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Examining Continuity of Early Expressive Vocabulary Development: The Generation R Study

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Abstract

Purpose: We investigated continuity and discontinuity of vocabulary skills in a population-based cohort in the Netherlands.

Method: Mothers of 3,759 children completed the MacArthur Communicative Development Inventory at 18 months and the Language Development Survey at 30 months. At either age, expressive vocabulary delay was defined as vocabulary scores < 10^{th} age- and gender-specific percentile.

Results: Most children had normal vocabulary development (85.2%) at both ages, 6.2% were “late bloomers,” 6.0% had late onset expressive vocabulary delay, and 2.6% had persistent expressive vocabulary delay. Word production and comprehension at 18 months explained 11.5% of the variance in 30-month vocabulary scores with low birth weight, child age, gender and ethnicity, maternal age and education, and parenting stress explaining an additional 6.2%. Multinomial logistic regression was used to identify biological, demographic, and psychological factors associated with each of the vocabulary delay outcome groups relative to the typically developing group.

Conclusions: Although multiple perinatal, demographic and maternal psychosocial factors significantly predicted vocabulary skills at 30 months, positive predictive value and sensitivity were low. Future studies should address to what extent additional factors, such as brain maturation and genetic influences, can improve the prediction and our understanding of continuity and discontinuity of language delay.

Examining Continuity of Early Expressive Vocabulary Development: The Generation R Study

There are huge individual differences in rate of early expressive vocabulary development. For example, Rescorla and Achenbach (2002) reported a mean vocabulary of 105 words at 18 to 23 months on the 310-word Language Development Survey (LDS; Rescorla, 1989), but the standard deviation (*SD*) of 83 yielded a “normal” range of 22 to 188 words. Genetic/biological factors, environmental factors, and the interaction among these factors are all assumed to influence early vocabulary development, but predictive power of models tested to date has been disappointing (Reilly, Wake, Bavin, Prior, Williams, et al., 2007; Zubrick, Taylor, Rice, & Slegers, 2007).

Another central issue is continuity of vocabulary skills in early childhood. For some toddlers, delayed vocabulary acquisition is the first indication of a persisting language impairment that may be associated with poor social competence (Gertner, Rice, & Hadley, 1994); behavioral problems (Rescorla, Ross, & McClure, 2007), attention deficit/hyperactivity (Giddan & Milling, 1999), and cognitive delays/reading problems (Oliver, Dale, & Plomin, 2004; Rescorla, 2002, 2009; Snowling, Adams, Bishop, & Stothard, 2001). However, most late talkers catch up during the preschool period (Ellis Weismer, 2007; Rescorla, 2002; Thal, Tobias, & Morrison, 1991) and generally perform in the average range by age 5, although they continue to have weaker language skills than peers with typical language histories (Rescorla, 2009). Longitudinal studies have yielded few strong predictors of the outcome of early language delay, and many such studies had small and homogeneous samples.

Prior to outlining the goals of our study, which utilized a large and diverse sample of children in the Netherlands, we summarize findings from other studies that have examined the prediction of early language delay and the persistence of early language delay in large, general population samples.

Prediction of Early Language Delay

Bishop, Price, Dale, and Plomin (2003) reported heritability findings for 570 British twin probands identified at age 2 with vocabulary scores < 10^{th} percentile on the MacArthur Communicative Development Inventory UK Short Form (MCDI: UKSF; Dionne, Dale, Boivin, & Plomin, 2003). Heritability was 24% for the full cohort, much lower than the heritability of 73% that Dale et al. (1998) had reported for one of the two birth cohorts in the same sample. Bishop et al. (2003) also reported that heritabilities for the probands who manifested persistent versus transient language delay at ages 3 or 4 based on the MCDI: UKSF were all ≤ 25%, whereas heritability was 41% for the 134 children whose mothers had consulted a professional by age 4 about the child's language but only 8% for the 289 children whose mothers had not consulted a professional. Thus, heritability estimates appeared to vary widely depending on the cohort of children studied and the outcome measure used to determine persistent language delay.

In the Early Language in Victoria Study (ELVS; Reilly et al., 2007), prediction of language functioning at 24 months was examined in a community sample of 1,720 infants recruited at 8 months. At age 2, 20% of the sample were identified as late talkers, based on MCDI expressive vocabulary scores < 10^{th} percentile based on U.S. norms (Fenson, Dale, Reznick, Thal, Bates, et al., 1993). When gender, preterm birth, birth weight, birth order, socioeconomic status (SES), maternal mental health, maternal vocabulary and education, maternal age, family history of speech-language difficulties, and non-English family background were used in a linear regression to predict age 2 MCDI scores, the model accounted for only 7% of the variance. However, when 12-month scores on the Communication and Social Behavior Scales (CSBS; Wetherby & Prizant,

2002) were added to the predictive model, the partial R^2 was 14.2%. The authors concluded that communication skills already attained at 12 months were a much better predictor of 24 months language functioning than were any other child, family, or environmental predictors in their model. However, even with 12 months communication skills in the model, most of the variance in 24 months expressive language remained unexplained.

Zubrick et al. (2007) tested numerous maternal, child, and family variables as predictors of individual differences in language acquisition at 24 months in a sample of 1,766 Australian children followed annually from birth. Late language emergence (LLE) was identified in 13% of the sample, using a criterion of scores $\geq$ 1 *SD* below the U.S. mean on the Communication subscale of the Ages and Stages Questionnaire (Bricker & Squires, 1999), which was obtained from the parents by mail. 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.

In a cohort of a random community sample of 1,189 children aged 12-39 months and born in Connecticut, Horwitz et al. (2007) investigated the association of maternal, child, and family characteristics with early expressive language delay. At age 18-23 months, 13.5% of the children had expressive language delays defined as MCDI short form expressive vocabulary scores < 10^{th} percentile. Among the strongest predictors of expressive language delay at age 18-23 months were low maternal education, low maternal expressiveness, and high parenting stress. Small-scale studies (n < 110) have also reported that parenting stress is associated with language problems

(Magill-Evans & Harrison, 1999; Noel, Peterson, & Jesso, 2008). Furthermore, some data suggest that children from immigrant families, many of whom have low SES, tend to have slower early language development than children from non-immigrant families (Rescorla & Achenbach, 2002; Reilly et al., 2007).

Continuity of Early Language Functioning

Dale, Price, Bishop, and Plomin (2003) reported that 44% of the 740 late talkers identified at age 2 with MCDI: UKSF vocabulary scores < 10^{th} percentile still manifested expressive language delays at age 3 (i.e., 326), whereas only 7% of the 7,068 toddlers with typical language development at age 2 were delayed by age 3 (i.e., 509). Thus, of 835 children with an expressive language delay at 3, 61% had not been delayed at 2. Age 2 vocabulary scores and nonverbal cognitive ability were significant predictors of age 3 outcomes, but effect sizes were small, and adding maternal education, the child's history of ear infection, and gender to the model did not substantially improve prediction. In sum, language delay at age 2 and a number of additional factors only poorly predicted language delay at a later age, and most children with language delay at age 3 had normal language at age 2.

Feldman et al. (2005) reported a correlation of .58 between MCDI expressive vocabulary scores at age 2 and 3 based on a small study sample including 113 children. Yet, sensitivity was 50% and positive predictive value was 64% when language delay at age 2 (MCDI vocabulary scores < 10th percentile) and language delay at age 3 (parent-reported vocabulary > 1 *SD* below the mean) were cross-tabulated. 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.

Similar results were reported by Westerlund, Berglund, and Eriksson (2006), who evaluated the effectiveness of the Swedish screening version of the MCDI at 18 months in identifying language delay at age 3 years in an unselected Swedish population of 2,080 children. Only 17.6% of the 108 children delayed on MCDI vocabulary at 18 months were still delayed at age 3 based on formalized observations by research nurses, indicating very low positive predictive value. Sensitivity was also modest (50%), indicating that only half the children with apparent language delay at 3 had been delayed on the Swedish MCDI at 18 months.

Lyytinen, Poikkeus, Laakso, Eklund, and Lyytinen (2001) reported age 3½ language outcome data for 200 Finnish age 2 late talkers. 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 3.5 years. Taken together, all predictors explained 48% of the total variance, with receptive language at 30 months explaining 24%.

Summary

Although several population-based studies have tested many predictors of early language delay, results have been inconsistent, appear to vary across countries and most variance has not been explained. Although Bishop et al. (2003) indicated a large role for shared environment, two Australian studies found that a host of environmental factors explained very little variance in language skills (Reilly et al., 2007; Zubrick et al., 2007). So far, some evidence has identified maternal education, child ethnicity, parenting stress, and perinatal factors as predictive of early language differences. However, more consistently predictive are gender, later birth position, and family history of language delay. The best predictor of language functioning in Reilly et al. (2007) was earlier communication, and the strongest correlates in Zubrick et al. (2007) were concurrent motor, cognitive, adaptive, and personal-social skills, but even these factors explained relatively little variance. On the other hand, receptive language skills at age 30 months accounted for 24% of the variance in expressive language skills at age 3½ in the Lyytinen et al. (2001) Finnish study. Taken in aggregate, results from Dale et al. (2003), Feldman et al. (2005) and Westerlund et al. (2006) suggest that parent report measures of language development in toddlerhood only poorly predict subsequent language outcome. Finally, Leonard (2009) and Ellis Weismer (2007) note that the percentage of late talkers still delayed at age 4 or 5 is too low to account for the 7% prevalence of SLI at age 5 (Tomblin et al., 1997), leading Ellis Weismer (2007) to ask, "where those 7% of kindergarten children with SLI come from if not from the ranks of late talkers." (p. 95). Few existing studies have addressed this important question of what characterizes children with later emerging language delay.

Rationale for the Study

The present study used a large population-based sample of Dutch children that was diverse in ethnicity, maternal education, and family income. Children were studied at 18 and 30 months of age. Three major questions were addressed: (1) which biological, environmental and child factors predict expressive vocabulary development at 18 months; (2) what is the continuity of early vocabulary development from 18 to 30 months; and (3) how do biological, environmental and child factors relate to continuity versus discontinuity in early vocabulary skills from 18 to 30 months.

Method

Participants

This research was embedded in the Generation R Study, a population-based cohort in Rotterdam, the Netherlands (Jaddoe, et al., 2008). All children were born between April 2002 and January 2006. The study has been approved by the Medical Ethics Committee of the Erasmus Medical Center, Rotterdam, and written informed consent was obtained from all adult participants. Language data at 18 months were obtained for 5,289 Generation R children based on questionnaires completed by parents. When these children were 30 months of age, 1,115 of their mothers did not report information on vocabulary development. Furthermore, we excluded 415 children whose ages were out of range for our language measures. This left 3,759 children (71.1% of the 5,289 eligible subjects). Language data were all obtained by questionnaires completed by parents. Although 18 months and 30 months were the targeted ages for the two language assessments, parents varied in how promptly they returned the questionnaires (Table 1).

Measures

MacArthur Communicative Development Inventory - Netherlands (MCDI-N). Vocabulary skills at 18 months were assessed using the Dutch version of the MacArthur Short Form Vocabulary Checklist (MCDI-N; Zink & Lejaegere, 2003), a list of 112 monomorphemic root words derived from the complete Dutch version of the MCDI: Words and Sentences (Zink & Lejaegere, 2002). Translated versions of the MCDI-N were available in English and Turkish. Moroccan parents who spoke only Arabic were interviewed at home by Arabic-speaking research assistants to obtain language data. The MCDI-N has excellent internal consistency and test-retest reliability, as well as strong concurrent validity (Zink & Lejaegere, 2003).

MCDI-N expressive scores were derived by summing parents' positive responses in the "says" column. In the current study, receptive scores on the MCDI-N were calculated by summing all the words the parent checked in the "understands" column. However, some previous studies (e.g. Fenson, et al. 1993; Reilly, et al. 2007) have calculated MCDI receptive vocabulary scores by summing all the responses in both the "understands" and "says" columns, under the assumption that the child understands all words that he uses productively. When we calculated receptive scores using this "dual" method, mean receptive vocabulary score was slightly higher, namely 58.4 (*SD*, 26.6) versus 56.1 (*SD*, 25.1), but the two scores were correlated at .96.

Internal consistencies were .98 (receptive) and .97 (expressive). Because expressive vocabulary scores were positively skewed, they were log-transformed. The log-transformed expressive vocabulary scores and the normally distributed raw receptive vocabulary scores were *z*-standardized across the study sample. To identify vocabulary delay at 18 months, we converted the expressive and receptive vocabulary raw scores into age- and gender-specific percentile scores based on the whole Generation R sample using one month age brackets. Expressive and receptive vocabulary delay at 18 months was defined as scores < 10^{th} percentile, in line with previous research (Dale, 1996).

Language Development Survey (LDS). Expressive vocabulary skills at 30 months were assessed using parent report on a Dutch translation of the Language Development Survey (LDS; Rescorla, 1989). Translations into English and Turkish were available, and Moroccan parents who spoke only Arabic were interviewed at home by Arabic-speaking research assistants. The LDS 310-word checklist has demonstrated excellent internal consistency, test-retest reliability, and concurrent validity (Achenbach & Rescorla, 2000; Rescorla, 1989; Rescorla & Alley, 2001). In this study, internal consistency of the LDS was .99. LDS total vocabulary scores were *z*-standardized across the study sample after log transformation to improve the normality of the distribution. To determine vocabulary delay at 30 months, we converted raw total vocabulary scores into age- and gender-specific percentile scores based on the complete Generation R sample, again using one month age brackets. We defined expressive vocabulary delay at 30 months as an LDS vocabulary score < 10^{th} percentile.

Demographic predictors. A variety of parental and family predictors used in previous studies (e.g., child ethnicity, maternal age, maternal education, family income, and marital status) were coded from questionnaires administered during pregnancy and used to predict MCDI-N expressive vocabulary score at 18 months as well as to predict continuity in vocabulary skills from 18 to 30 months.

In highly diverse Rotterdam, children of different ethnic backgrounds grow up in different sociocultural and linguistic environments and have quite different adult outcomes. Thus, it appears highly likely that children of different ethnicities would vary widely in their early language skills. The Generation R study uses the ethnicity categorization of Statistics Netherlands (Statistics Netherlands, 2004), whereby children whose parents and grandparents were born in the Netherlands are considered Dutch. Children who have a parent or a grandparent born in any other European country or in the U.S., Canada, Australia, or Japan are classified as "Other Western," suggesting that "Other Western" equates to "white" or "non-white from an affluent country." In contrast, "non-Western" children have a parent or grandparent born in Turkey, Morocco, Surinam, the Dutch Antilles, and Cape Verde. As can be seen in Table 1, the sample was 69.6% Dutch, 9.1% Other Western, and 19.9% non-Western.

In the Netherlands, children must attend school until the end of the school year in which they turn 16 (Dutch Ministry of Education, Culture and Science, 2007) and must attain a basic qualification (e.g., senior general education, pre-university education, or secondary vocational education Level 2 certificate). Following the definitions of Statistics Netherlands (2004), we divided maternal education into four categories: *Low* education (no education, primary school or $\leq$ 3 years secondary school, typically $\leq$ 12 years of education); *Mid-low* education (> 3 years secondary school, intermediate vocational training, 1st year higher vocational training); *Mid-high* education (higher vocational training; Bachelor's degrees); and *High* education (Master's degree or PhD). The distribution of maternal education was 34.2% High, 25.4% Mid-high, 25.4% Mid-low and 11.9% Low (Table 1). Dutch and Other Western children had mothers with higher levels of education (38.7% and 43.3% High, respectively) than did non-Western children (16.6% High). Net family monthly income was categorized into "< 1200 Euros" (i.e. below the Dutch social security level), "1200-2000 Euros" and "> 2000 Euros" (more than modal income). Marital status was classified as "married", "cohabiting," or "single motherhood".

Perinatal predictors. Birth weight was obtained from medical records and gestational age was established by fetal ultrasound examinations. In this sample, 4.8% were prematurely born and 4.6% had a low birth weight (i.e. < 2500g), somewhat lower than the 8.0% and 7.1 % rates in the Netherlands generally (Den Ouden & Buitendijk, 2003; Perinatal Registration Netherlands, 2004).

Parenting stress. Parenting stress was included as a predictor because previous research has indicated an association between parenting stress and slower language development (Horwitz, et al., 2003). Mothers reported information on parenting stress using the Dutch short version of the Nijmegen Parenting Stress Index (NOSIK; De Brock, Vermulst, Gerris, & Abidin, 1992) in the 18-month questionnaire. We used an adapted version of a NOSIK subscale assessing maternal perceptions of caregiving, calculated by averaging 12 items including scales ranging from 0 (totally disagree) to 3 (totally agree) (e.g. "I have much more trouble raising children than I thought."). Internal consistency was adequate in this sample ($\alpha = .74$).

Receptive language functioning. Because receptive language is among the best predictors of expressive language (Ellis Weismer, 2007; Leonard, 2009), MCDI-N receptive vocabulary was included as a predictor for 18 and 30 months expressive vocabulary, as well as of vocabulary skills from 18 to 30 months.

Nonverbal abilities. Finally, the adapted Dutch version of the Parent Report of Children's Abilities (PARCA; Saudino, et al., 1998) was used at 30 months to assess nonverbal abilities. PARCA scores were calculated by summing the 22 parent-administered items (tapping matching-to-sample, block building, and imitation) and the 26 parent-report questions (assessing quantitative skills, spatial abilities, symbolic play, planning and organizing, adaptive behaviors, and memory). PARCA scores were normally distributed and *z*-standardized across the current study sample. In a validation study of the original PARCA based on a sample of 107 2-year-old children, internal consistencies were good (.83 and .74) and correlations with the Mental Development Index (MDI) of the Bayley Scales of Infant Development-II were large (r = .55) (Saudino, et al., 1998).

Attrition Analysis

When the 3,759 included children who had vocabulary scores at both ages were compared with the 1,530 excluded children who had missing vocabulary scores at 30 months, included children were less likely to have a lower birth weight (4.6% vs. 6.6%, χ^2 = 9.28, df = 1, p < .001); had a higher gestational age (M = 39.9 weeks (SD, 1.7) vs. 39.7 weeks (SD, 1.9), t = 2.33, p = .020); were more likely to be Dutch (69.6% vs. 55.5%, χ^2 = 123.0, df = 2, p < .001); and had mothers with high levels of education (% High education 34.2 % vs. 22.9%, χ^2 = 188.8, df = 3, p < .001) and older ages (M = 31.6 years (SD, 4.5) vs. 30.4 years (SD, 5.2), t = 8.63, p < .001).

Statistical Analyses

To address the first research question, we used univariate and hierarchical linear regression analyses to test the relative contributions of all predictors to non-age and non-gender specific MCDI-N expressive *z*-scores at 18 months. To be included, a predictor was required to be significantly related with the outcome in the univariate regression analyses. To build a hierarchical linear regression model predicting MCDI-N expressive *z*-scores at 18 months we used the approach by Cohen, Cohen, West & Aiken (2003), whereby four functional sets of predictors were determined a priori and categorized into (1) demographic and maternal psychosocial variables, i.e. maternal educational level and age, family income, marital status, child ethnicity and parenting stress; (2) perinatal factors, i.e. low birth weight and gestational age; (3) child factors, i.e. child age at language assessment and gender; and (4) receptive vocabulary development at 18 months expressed as MCDI-N receptive *z*-scores. Using a forced entry procedure these four functional sets were entered consecutively into the hierarchical regression analysis.

To address the second research question, we used the categorical assignment of expressive vocabulary delay at 18 and at 30 months (defined as word production scores below the age- and gender specific 10th percentile at the respective age period) to cross-tabulate expressive vocabulary delay status at both ages. This cross-tabulation yielded four groups: (a) children with no expressive vocabulary delay; (b) late bloomers, i.e. children with expressive vocabulary delay at 18 months but normal vocabulary development at 30 months; (c) children with late onset expressive vocabulary delay, i.e. normal at 18 months but delayed at 30 months; and (d) children with persistent expressive vocabulary delay. We then compared these four groups on all predictors, using one-way ANOVAs with Student-Newman-Keuls (S-N-K) post-hoc tests for continuous variables and Chi-square tests for categorical variables.

To address the third research question, all predictors that significantly differentiated among the groups were then used in a hierarchical linear regression analysis to determine the percentage of unique variance in (non-age- and non-gender specific) LDS vocabulary *z*-scores at 30 months accounted for by these predictors. Again the predictors were organized into functional sets that were entered consecutively into the hierarchical linear regression analysis. As both MCDI-N receptive and expressive *z*-scores were used in this analysis, the model consisted of five functional sets, i.e. (1) demographic and maternal psychosocial factors; (2) perinatal factors; (3) child factors; (4) 18-month expressive vocabulary development; and (5) 18-month receptive vocabulary development. Finally, the third research question was also addressed by using multinomial logistic regression analysis to determine which of the predictors, when entered into the model simultaneously, yielded significant odds ratios (ORs) for the three delay outcome groups relative to the reference group with normal vocabulary development. All analyses were based on 3,759 observations, except for the analysis of nonverbal cognitive development, which was based on 3,481 observations only, due to incomplete data on the PARCA in 7.3% of the subjects. To test whether our results were influenced by child ethnicity (and the language spoken at home), we reran our analyses among Dutch children only (n = 2635).

We used SPSS for Windows (Version 17.0) for data analysis. To handle missing values in some of the predictors (ranging from 1.0% missing values in parenting stress to 15.2% missing values in family income, see Table 1) we applied multiple imputation to generate five datasets. In this procedure, missing values were replaced by imputed values by sampling these values from their predictive distribution based on the relations between all predictors included in the present study (Sterne et al., 2009).

Results

In the first set of analyses, we addressed which demographic, maternal psychosocial, perinatal and child factors predicted MCDI-N expressive vocabulary at 18 months (non-age and non-gender specific *z*-scores) using univariate and hierarchical linear regression analyses (see

Table 2). Non-Western child ethnicity, gestational age, child age at 18-month assessment, and receptive vocabulary *z*-scores at 18 months were positively related to MCDI-N expressive vocabulary *z*-scores, whereas maternal age, Other Western child ethnicity, parenting stress, low birth weight, and being a boy were negatively associated with MCDI-N expressive vocabulary *z*-scores. In the univariate regression analyses, concurrent receptive vocabulary *z*-scores were moderately associated with the expressive vocabulary scores at 18 months ($\beta = .44$, $t = 29.8$, $p = .001$) explaining 19.1% of the variance, but the remaining significant associations between the predictors and 18-month expressive vocabulary scores were relatively weak, as can be seen in Table 2. Furthermore, maternal education, family income, and marital status were not significantly associated with expressive vocabulary development at 18 months (Table 2).

In a next step, hierarchical linear regression analysis examined the percentage of unique variance in expressive vocabulary z-scores at 18 months accounted for by all predictors that had significantly been related to the outcome in the univariate regression analyses. As described above, the different predictors were organized into four functional sets that were entered consecutively into the hierarchical regression analysis. Maternal age, parenting stress, and child ethnicity entered in Step 1 explained 1.4% of the variance in 18 months expressive vocabulary. Gestational age and birth weight entered at Step 2 explained an additional 1.2%. Gender and age at the 18-month evaluation (Step 3) explained an additional 3.6%. Finally, MCDI-N receptive score at 18 months added at Step 4 explained an additional 15.9%. Thus, of the 22.1% of the variance in 18 months expressive vocabulary score explained by the eight predictors, concurrent receptive vocabulary scores accounted for 15.9%, with only 6.2% explained by demographic, perinatal and child factors. Very similar results were obtained when the same analysis was run with Dutch children only, with 25.9% explained by the full model.

The second set of analyses addressed the continuity of vocabulary skills from 18 to 30 months. As shown in Table 3, 85.2% of the sample had no expressive vocabulary delay at either age, 6.2% were late bloomers, 6.0% had late onset expressive vocabulary delay, and 2.6% had persistent expressive vocabulary delay. Most children 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 delayed at 30 months had not scored below the 10^{th} 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 area under the curve (AUC) of .74 (95% CI .71; .77), p = < .001), indicating only fair predictive accuracy.

We also tested gender differences when using a gender-neutral, age-specific 10^{th} percentile cutpoint. At both 18 months and 30 months, boys were more likely to be delayed than girls (10.1% vs. 7.5%, $\chi^2 = 7.91$, df = 1, $p = .005$ at 18 months; 11.1% vs. 6.1%, $\chi^2 = 29.2$, df = 1, $p < .001$ at 30 months), consistent with the fact that girls had larger vocabularies than boys (MCDI-N *z*-scores (0.12 vs. -0.12, $F(1, 3758) = 58.28$, $p < .001$), and LDS *z*-scores (0.10 vs. -0.10, $F(1, 3758) = 36.13$, $p < .001$) than boys.

The overall pattern of results presented in Table 3 suggests important demographic and birth history differences between children in the four outcome groups, which were tested using one-way ANOVAs with Student-Newman-Keuls (S-N-K) post-hoc tests for continuous variables and Chi-square tests for categorical variables. Late bloomers were most likely to be Dutch (76.3%, 95% CI = 73.1; 79.5), whereas children with late onset expressive vocabulary delay were least likely to be Dutch (45.4%, 95% CI = 40.5; 50.3%). Although children with late onset expressive vocabulary delay did not differ in the rate of low maternal educational level from children with persistent vocabulary delay (27.3%, 95% CI = 21.6; 33.0 and 19.8%, 95% CI = 10.7; 28.9, respectively), they had more mothers with a low educational level than children with no expressive vocabulary delay (10.7%, 95% CI = 9.0; 12.4) or late bloomers (14.7%, 95% CI = 8.6; 20.8). Similar patterns were found for parenting stress and low family income. Furthermore, children with late onset vocabulary delay had the youngest mothers (29.7 years, 95% CI = 29.0; 30.3). Late bloomers and children with persistent vocabulary delay did not differ in gestational age, but these two groups had lower gestational ages than children with no expressive vocabulary delay and late onset expressive vocabulary delay. We observed similar results with regard to birth weight differences.

Table 3 also shows in which way the four outcome groups differ in terms of vocabulary development at 18 and 30 months and nonverbal cognitive development at 30 months. As would be expected given how the four outcome groups were defined, they differed significantly in MCDI expressive vocabulary score at 18 months. Additionally, the late bloomers and children with persistent expressive vocabulary delay had the lowest comprehension *z*-scores at 18 months (-.47, -.60, respectively), although their *z*-scores for comprehension were less extreme than their expressive *z*-scores (-2.10, -2.12, respectively). Although children with late onset delay did not meet the 10^{th} percentile cut-off for expressive delay at 18 months, their mean MCDI-N expressive vocabulary score was about one-half *SD* below that of the typically developing group, but not as low as the mean score of the late bloomers or persistently delayed children. LDS *z*-scores at age 30 months differed significantly across the four outcome groups, as would be expected. Children with no expressive vocabulary delay had significantly larger vocabularies than children in the “late bloomer” group. The difference in mean LDS score for the persistent delay group relative to the no delay group was more than three *SD*s (-2.87 vs. .24). Finally, children with no expressive delay at either age had significantly higher nonverbal cognitive ability scores than the late bloomers. PARCA scores did not differ between the late bloomers and children with late onset expressive vocabulary delay, but the persistent delay group showed the lowest PARCA scores.

The next set of analyses addressed the prediction of expressive vocabulary development at 30 months. As would be expected, LDS scores at 30 months were more highly correlated with 18 months MCDI-N expressive scores ($r = .34$, $p < .001$) than with 18 months MCDI-N receptive scores ($r = .19$, $p < .001$). Hierarchical linear regression analysis examined the percentage of unique variance in non-gender specific *z*-standardized LDS vocabulary scores at 30 months accounted for by all predictors that significantly differentiated among the four language outcome groups. In Step 1, maternal age and education, marital status, family income, child ethnicity, and parenting stress explained 4.8% of the variance in LDS vocabulary at 30 months. In Step 2, gestational age and birth weight explained an additional .2%. In Step 3, child gender and age at the 18- and 30-month assessments explained an additional 1.2%. Entered in Step 4, 18 months MCDI-N expressive *z*-scores explained an additional 11.0%, whereas 18 months MCDI-N receptive *z*-scores entered in Step 5 explained an additional 0.5%. (When MCDI-N receptive vocabulary was entered at Step 4, it explained 4.3% and expressive vocabulary entered at Step 5 explained an additional 7.2%). In sum, the complete model explained 17.7% of the variance in LDS scores at 30 months, with 18-month vocabulary scores accounting for 11.5%. Maternal age, child age at the 30-month-assessment, and expressive and receptive vocabulary *z*-scores at 18 months were positively related to LDS vocabulary scores at 30 months, whereas low and mid-low maternal education, non-Western and Other Western child ethnicity, parenting stress, low birth weight, being a boy and child age at the 18-month-assessment were negatively associated with LDS vocabulary scores at 30 months. The remaining predictors were not linked to LDS vocabulary at 30 months. We observed very similar results when we reran the hierarchical linear regression analysis among Dutch children only.

The final set of analyses examined how demographic, maternal psychosocial, perinatal and child factors relate to continuity versus discontinuity in early vocabulary skills from 18 to 30 months. Table 4 shows the results of a multinomial logistic regression determining which variables independently predicted a higher risk of any of the three expressive vocabulary delay outcome groups. The multinomial logistic regression produced three sets of results, one for each delay group relative to the no delay reference group. Higher maternal age was related to a higher risk of being a late bloomer but to a lower risk of late onset expressive vocabulary delay and not to persistent expressive vocabulary delay. Mid-low maternal educational level was associated with a higher likelihood of late onset expressive vocabulary delay but not to the two remaining expressive vocabulary delay outcome groups. Low maternal educational level was not related to being a late bloomer but was linked to a higher risk of late onset expressive vocabulary delay and persistent expressive vocabulary delay. Non-Western ethnicity predicted a lower likelihood of being a late bloomer but a higher likelihood of late onset expressive vocabulary delay; it did not predict persistent expressive vocabulary delay. Other Western ethnicity was only associated with a higher risk of late onset expressive vocabulary delay. Single motherhood predicted a lower risk of being a late bloomer but did not predict the other two delay outcome groups. Parenting stress was only related to a higher risk of late onset expressive vocabulary delay. Family income, mid-high maternal educational level and having cohabiting parents were not associated with any of the three expressive vocabulary delay outcome groups. Neither gestational age nor low birth weight was related to the three expressive vocabulary delay outcome groups, except that older gestational age was associated with a lower likelihood of being a late bloomer.

As can be seen in Table 4, receptive vocabulary delay at 18 months predicted all three expressive vocabulary delay outcome groups. Children had a 4 times higher risk of being a late bloomer (OR = 4.25, 95% CI = 3.00; 6.02, $p < .001$) and of developing late onset expressive vocabulary delay (OR = 3.92, 95% CI = 2.71; 5.67, $p < .001$) when they had displayed receptive vocabulary delay at 18 months. Receptive vocabulary delay at 18 months predicted a 9 times higher risk of persistent expressive vocabulary delay (OR = 9.09, 95% CI = 5.81; 14.21, $p < .001$). Inspection of the 95% CIs for the ORs indicates that receptive vocabulary delay was more strongly related to persistent expressive vocabulary delay than to late onset expressive vocabulary delay. However, the remaining pair-wise comparisons of ORs for receptive vocabulary delay did not differ. The multinomial logistic regression analysis among Dutch children only yielded very similar results.

To summarize, children had a higher risk of being a late bloomer when they had displayed receptive vocabulary delay at 18 months and when their mothers were older. Furthermore, children of single mothers, with non-Western ethnicity, and with older gestational age had a lower risk of being a late bloomer. On the other hand, children of older mothers had a lower risk of late onset expressive vocabulary delay and both low and mid-low maternal education were related to a higher risk of late onset expressive vocabulary delay. Moreover, Other Western and non-Western child ethnicity, higher levels of parenting stress and receptive vocabulary delay at 18 months were associated with a higher risk of late onset expressive vocabulary delay. Finally, low maternal education and receptive delay at 18 months were associated with a higher risk of persistent expressive vocabulary delay.

Discussion

Theoretical Implications of our Findings

An important finding from our study was that only a small portion of the variance in expressive vocabulary at 18 and 30 months was accounted for by the maternal, demographic, and perinatal factors in our model (6.2% at 18 months and 6.2% at 30 months), consistent with Reilly et al. (2007) and Zubrick et al. (2007). Also consistent with the Australian studies, gender was a significant predictor, but its contribution was also small. The strongest predictor of 18 months expressive vocabulary was concurrent receptive vocabulary (accounting for 15.9% of the variance). The strongest predictor of 30 months expressive vocabulary was 18 months expressive vocabulary, which accounted for 11.0% when entered before 18 months receptive score (which then added 0.5% in the last step). When 18 months receptive vocabulary was entered before 18 months expressive vocabulary, they explained 4.3% and 7.2%, respectively. These results parallel those of Reilly et al. (2007) in showing that the strongest predictors of current expressive language are past or concurrent language and communication skills, but that even these good predictors leave most of the variance unexplained. That only 22.1% and 17.7% of the variance in 18 and 30 months expressive language was explained by our full prediction model corroborates other research in showing that most of the variance in 18 and 30 months expressive language skills is unexplained even when a large number of plausibly relevant demographic, perinatal, and developmental predictors are modeled.

Although it would seem that family income, marital status, parenting stress, maternal age, maternal educational level, birth weight, gestational age, child ethnicity, and gender would be among the most important factors for explaining individual differences in expressive vocabulary at 18 and 30 months, their predictive ability was very modest. Thus, other factors not included in our model must account for substantial amounts of observed variance. One such factor might be genetic endowment for language, perhaps measured by family history of language delay, which has been shown to be an important predictor in the study by Zubrick et al. (2007). Bishop et al.'s (2003) twin study did indicate significant heritability in 24 months MCDI score, but there were major cohort differences in heritability. Another factor might be rate of brain maturation, as the end of rapid myelination of language-related brain regions has been shown to coincide with accelerated vocabulary growth in toddlerhood (Pujol et al., 2006).

Psychometric Utility of Early Language Screening

Our results indicated that the MCDI-N at 18 months had both low positive predictive value (29%) and low sensitivity (30%) when predicting LDS scores at 30 months, with most of the children delayed at 18 months no longer delayed at 30 months and most of the children delayed at 30 months not having been delayed at 18 months. These findings corroborate Westerlund et al. (2006), who reported that positive predictive value from the Swedish version of the MCDI at 18 months was only 17.6%, and that half the children delayed at 3 had not been delayed at 18 months. Although better positive predictive value for the MCDI from age 2 to age 3 has been reported by Dale et al. (2003) and Feldman et al. (2005) (44% and 64%, respectively), more than half the children with an expressive language delay at 3 in these studies had not been delayed at 2, suggesting many "new cases."

To some extent, the poor decision statistics observed in the current study derive 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. This was evident in our data, in that children delayed at 30 months only had quite low MCDI-N expressive vocabulary scores at 18 months, but not low enough to be below the 10th percentile cutpoint. However, the poor prediction we found is not only attributable to dichotomization, as seen in the 74% AUC on our ROC analysis, which tests all cutpoints in a continuous fashion. Furthermore, the correlation between MCDI-N word production at 18 months and LDS word production at 30 months was only .34, which indicates only a moderate degree of association between these two continuous measures. Modest ROC results were also reported by Feldman et al. (2005), but Feldman et al.'s (2005) correlation of .58 between MCDI scores at 24 and 36 months was slightly higher than our correlation of .34 between the 18 months MCDI-N and the 30 months LDS. Thus, our results are in line with previous research showing that MCDI scores at 18 months even less accurately predict subsequent language delay than MCDI scores at 24 months (Dale et al., 2003; Feldman et al, 2005; Westerlund et al., 2006).

Public Health Implications

Because only 17.7% of the variance in 30 months expressive vocabulary was explained by our full prediction model, and because sensitivity and positive predictive values for the MCDI-N were very low, it seems evident that there is little public health benefit in screening for language delay at 18 months using the MCDI-N. Although it is widely assumed and expected that very early screening for a range of developmental outcomes is necessary and efficient, our findings are consistent with previous population-based studies (Dale et al, 2003; Westerlund et al. 2006) in suggesting that screening should be conducted at later points in development for early speech and language problems. Future studies are needed to identify the age period in which population-wide screening for language problems is most useful. Nevertheless, our results pertaining to the three different expressive vocabulary delay outcome groups suggest some possible public health implications.

Late bloomers were more likely to have Dutch than non-Western or Other Western ethnicity, as well as lower birth weights, but they were not more likely to have mothers who were unmarried or had low education. Furthermore, children of older mothers who had younger gestational ages had a somewhat higher risk of being a late bloomer, which has frequently been reported in previous research. One might speculate that these children manifested early expressive vocabulary delay due to some mild neuro-developmental lag, but that stimulating home environments helped them to catch up by 30 months. A possible public health implication is that toddlers with mild language delay at 18 months from families with few demographic risk factors are unlikely to need any formal intervention, because stimulation provided at home will most likely lead to resolution of the early delay by age 3.

Children with late onset expressive vocabulary delay were least likely to come from families with Dutch parents, and were most likely to have mothers with younger ages. Furthermore, children with late onset expressive vocabulary delay were more likely to come from low income families and to have mothers with low educational level and higher levels of parenting stress than children with no expressive vocabulary delay and late bloomers. One might speculate that these children received less stimulation from their socially disadvantaged and stressed mothers, which is a well-established correlate for poor language functioning (Hart & Risley, 1995; Hoff, 2003; Horwitz, et al., 2003; Magill-Evans & Harrison, 1999; Noel, et al., 2008). A possible public health implication of this pattern of results is that children from low-income immigrant families in which mothers are young, have limited education, and are experiencing parenting stress are at risk for language delay by 30 months even if they are not significantly delayed at 18 months. These children would appear to be good candidates for an intervention in which public health workers counseled mothers about providing an enriched language stimulation environment or helped parents obtain high-quality center-based child care.

Children with persistent expressive vocabulary delay were more likely to have mothers with higher levels of parenting stress than children with no expressive vocabulary delay and late bloomers. Additionally, children with persistent expressive vocabulary delay had lower gestational ages and the highest percentage of low birth weight children. In comparison to the other vocabulary delay groups, these children also had the lowest verbal and nonverbal cognitive scores at 30 months, and delayed word comprehension at 18 months predicted a 9-fold higher risk of persistent vocabulary delay for this group. Low maternal educational level was also associated with a higher risk of persistent expressive vocabulary delay. One might speculate that the chronic language acquisition problems of this group of children can be explained by both biological and socio-demographic vulnerabilities, perhaps combined with some genetic predisposition. A possible public health implication is that children with both perinatal and familial risk factors who demonstrate receptive and expressive vocabulary delays at 18 months are at high risk for ongoing developmental and educational difficulties and therefore excellent candidates for comprehensive early intervention.

Limitations of the Study

One limitation of this study is that data on verbal and nonverbal cognitive development were completely based on maternal report. Although the parent-based measures used in this study have been shown to significantly predict tester-administered measures both concurrently (Rescorla 1989; Saudino et al. 1998; Zink & Lejaegere, 2003) and predictively (Oliver, Dale, & Plomin, 2004; Rescorla, 2002), structured testing and/or observation would have been a valuable addition to the study. An additional limitation is that different language measures were used at 18 and 30 months. Although Rescorla et al. (2005) reported high concurrent correlations between the original MCDI and the LDS, measure variance may have somewhat attenuated prediction results in this study. Additionally, we obtained a slight floor effect on the MCDI at 18 months (mean = 17.5, out of maximum score of 112) and a slight ceiling effect on the LDS at 30 months (mean = 238.4, out of maximum score of 310), which may have reduced sensitivity. Moreover, measures of family history of language delay, of home language stimulation, and of brain maturation were not available to be included in the model. Had these variables been included, more of the variance in 18 and 30 months expressive vocabulary skills might have been explained. Finally, selective attrition is another limitation of our study, in that data on vocabulary development were more complete in Dutch children of higher-educated mothers.

However, these limitations are offset by numerous strengths of the study. We utilized a very large population-based sample in the Netherlands that was diverse in maternal education, ethnicity, national origin, and language spoken in the home, we assessed vocabulary development at two time points, and information on a large number of possible predictors of vocabulary development was obtained. In addition, due to the large size of the current study sample, we were able to identify predictors of early vocabulary development that would remain unnoticed in small and underpowered study samples.

Implications for Future Research

That receptive vocabulary delay at 18 months yielded high odds ratios in predicting the three expressive vocabulary delay outcome groups, in particular persistent expressive vocabulary delay, is consistent with previous small-scale studies showing that delays in receptive language predict persistent expressive language delay (Ellis Weismer, 2007; Leonard, 2009; Thal et al., 1991). Given the low positive predictive value of MCDI-N expressive vocabulary at 18 months found in this sample and in the Westerlund et al. (2006) sample, a possible fruitful strategy for future research might be to use a combined receptive and expressive vocabulary score for prediction. However, this suggestion must be tempered by the fact that adding 18 months receptive skills to the regression model after 18 months expressive skills had been entered explained little additional variance in 30 months vocabulary scores.

Our findings and those of other researchers that even with a large group of plausible predictors most of the variance in 18 and 30 months language remains unexplained suggests that future predictive models will need to include even more potentially relevant variables. These findings also suggest that individual differences in language skills arise from a large number of causal factors, with each factor contributing a relatively small effect. This cumulative risk model suggests that as genetic, perinatal, and environmental risk factors accumulate, the child is at progressively greater risk for a language delay, despite the small impact any single factor is likely to have.

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Table 1

Participant Characteristics (N = 3,759)

Maternal characteristics	*M* (*SD*)[a]
Age, years	31.6 (4.5)
Education (%)	
High	34.2
Mid-high	25.4
Mid-low	25.4
Low	11.9
Missing	3.0
Family income (%)	
> 2000 Euros	65.3
1200-2000 Euros	12.2
< 1200 Euros	7.3
Missing	15.2
Marital status (%)	
Married	51.1
Cohabiting	38.7
Single	6.6
Missing	3.6
Parenting stress, score[b]	.30 (.29)
Child characteristics	*M* (*SD*)[a]
Gestational age at birth, weeks	39.9 (1.7)
Prematurity, Yes (%)	4.8
Birth weight, grams	3455 (561)
Low birth weight, Yes (%)	4.6
Gender, boys, Yes (%)	49.6
Child ethnicity (%)	
Dutch	69.6
Other Western	9.1
Non-Western	19.9
Missing	1.4

Table 1

Participant Characteristics (N = 3,759) (continued)

Child characteristics	*M* (*SD*)[a]
Age at the ‘18’ months assessment	18.2 (0.6)
16-17 months (%)	42.8
18-19 months (%)	54.6
20 months (%)	2.7
Age at the ‘30’ months assessment	30.9 (1.2)
28-29 months (%)	20.8
30-31 months (%)	63.6
32-35 months (%)	15.6
Word production at ‘18’ months, score	17.5 (16.6)
Word comprehension at ‘18’ months, score	56.1 (25.1)
Word production at ‘30’ months, score	238.4 (58.9)

Note. [a]Unless otherwise indicated.
[b] Data on parenting stress was missing in 1.0%

Table 2

Univariate Linear Regression Analyses Predicting Continuous Word Production z-standardized Scores at 18 Months (N = 3759)

	Word production at 18 months, *z*-score						
	B	*SE* of *B*	β	R^2	df	*F*	*p*
Maternal age, years[a]	-.18	.00	-.08***	.007	1	25.6	<.001
Maternal education [b]				.002	3	2.24	.089
High (*reference*)							
Mid-high	.01	.06	.01				
Mid-low	.10	.04	.05*				
Low	.01	.06	.01				
Family income[b]				.000	2	0.45	.655
>2000 Euros (*reference*)							
1200-2000 Euros	.03	.05	.05				
< 1200 Euros	.00	.07	.01				
Marital status [b]				.002	2	2.95	.061
Married (reference)							
Cohabiting	.07	.04	.04*				
Single	.10	.07	.03				
Parenting stress, per *SD*[a]	-.05	.02	.05**	.003	1	9.75	.002
Child Ethnicity [b]							
Dutch (*reference*)							
Other Western	-.16	.06	-.05**				
Non-Western	.13	.04	.05**				
Gestational age, weeks	.06	.01	.10***	.010	1	38.2	<.001
Low birth weight[c]	-.40	.08	-.08***	.007	1	26.1	<.001
Gender[c]				.015	1	58.3	<.001
Girls (*reference*)							
Boys	-.25	.03	-.12***				
Child age 18-20 months, per month[a]	.23	.03	.14***	.020	1	79.3	<.001
Word comprehension at 18 months, *z*-score[a]	.44	.03	.44***	.191	1	887.5	<.001

Note. [a] Quantitative predictor: *B* represents the mean increase in word production *z*-score for each unit increase in the predictor.
[b] Categorical predictor: *B* represents the mean difference in word production *z*-score between the category of interest and the reference category.
[c] Binary predictor: *B* coefficient represents the mean difference in word production *z*-score between the 2 categories.
**p* < .05 ***p* < .01, ****p* < .001

Table 3

Participant Characteristics by Level of Expressive Vocabulary Skills at 18 and 30 Months of Age (N = 3759)

	No expressive vocabulary delay[a] (*n* = 3204) *M* (95% CI)[b]	Late bloomers[a] (*n* = 232) *M* (95% CI)[b]	Late onset expressive vocabulary delay[a] (*n* = 227) *M* (95% CI)[b]	Persistent expressive vocabulary delay[a] (*n* = 96) *M* (95% CI)[b]	Significance testing and effect size for continuous measures
Mother					
Maternal age, years	31.7_a (31.6; 31.9)	32.6_a (32.1; 33.2)	29.7_b (29.0; 30.3)	31.7_a (30.6; 32.9)	$F(3, 3756) = 19.1$, $p < .001$, $\eta^2 = .02$
Maternal education (%)					
High	35.3 (33.9; 36.7)	38.4 (33.2; 43.6)	21.1 (15.2; 27.0)	30.2 (21.7; 38.7)	χ^2 (9) = 85.5, $p < .001$
Mid-high	27.9 (26.4; 29.4)	21.1 (15.3; 26.9)	18.1 (12.1; 24.1)	19.8 (10.7; 28.9)	
Mid-low	26.1 (24.6; 27.6)	25.9 (20.2; 31.6)	33.5 (28.1; 38.9)	30.2 (21.7; 38.7)	
Low	10.7 (9.0; 12.4)	14.7 (8.6; 20.8)	27.3 (21.6; 33.0)	19.8 (10.7; 28.9)	
Marital status (%)					
Married	51.6 (50.4; 52.8)	56.0 (51.6; 60.4)	57.7 (53.4; 62.0)	58.3 (51.7; 64.9)	χ^2 (6) = 24.1, $p < .001$
Cohabiting	41.8 (40.5; 43.1)	40.9 (35.9; 45.9)	30.8 (25.3; 36.3)	32.3 (23.9; 40.7)	
Single motherhood	6.6 (0.04; 12.8)	3.0 (-3.4; 9.4)	11.5 (5.2; 17.8)	9.4 (0.1; 18.7)	
Family income (%)					
> 2000 Euros	74.7 (73.8; 75.6)	71.6 (68.1; 75.1)	51.1 (43.1; 59.1)	64.6 (58.5; 70.7)	χ^2 (6) = 78.43, $p < .001$
1200-2000 Euros	18.4 (16.8; 20.0)	22.4 (16.6; 28.2)	30.4 (24.9; 35.9)	19.8 (10.7; 28.9)	
< 1200 Euros	7.0 (5.3; 8.7)	6.0 (-0.3; 12.3)	18.5 (12.5; 24.5)	15.6 (6.3; 24.9)	
Parenting stress, score	0.29_b (0.28; 0.30)	0.31_b (0.27; 0.34)	0.41_a (0.36; 0.45)	0.37_a (0.29; 0.46)	$F(3, 3756) = 12.7$, $p < .001$, $\eta^2 = .01$
Child					
Gender (%)					
boys	49.7 (48.4; 51.0)	46.6 (41.8; 51.4)	53.3 (48.8; 57.8)	49.0 (41.7; 56.3)	χ^2 (3) = 2.12, $p = .548$
girls	50.3 (49.0; 51.6)	53.4 (48.9; 57.9)	46.7 (41.9; 51.5)	51.0 (43.9; 58.1)	
Ethnicity (%)					
Dutch	71.7 (70.8; 72.6)	76.3 (73.1; 79.5)	45.4 (40.5; 50.3)	58.3 (51.7; 64.9)	χ^2 (6) = 86.3, $p < .001$
Other Western	8.9 (7.2; 10.6)	8.6 (2.3; 14.9)	13.2 (7.0; 19.4)	13.6 (4.1; 23.1)	
Non-Western	19.4 (17.8; 21.0)	15.1 (0.9; 21.2)	41.4 (36.3; 46.5)	28.1 (19.4; 36.8)	

Table 3

Participant Characteristics by Level of Expressive Vocabulary Skills at 18 and 30 Months of Age (N = 3759) (continued)

	No expressive vocabulary delay[a] (*n* = 3204) *M* (95% CI)[b]	Late bloomers[a] (*n* = 232) *M* (95% CI)[b]	Late onset expressive vocabulary delay[a] (*n* = 227) *M* (95% CI)[b]	Persistent expressive vocabulary delay[a] (*n* = 96) *M* (95% CI)[b]	Significance testing and effect size for continuous measures
Mother					
Gestational age, weeks	39.95_a (39.89; 40.00)	39.38_b (39.10; 39.67)	39.86_a (39.61; 40.11)	39.41_b (38.86; 39.97)	$F(3, 3756) = 10.0$, $p < .001$, $\eta^2 = .01$
Prematurity (%)	4.4 (2.7; 6.1)	8.2 (1.9; 14.5)	5.3 (-1.2; 11.8)	10.4 (0.7; 20.1)	χ^2 (3) = 13.8, $p = .003$
Birth weight, grams	3471_a (3452; 3490)	3348_{ab} (3267; 3431)	3419_a (3342; 3495)	3278_{bc} (3137; 3420)	$F(3, 3756) = 7.2$, $p < .001$, $\eta^2 = .01$
Low birth weight (%)	3.9 (2.2; 5.6)	9.9 (3.7; 16.1)	5.3 (-1.2; 11.8)	11.5 (1.9; 21.1)	χ^2 (3) = 28.9, $p < .001$
Word production at 18 months, z-score	0.24_a (0.21; 0.26)	-2.10_c (-2.16; -2.04)	-0.29_b (-0.39; -0.19)	-2.12_c (-2.21; -2.03)	$F(3, 3756) = 981.2$, $p < .001$, $\eta^2 = .44$
Word comprehension at 18 months, z-score	0.07_a (0.03; 0.10)	-0.47_c (-0.61; -0.33)	-0.20_b (-0.35; -0.04)	-0.60_c (-0.86; -0.35)	$F(3, 3756) = 37.3$, $p < .001$, $\eta^2 = .03$
Word production at 30 months, z-score	0.24_a (0.22; 0.25)	-0.01_b (-0.07; 0.05)	-2.16_c (-2.38; -1.93)	-2.87_d (-3.33; -2.42)	$F(3, 3756) = 1358.9$, $p < .001$, $\eta^2 = .54$
Nonverbal cognitive development at 30 months (PARCA), z-score	0.07_a (0.04; 0.11)	-0.29_b (-0.43; -0.15)	-0.48_b (-0.63; -0.33)	-0.77_c (-1.13; -0.39)	$F(3, 3477) = 42.3$, $p < .001$, $\eta^2 = .04$

Note. PARCA = Parent Report of Children's Abilities.
[a] Vocabulary development was reported by mothers at 18 months using the Dutch short form version of the MCDI (Zink & Lejaegere, 2003). At 30 months mothers reported vocabulary development using the LDS (Rescorla, 1989). Expressive vocabulary delay at 18 and 30 months was defined as a word production score < age- and gender-specific 10th percentile. For maternal education, child gender, ethnicity and low birth weight percentages represent the proportion of children (or mothers) in the defined group who fall into the respective category of vocabulary skills at 18 and 30 months of age.
[b] Unless otherwise indicated
p-values were derived from ANOVAs for continuous variables and from chi-square tests for categorical variables. Means with different subscripts are significantly different at $p < .05$ (S-N-K).

Table 4

Predictors of Temporary or Persistent Expressive Vocabulary Delay in Early Childhood

	No expressive vocabulary delay OR (95% CI)	Late bloomers OR (95% CI)	Late onset expressive vocabulary delay OR (95% CI)	Persistent expressive vocabulary delay OR (95% CI)
Maternal age, years	*reference*	1.05 (1.02; 1.09)**	0.95 (0.92; 0.98)**	1.02 (0.97; 1.07)
Maternal education	-	-	-	-
High (*reference*)	-	-	-	-
Mid-high	*reference*	0.75 (0.51; 1.12)	0.98 (0.63; 1.53)	0.91 (0.50; 1.68)
Mid-low	*reference*	1.03 (0.71; 1.50)	1.55 (1.01; 2.37)*	1.44 (0.81; 2.59)
Low	*reference*	1.51 (0.93; 2.47)	2.55 (1.58; 4.11)***	2.13 (1.04; 4.38)*
Marital status	-	-	-	-
Married (*reference*)	-	-	-	-
Cohabiting	*reference*	0.88 (0.66; 1.17)	0.74 (0.54; 1.01)	0.68 (0.43; 1.08)
Single motherhood	*reference*	0.37 (0.16; 0.85)*	0.85 (0.51; 1.41)	0.73 (0.32; 1.66)
Family income	-			
> 2000 Euros (*reference*)	-			
1200-2000 Euros	*reference*	1.46 (0.92; 2.34)	1.37 (0.96; 1.97)	1.03 (0.52; 2.06)
< 1200 Euros	*reference*	1.55 (0.74; 3.25)	1.28 (0.72; 2.27)	1.80 (0.78; 4.15)
Parenting stress, per SD	*reference*	1.03 (0.89; 1.19)	1.18 (1.06; 1.32)*	1.18 (0.99; 1.40)
Ethnicity	-			
Dutch (*reference*)	-			
Other Western	*reference*	0.77 (0.46; 1.28)	2.06 (1.32; 3.22)**	1.55 (0.81; 2.97)
Non-Western	*reference*	0.60 (0.39; 0.94)*	1.79 (1.25; 2.55)**	1.03 (0.58; 1.82)
Gestational age, weeks	*reference*	0.91 (0.84; 0.98)*	1.02 (0.92; 1.12)	0.96 (0.85; 1.09)
Low birth weight	*reference*	1.55 (0.82; 2.94)	1.28 (0.60; 2.73)	2.22 (0.89; 5.56)
Receptive vocabulary delay at	-			
18 months	*reference*	4.25 (3.00; 6.02)***	3.92 (2.71; 5.67)***	9.09 (5.81; 14.21)***

Note. OR = Odd ratio; CI = Confidence Interval.
The model was based on multinomial logistic regression analysis. The different expressive vocabulary delay categories were compared to the reference group, i.e. no expressive vocabulary delay.
*$p < .05$, **$p < .01$, ***$p < .001$