, whereas the children who were still delayed (DSS $\leq$ 10th percentile) were worse than comparison children on everything except receptive language and reading/spelling [Paul et al., 1997].

Moyle et al. [2007] reported age 5 outcomes for 30 late talkers first identified at age 2 by scores $\leq$10th percentile on the CDI. At age 5, late talkers had significantly lower scores than comparison children matched on age, SES, gender, and nonverbal cognitive ability on three TOLD-P3 subtests [Newcomer and Hammill, 1997]: Oral Vocabulary, Grammatic Completion, and Sentence Imitation (Cohen's *d* values of 0.97, 1.46, and 1.52, respectively). Ellis Weismer [2007] reported age 5½ outcomes for 40 late talkers identified at age 2 (11% with comprehension delays) and 43 typically developing peers. Only three of the late talkers scored at least 1 SD below the mean on TOLD-P3 Speaking Quotient at age 5½. However, even with these three children excluded, the late talkers obtained significantly lower scores than comparison children on both the Listening and Speaking Quotients of the TOLD-P3. Group differences were particularly marked in sentence imitation. Performance on a fast mapping task at 2½ explained 36% of the variance in MLU at 3½ [Ellis Weismer, 2007]; when CDI and Preschool Language Scale-3 [PLS-3, Zimmerman et al., 1992] scores were added as predictors, 65% of the variance was explained. As would be expected, prediction was weaker to age 5½, with age 2½ PLS-3 scores, CDI vocabulary, and nonverbal ability accounting for 51% of the variance in TOLD-P3 scores.

Rescorla [2002] reported school-age outcomes for 34 late talkers and 25 comparison children matched at intake on age, socioeconomic status (SES), and nonverbal cognitive ability. By age 6 [Rescorla, 2002], only 6% of the late talkers had scores <10th percentile on at least two TOLD-2 [Newcomer and Hammill, 1988] subtests. Nevertheless, the late talker group means were significantly lower than those for typically developing comparison children on vocabulary, grammar, phonology, and verbal memory tasks, with most Cohen's *d*s $\geq$ 0.85. For the combined late talker and comparison group samples, vocabulary score on the Language Development Survey [LDS; Rescorla, 1989] at age 2, grammar skills at age 3 as measured by MLU and IPSyn, and grammar skills at 5 as measured by the Patterned Elicitation Syntax Test [PEST; Young and Perachio, 1983] collectively explained 35% of the variance in age 8 scores on the Clinical Evaluation of Language Fundamentals [CELF-R; Semel et al., 1987].

Rescorla [2005] reported language and reading outcomes at age 13 for 28 late talkers and 25 typically developing children from the initial intake samples. As a group, late talkers performed in the average range on all standardized language and reading tasks at age 13, but they scored significantly lower than SES-matched peers on vocabulary, grammar, verbal memory, and reading comprehension. Regression analyses for the combined groups indicated that age 2 LDS vocabulary score explained 20% of the variance in age 13 vocabulary and verbal memory and 14% of the variance in age 13 grammar. Although much variance was left unexplained, these results indicated that slow vocabulary development at age 2–2½ was associated with a weakness in language-related skills into early adolescence relative to typically developing peers.

Rescorla [2009] reported language and reading outcomes at 17 years of age for 26 late talkers and 23 typically developing children matched at intake on age, SES, and nonverbal ability. Although late talkers performed in the average range on all language and reading tasks at age 17, they obtained significantly lower vocabulary, grammar, and verbal memory scores than peers with TL histories. The largest effect size was a Cohen's *d* of 1.08 on story recall. With the late talker and comparison groups combined, age 2 LDS vocabulary score, entered first, explained 17% of the variance in the age 17 vocabulary/grammar aggregate; Reynell Expressive and Reynell Receptive scores, entered next, were not significant predictors. Interestingly, Bayley nonverbal score, added last, explained an additional 13% of the variance. Results were similar for the verbal memory aggregates, with the LDS accounting for 17% and Bayley nonverbal score accounting for an additional 11% of the variance. Thus, 28–30% of the variance in age 17 language scores was explained by two age 2 measures.

Summary

School-age outcomes from small-scale longitudinal studies of late talkers indicate that: (a) most late talkers scored in the normal range by age 6 or 7 but continued to have significantly weaker language skill than typically developing peers through adolescence; (b) significant predictors of outcome, which varied across studies, included vocabulary at age 2, nonverbal IQ, and preschool expressive and receptive language, but at best only about half the variance in school-age outcomes was explained in these studies.

OUTCOMES FROM LARGE-SCALE EPIDEMIOLOGICAL STUDIES

Outcomes to 18–24 Months for Large-Scale Epidemiological Studies

The Early Language in Victoria Study [ELVS; Reilly et al., 2007] identified 20% of a community sample of

1,720 2-year-olds as late talkers, based on CDI expressive vocabulary scores <10th percentile based on U.S. norms [Fenson et al., 1993]. When gender, preterm birth, birth weight, birth order, SES, maternal mental health, maternal vocabulary and education, maternal age, family history of speech-language difficulties, and non-English family background were used as predictors of CDI scores, the model accounted for only 7% of the variance. When 12-month scores on the Communication and Symbolic Behavior Scales [CSBS; Wetherby and Prizant, 2002] were added to the predictive model, the partial R^2 was 14%, but most of the variance in 24 months expressive language remained unexplained.

Zubrick et al. [2007] assessed language skills at 24 months in a sample of 1,766 Australian children from English-speaking families. Late language emergence (LLE) was diagnosed based on parental report obtained by mail on six receptive and expressive language items of the Communication scale of the Ages and Stages Questionnaire [ASQ; Bricker and Squires, 1999] (e.g., pointing to pictures on request, using two- or three-word phrases). The criterion of scores ≥1 SD below the U.S. mean identified 13% of the sample with LLE (238 children). Children with LLE were more likely to also be delayed in ASQ Gross Motor (6 vs. 1%), Fine Motor (8 vs. 3%), Adaptive (21 vs. 6%), and Personal-Social (8 vs. 1%) skills than children with TL, suggesting that the LLE group included children with ID, ASD, or other developmental disabilities. Multivariate logistic regression with LLE as the target outcome indicated no significant prediction from parental education or mental health, maternal age, SES, parenting style, or family functioning. However, significant odds ratios (ORs) were obtained for family history of LLE (2.1), number of siblings (2.1), male gender (2.7), premature birth (1.8), <85% optimal birth weight (1.9), and delays on concurrent ASQ Gross Motor (3.1), Fine Motor (2.4), Adaptive (2.6), and Personal-Social (5.5) scores. Zubrick et al. [2007] concluded that the results are consistent with a models of language that "posit strong role for neurobiological and genetic mechanisms" rather than models attributing major influence to maternal and family characteristics.

The Norwegian Mother and Child Cohort Study [Schjolberg et al., 2011] investigated predictors of language delay at 18 months for 42,107 children as reported on the ASQ [Bricker and Squires, 1999]. A regression model with numerous predictors (being a boy, low birth weight or gestational age, multiple birth, older siblings, low maternal education, maternal distress/depression, and non-Norwegian language background) explained 4–7% of language outcomes, leaving most of the variance in language performance at 18 months unexplained.

Henrichs et al. [2011] tested predictors of 18-month scores on the 112-word Dutch version of the MacArthur Short Form Vocabulary Checklist [MCDI-N; Zink and Lejaegere, 2003]. Translations were available in English and Turkish; Moroccan parents who spoke only Arabic were interviewed at home by Arabic-speaking research assistants. Maternal age, parenting stress, and child ethnicity explained 1% of the variance in 18 months expressive vocabulary, gestational age and birth weight explained an additional 1%, gender and age at the 18-month evaluation explained an additional 4%, and MCDI-N receptive score at 18 months explained an additional 16%, for 22% in total.

Summary

Large-scale epidemiological studies predicting language outcomes at 18–24 months indicate that: (a) demographic and birth variables accounted for only a modest percentage of the variance in outcomes at 18 or 24 months and (b) adding in earlier or concurrent developmental variables accounted for more variance in outcomes, but most variance was still unexplained.

OUTCOMES FROM 16 TO 18 MONTHS FOR LARGE-SCALE EPIDEMIOLOGICAL STUDIES

Horwitz et al. [2003] studied 1,189 Connecticut children with elevated rates of demographic risk factors (e.g., 35% poor, 15% more than one language spoken in the home, and 37% non-white). When language delay was defined as a CDI short form expressive vocabulary score <10th percentile, rates of delay were 12.5% at 18–23 months, 15% at 24–29 months, and 18% at 30–35 months. Multivariate logistic regression analysis indicated that language delay was associated with demographic risk, but relative risk ratios were <2.0 except for being from a bilingual household (2.78) (e.g., low maternal education = 1.26, poverty = 1.33, minority status = 1.28, number of siblings = 0.83, and parenting stress = 1.61, all quite small effects).

Ellis and Thal [2008] summarized age 6 outcomes for a sample of 577 children classified at 16 months into three groups: 461 typically developing children; 81 "late producers" (children with expressive delay only, 14% of the sample); and 35 "late comprehenders" (children with receptive and expressive delay, 6% of the sample). At age 6, 2.2% of the 577 children met criteria for specific language impairment (SLI): 1.5% of the typically developing group, 3.7% of the late producers, and 8.5% of the late comprehenders. Of the 13 children diagnosed with SLI at age 6, seven had been typically developing, three had been late producers, and three had been late comprehenders at age 16 months. This suggests that early receptive/expressive delay confers greater risk for later SLI than does expressive delay only, but that more children with SLI at age 6 had TL histories as toddlers than language delays as toddlers.

Westerlund et al. [2006] assessed language development at 18 months and 3 years for children seen at Swedish child health care centers. Parents of 891 children completed the 90-word Swedish Communication Screening at 18 months [SCS18; Ericksson et al., 2002], with an expressive delay cutoff of <8 words. Language delay at age 3 was diagnosed if the child manifested lack of three-word sentences or failed to comprehend three of five comprehension questions posed by health center nurses. Only half the children delayed at 3 had been delayed at 18 months (sensitivity = 50%). Most of the children identified as delayed at 18 months were not delayed at age 3 (positive predictive value = 18%). Most children not delayed at 3 had not been delayed at 18 months (specificity of 90%). The area under the curve (AUC) of 77% obtained via receiver operating characteristics (ROC) analyses indicated only fair prediction. Increasing the 18-month SCS18 cutoff to <15 words raised sensitivity to 66%, but at the cost of positive predictive value of only 10% and specificity of only 73%. Furthermore, using words comprehended or gestures produced rather than words produced yielded even poorer prediction, and combining the three measures yielded a lower AUC than using production alone.

Henrichs et al. [2011] reported outcome data at 30 months for 3,759 of the Dutch children for whom expressive and receptive vocabulary delay at

18 months was determined by MCDI scores <10th percentile. Expressive vocabulary delay at 30 months was defined as a score <10th percentile on the Dutch translation of the LDS [Rescorla, 1989]. The correlation between MCDI-N expressive scores at 18 months and LDS scores at 30 months was only 0.34, much lower than the concurrent correlation of 0.95 between the CDI and the LDS in 2-year-olds [Rescorla et al., 2005].

Of the 3,759 children in the Henrichs et al. [2011] study, 85% had no expressive vocabulary delay at either age, 6% were delayed at 18 months and not delayed at 30 months (late bloomers), 6% had late onset expressive vocabulary delay (not delayed at 18 months but delayed at 30 months), and 3% had persistent expressive vocabulary delay (delayed at both ages). Most children (71%) delayed at 18 months on the MCDI-N scored in the normal range at 30 months on the LDS (positive predictive value = 29%), and most children (70%) delayed at 30 months had not scored below the 10th percentile at 18 months (sensitivity = 30%). Most children who scored in the normal range at 18 months continued to score in the normal range at 30 months (negative predictive value = 93%), and most children with normal skills at 30 months also had normal skills at 18 months (specificity = 93%). The ROC curve using MCDI-N expressive vocabulary scores at 18 months to predict LDS delay status at 30 months had an AUC of 0.74 (95% CI: 0.71, 0.77; $p = < 0.001$), indicating only fair predictive accuracy.

Henrichs et al. [2011] reported that hierarchical linear regression analysis examining prediction of 30 months vocabulary score yielded significant but small effects (complete model = 18%). Maternal age and education, marital status, family income, child ethnicity, and parenting stress explained 5% of the variance in LDS vocabulary at 30 months; gestational age and birth weight explained an additional 0.2%; gender and age at the 18- and 30-month assessments explained an additional 1%; 18 months MCDI-N expressive *z*-scores explained an additional 11%; and 18 months MCDI-N receptive *z*-scores explained an additional 0.5%. Children in the late onset group and the persistent delay group tended to have lower family income, less educated mothers, and more parental stress than children in the no delay and late bloomer groups. Late bloomers and children with persistent delay had lower gestational ages and lower birth weights than children with no expressive vocabulary delay and late onset expressive vocabulary delay. The persistent delay group showed the lowest nonverbal scores.

Summary

Large-scale epidemiological studies predicting language outcomes from 16 to 18 months indicate that: (a) language status at 16–18 months had low positive predictive value for later language delay; (b) most children delayed at later ages had not been delayed at 16–18 months (low sensitivity); (c) demographic and birth variables accounted for only a modest percentage of the variance in outcomes at 30 months; and (d) adding in earlier language status accounted for more variance in outcomes, but most variance was still unexplained.

OUTCOMES FROM 24 MONTHS IN LARGE-SCALE EPIDEMIOLOGICAL STUDIES

Armstrong et al. [2007] reported findings through fifth grade for 689 children from the NICHD Early Child Care Research Network data set. Three groups were defined based on CDI scores at 24 months and Reynell Expressive Language Scale scores [Reynell and Gruber, 1990] at 36 and 54 months: 131 late talkers, who scored ≤10th percentile on the CDI and <85 on the Reynell at 36 and 54 months; 39 late bloomers, who scored ≤10th percentile on the CDI and ≥85 on the Reynell at 54 months; and 558 typically developing children, who scored >10th percentile on the CDI at 24 month and ≥85 on the Reynell at 54 months. Differences between the three groups persisted through fifth grade on the Woodcock-Johnson-Revised [WJ-R; Woodcock and Johnson, 1992] Picture Vocabulary, Letter Word Identification, and Memory for Sentences subtests, although the late talker group scored in the average range on the first two subtests at all time points. For all measures, the late talker group performed worst, the typically developing group performed best, and the late bloomer group performed in between the other two groups, with little change in the gaps between groups over time.

Outcomes from age 2 to age 4 were reported for 1,596 of the children in the Australian ELVS cohort [Reilly et al., 2010]. Based on a cutpoint of >1.25 SDs below the mean on the Clinical Evaluation of Language Fundamentals—Preschool [CELF-P2; Wiig et al., 2006] to identify language delay, 13% were delayed in expressive language and 16% were delayed in receptive language, with 21% scoring below this cutpoint on either scale. After excluding children with low nonverbal IQs, ASD, hearing impairment, and non-English-speaking background (NESB), 17% were diagnosed with SLI based on receptive and/or expressive delay. A multivariate regression model with 12 predictors (male, twin, preterm, low birth weight, older siblings, NESB, low SES, family history of language problems, maternal education, maternal mental health problem, maternal age, and maternal vocabulary) explained 19% of the variance in CELF-P2 receptive language and 21% in CELF-P2 expressive language. Adding in language delay at age 2 increased the variance accounted for to 24% (receptive) and 30% (expressive), indicating stronger prediction from age 2 to age 4 than from 12 months to age 2 but still much unexplained variance. The strongest predictor of delayed expressive language at 4 was a foreign language home background, with an OR of 6.96. Being a boy (OR = 1.90), being a fourth child (OR = 2.36), and family history of language problems (OR = 1.82) were the next best predictors of delayed expressive language.

Dale et al. [2003] identified late talkers in a sample of UK twins at age 2 based on expressive vocabulary scores <10th percentile (≤15 words) on the 100-word MacArthur Communicative Development Inventory UK Short Form [MCDI: UKSF; Dionne et al., 2003]. All data were collected via parent reports sent by mail. After excluding children with uncertain zygosity, genetic syndromes, ASD, and non-English-speaking families, 802 of the 8,386 children (9.6%) were identified with early language delay (ELD). Compared with the 7,584 children with TL, the age 2 ELD group had more boys (65 vs. 47%) and lower nonverbal ability, grammar, and "displaced reference" scores. Their mothers also had lower educational attainment. However, on all these measures, there was considerable variation within the ELD group. The largest effect size was for nonverbal ability (5.7%).

When a score ≤15th percentile on two of three language measures (vocabulary, grammar, and abstract language) was used to identify ELD at age 3, 11% of the sample was delayed

(835 children), 61% of whom had not been delayed at 2; 44% of the 2-year-olds with ELD were still delayed at 3. When the same criterion was used at age 4, 12% of the sample was delayed in language (746 children), only 34% of whom had been delayed at 2; 40% of the 2-year-olds with ELD were still delayed at 4.

Dale et al. [2003] used logistic regression analyses to determine decision statistics for prediction from age 2 to ages 3 and 4. Age 2 vocabulary, displaced reference, and nonverbal ability scores as well as gender and maternal education were used in a prediction model for age 3 and age 4 delay for the age 2 children with ELD. Sensitivity was 42% at age 3 and 52% at age 4, meaning that half or fewer of the children delayed at follow-up were predicted to be delayed based on the model. Similarly, only 57% of the children predicted to be delayed by the model at age 3 (and 64% at age 4) were actually delayed at those ages (positive predictive value). When the full age 2 sample was used, sensitivity was very poor (19% at both ages), as was positive predictive value (53% at 3 and 58% at 4). In sum, language delay at age 2 and a number of additional factors poorly predicted language delay at a later age, more than half of children with ELD at 2 were in the normal range at ages 3 or 4, and most children with language delay at ages 3 and 4 had normal language at age 2.

Because the Dale et al. [2003] sample was comprised of twins, the relative contributions of genetic and environmental factors associated with language delay could be tested. Bishop et al. [2003] concluded that shared environmental factors accounted for more variance in age 2 ELD (71–72%) than did genes (22–25%), regardless of whether the children had a persistent or a transient delay as measured by parent report at ages 3 and 4.

Rice et al. [2008] reported age 7 outcome data for children with LLE and children with normal language emergence (NLE) from the Zubrick et al. [2007] study. At age 2, 128 children had expressive language delay (19% of the sample), 88 of whom also had receptive delays at age 2. Exclusion criteria included ID, ASD, deafness, Down syndrome, and cerebral palsy. At age 7, the children with LLE did not differ from the NLE group on SES/demographic variables or on nonverbal intelligence, and they scored in the normal range on all language measures given. However, they had significantly lower scores than the NLE group on receptive vocabulary, articulation, and numerous grammatical scales, with the largest Cohen's *d*s on the morphosyntax measures. The percentages of LLE children who were impaired (−1 SD below the mean) ranged from 4 to 23% across the 17 outcome measures, with significant group differences for seven of the measures.

Summary

Large-scale epidemiological studies predicting language outcomes from 24 months indicate that: (a) most late talkers scored in the normal range by age 6 or 7 but continued to have significantly weaker language skills than typically developing peers; (b) few significant predictors of outcome were found, and (c) positive predictive value from age 2 was generally low.

CONCLUSIONS

Outcomes of Late Talkers

Although several studies have reported outcomes for late talkers identified between 18 and 35 months of age, findings vary as a function of age at intake, age at follow-up, composition of the sample, and outcome measures used. For example, late talkers identified at 18 months tend to have smaller percentages of persistent delay by age 3 than late talkers identified at 24 months, as seen in rates of 18% in Westerlund et al. [2006] and 29% in Henrichs et al. [2011] versus 44% in Dale et al. [2003]. Furthermore, the older late talkers are at follow-up, the larger the percentage who will be recovered. For example, the percentage of Paul's late talkers who scored in the normal range for syntax increased from 41% at age 3 to 84% at age 7 [Paul, 1996]. With respect to sample composition, Ellis and Thal [2008] reported that 8.5% of late talkers with slow comprehension had persistent delay from 16 months to age 6 versus only 3.7% of those with Fischel normal comprehension. Finally, vocabulary measures tend to show better outcomes than grammar measures, and grammar measures vary in their degree of stringency. For example, the percentage of Rescorla's 34 late talkers scoring ≥16th percentile was 79% on the EOPVT, 58% on the Reynell Expressive Language Scale, 35% on MLU, and 24% on the IPSyn [Rescorla et al., 1997].

Despite the variations in outcomes reported across both small-scale and epidemiological studies of ELD, a robust finding across many studies is that most late talkers attained language scores in the average range by age 5, 6, or 7 [Fischel et al., 1989; Paul et al., 1997; Girolametto et al., 2001; Rescorla, 2002, 2005, 2009; Ellis Weismer, 2007; Ellis and Thal, 2008; Rice et al., 2008]. Furthermore, most late talkers scored in the average range by elementary school even on the tasks that appear to be the most challenging for them, namely grammatical and verbal memory measures [Rescorla, 2002; Rice et al., 2008].

Another very robust finding from outcome studies is that late talker groups consistently obtained significantly lower scores than groups with TL histories on most language measures, even when the late talkers performed in the average range. Paul [1996] and Rescorla [2002] were among the first to report this finding, which was replicated in Moyle et al. [2007], Ellis Weismer [2007], Rescorla [2005, 2009], Thal et al. [2005], Armstrong et al. [2007], and Rice et al. [2008]. This finding provides support for the dimensional account of language delay, according to which late talkers and children with TL development differ quantitatively on a hypothetical language ability spectrum [Rescorla, Fischel, 2009].

As articulated by Rescorla [2002, 2005, 2009], the language ability spectrum, like intelligence, can be conceptualized as deriving from variation in many discrete skills. The distinct yet interrelated abilities hypothesized to subserve language include auditory perception/processing, word retrieval, verbal working memory, motor planning, phonological discrimination, and grammatical rule learning. This notion of a spectrum of language ability is consistent with Leonard [1991] and Bishop and Edmundson [1987]. Ellis Weismer [2007] has related the notion of a language endowment spectrum to the broader theoretical debate regarding continuous versus dichotomous characterizations of language impairment.

Success in Predicting Late Talker Outcomes

When predicting language delay as a dichotomous outcome, both false positive and false negatives have been common. The false positive rate for late talkers is often very high (i.e., late talker scoring in the normal range at outcome), as indicated by generally low positive predictive values, such as 18% in Westerlund et al. [2006]; 29% in

Henrichs et al. [2011]; 44% (age 3) and 40% (age 4) in Dale et al. [2003]; 64% in Feldman et al. [2005]; and 39% in Fernald and Marchman [2012]. Because most late talker outcome studies do not report intervention information, it is difficult to determine the extent to which low positive predictive values are due to treatment success versus spontaneous remission.

High rates of false negative errors have also been widely reported in large-scale epidemiological late talker studies, in that the majority of children with language delays at follow-up had TL development at intake. Although most children with typical development at intake continue to have normal language skills at follow-up [e.g., negative predictive value of 93% in Henrichs et al., 2011], children who were not late talkers at intake generally comprise the majority of children delayed at outcome, e.g., 70% in Henrichs et al. [2011], 54% in Ellis and Thal [2008], 50% in Westerlund et al. [2006], and 61% (age 3) and 66% (age 4) in Dale et al. [2003]. However, this pattern has not generally been found in the small-scale late talker studies [e.g., Paul, 1996; Ellis Weismer, 2007; Rescorla, 2009], where very few children in the typically developing comparison groups manifested language delays at any follow-up age. The reason for this difference between epidemiological and small-scale late talker studies is that the small-scale studies selected typically developing comparison groups to have solidly average or even above average language skills, rather than just being above a 10% percentile cutoff. The only small-scale study in which many children with delays at 3 had been typically developing at age 2 was Feldman et al. [2005], which used a CDI score >10th percentile to define typical development at 2 and which contained many children from low SES families, known to be at risk for language delays with increasing age [Hart and Risley, 1995].

Ellis Weismer [2007] has highlighted the puzzling mismatch between the small percentage of late talkers who manifest SLI at age 5 and the 7% of kindergarten children identified with SLI [Tomblin et al., 1997]. As Ellis Weismer so cogently states, "Given the relatively low proportion of late talkers who display clinical language impairment at school entry, we must continue to ask where those 7% of kindergarten children with SLI come from if not from the ranks of late talkers" (p. 95). This apparent paradox should be a focus for further research, which can best be explored in diverse epidemiological samples that are being followed from 18 or 24 months, such as the Henrichs et al. [2011] Dutch sample or the Reilly et al. [2007] Australian sample.

As Henrichs et al. [2011] noted, poor decision statistics may derive in part from imposing a fixed cutpoint on an underlying continuum, whereby children just missing the cutpoint (i.e., at the 11th percentile) are classified as normal. However, Henrichs et al. [2011] also noted that the poor prediction in their sample was not only attributable to dichotomization, because the correlation between 18-month MCDI-N and 30-month LDS was only 0.34, and ROC analysis, which tests all cutpoints in a continuous fashion, yielded an AUC of only 74%.

Prediction of outcomes can also utilize continuous scores. Multiple regression analyses with small-scale studies involving late talker and typically developing groups have generally yielded moderately strong prediction. For example, Ellis Weismer found that 30-month fast mapping performance, CDI vocabulary, and PLS scores explained 65% of the variance in age 5 language outcome. Rescorla [2009] reported that 30% of the variance in age 17 vocabulary/grammar scores was predicted by LDS score and nonverbal ability at age 2. Fernald and Marchman [2012] reported that faster reaction time and greater accuracy in a lexical processing task at 18 months predicted steeper acceleration in vocabulary growth among late talkers from 18 to 30 months. In contrast, regression analyses with epidemiological samples have been able to account for rather small percentages of variance in outcome measures. For example, Henrichs et al. [2011] found that only 22% of the variance in 18 months expressive vocabulary score was explained (6% by demographic/perinatal factors and 16% by concurrent receptive vocabulary scores). Reilly et al.'s [2007] model predicted only 14% of the variance in CDI scores at 24 months (7% by demographic factors and 7% by 12-month communication scores on the CSBS). Zubrick et al. [2007], using logistic regression to predict LLE versus NLE at 24 months, reported that demographic factors were not significant predictors and that the highest ORs were for concurrent ASQ scores.

In summary, the likely reason that regression results are stronger for small-scale studies spanning many years (i.e., 15 years for the Rescorla age 17 results) than for epidemiological studies spanning short time periods is that the small-scale studies, by design, had sharply contrasting groups. The late talkers were selected to have severe delays (generally 1.5 SDs below age expectations) and the comparison children were selected to have solidly average or even above average language skills. Therefore, even though the late talkers eventually performed in the average range, they continued to have weaker skills than the comparison children and the variables that initially differentiated the two groups continued to differentiate them over time. By contrast, the epidemiological samples represented the full spectrum of language skills, with the late talkers at the tail of a continuous distribution (e.g., the bottom 10%) and the rest of the sample considered "normal." Furthermore, the epidemiological samples tended to be much more diverse in terms of SES than the small-sample studies, and the follow-ups to date have been quite short-term. It may be the case that when diverse samples such as the Dutch, UK, and Australian samples are followed up into the elementary school years, family SES factors will play an increasingly important role in accounting for variation in language skills.

Predictors of Outcome

Although several studies have tested predictors of outcome for late talkers, results have been inconsistent. For example, although Bishop et al. [2003] reported that shared environment impacted language delay and Horwitz et al. [2003] indicated strong demographic effects on language delay, two large Australian studies found that a host of environmental factors explained very little variance in language skills [Reilly et al., 2007; Zubrick et al., 2007]. It would seem that family income, marital status, ethnicity, parenting stress, and maternal educational level should be among the most important factors for explaining individual differences in language development. However, across most studies reviewed, their predictive ability has been quite modest. As noted above, longer term follow-ups in these large epidemiological samples are likely to indicate increasing effects of SES with age.

Reproductive factors such as gestational age, birth weight, and perinatal complications have also explained very

little variance in later language skills, consistent with many earlier studies of perinatal risk. This is probably because, as proposed by Sameroff and Chandler [1975], the "continuum of caretaker casualty" is more potent than the "continuum of reproductive casualty" in determining developmental outcomes. As Sameroff and Chandler noted, transactional effects between caregivers and children serve to magnify the effects of reproductive risk in more disadvantaged families but to minimize these effects in higher SES families.

Family history of language delay significantly increased the odds of being a late talker at 2 in the Zubrick et al. [2007] sample (OR = 2.1) and at 4 in the Reilly et al. [2010] sample (OR = 1.8), and history of language delay in the family has also been commonly reported in small-scale late talker studies. Lyytinen et al. [2001] found that genetic risk for dyslexia was strongly associated with persistent delay in late talkers identified at 2. Although these findings suggest that ELD may have a major genetic component, Bishop et al. [2003] noted that the magnitude of the genetic effect was very dependent on the particular outcome measure used to determine language delay as well as on the cohort analyzed.

Being a boy is one of the best predictors of being a late talker in epidemiological studies. Small-scale late talker samples typically have many more boys than girls, and late talkers in epidemiological studies also are more often boys than girls. Because girls typically have larger reported vocabularies than boys, using the same delay criterion for both genders (i.e., <50 words or <10th percentile on the CDI) will almost always yield more boys than girls. If a gender-specific cutpoint is used (i.e., 10th percentile on the CDI by gender), then genders will be equal in the late talker group, but the mean vocabulary score of the girl late talkers will be higher than the score of the boy late talkers.

The best predictors of expressive language appear to be earlier expressive language skills. This was found in both small-scale studies, such as those by Rescorla 2002, 2005, 2009] and Ellis Weismer [2007], as well as in epidemiological studies [Lyytinen et al., 2001; Reilly et al., 2007, 2010; Henrichs et al., 2011]. For example, Henrichs et al. [2011] reported that the strongest predictor of 30 months expressive vocabulary was 18 months expressive vocabulary, which accounted for 11% of the variance. Clearly, however, much variance was left unexplained.

An exciting possibility in recent late talker research is that some of the unexplained variance in late talker outcomes may be accounted for by language processing skills. As Fernald and Marchman [2012] and Marchman and Fernald [2008] have shown, reaction time and accuracy in a lexical processing task at 18 months significantly predicted later vocabulary growth in both typically developing children and late talkers, as well as predicting age 8 working memory. These findings are noteworthy, because verbal memory deficits are among the most robust and enduring weaknesses manifested by late talkers, even when they perform in the normal range at follow-up. Fernald and Marchman [2012] acknowledged that variation in lexical processing could be due to endogenous factors, but they also highlighted that variation in maternal speech to children has been demonstrated to predict later lexical processing skill at 24 months. It is likely that children vary in their inborn auditory processing ability, but that this ability is also shaped by subsequent language environment, such that children with richer language environments develop in their ability to efficiently process lexical information more than children with less rich language environments.

Implications

When expressive language delay is secondary to a more primary disability, such as autism or ID, then the likelihood of continuing delay is high and the benefits of early intervention are substantial. Additionally, when expressive language delay is the result of significant environmental neglect or abuse, it is important to intervene in order to protect the child and provide a more supportive and stimulating environment. To the extent that children with ID, ASD, or environmental deprivation would not be otherwise identified, picking them up in an expressive language screening would have some public health benefit. One might also make this argument for late talkers who are delayed in receptive language, given that receptive/expressive delay is often associated with nonverbal deficits and generally presages a poorer outcome than expressive delay alone.

On the other hand, children whose only developmental disability at 18–35 months is an expressive language delay are at less risk, as this review indicates. Most late talkers catch up to normative expectations, although some so not do so until age 5 or later and their language skills continue to be weaker than those of their peers, on average. Furthermore, the existing literature strongly suggests that most children with language delays at age 5 were not late talkers. Therefore, early identification and intervention with late talkers will not have much impact on preventing SLI in school-age children.

An implication of this review is that expressive language screening at 18–35 months can serve an important public health function because it can identify children whose expressive delay is secondary to another disability. This is particularly important for children with receptive language delay and weak nonverbal skills but who do not have ID or ASD and so might not be identified by other screening procedures. Children with receptive delays are fairly likely to have continuing language delay, as well as being at risk for later learning and behavioral/emotional problems. Therefore, they are the late talkers most in need of early intervention.

Although not providing definitive evidence, the current review suggests that demographic risk associated with low SES may become more important as a causal factor in language delay as children get older. In contrast, individual differences in basic language endowment seem more important as a primary causal factor in language delay from 18 to 35 months. To be sure, children from very disadvantaged families, or from families where more than one language is spoken, may show delays in this 18- to 35-month period, and the more such families there are in a large, diverse sample, the more likely demographic factors are to emerge as significant predictors.

In summary, language is a complex set of skills. A large number of biopsychosocial factors are most likely responsible for individual differences in the skills that subserve language ability. Early in development, biological factors may have the most important influence, as indicated by the familial aggregation of language problems. However, inborn characteristics are influenced by environmental factors. Therefore, by the time children start talking, their capacity for language learning reflects both their biological endowment and their linguistic environment. As children enter the preschool period, psychosocial factors such as how much (and how well) parents talk to them probably become

increasingly important. Thus, children who manifest SLI at age 5 most likely represent a mixture of children, some who have been delayed since they were toddlers, as well as some who are at psychosocial risk. Children with SLI at 5 typically have poorly developed listening skills, limited vocabularies, weak grammatical skills, and poorly developed higher level language abilities such as defining, describing, and narrating.

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