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The Predictive Value of Early Childhood Factors for Language Outcome in Pre-school Children

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Abstract

Objective: To identify the predictive value of early childhood factors for language outcome at ages 2 and 3.

Method: A community-based sample of 2542 children, recruited at 18 months during their routine visit of a child health care centre, was followed in a prospective study in the Netherlands. Child and family characteristics and factors for social environment and neurobiological development were tested as predictors of a) language performance (child-test applied by child health care physician) at age 2, b) receptive language (child-test applied by parents) at age 3, c) expressive language (parent report) at age 3, and d) language delay (clinical diagnosis).

Results: Predictive of language delay were male gender (OR 0.23; 95% CI: 0.12-0.46), high birth order (1st born, OR 1.85; CI: 0.98-3.52; 2nd born, OR 2.58; CI 1.15-5.79; 3rd born, OR 5.28; CI 1.45-19.3)) and late age (in months) of first walking (OR 1.17; CI: 1.05-1.30). Predictive for favourable language performance for both ages were being a girl, low birth order, early age of first walking, shared reading and singing together. The total predictor set explained only 10-25% of the variance.

Conclusions: High risk selection based on a set of predictors might not be a valid strategy for early detection of language delays.

Introduction

Language development is a complex process. Language acquisition abilities peak during the first seven years of life and it is crucial to ensure that the factors affecting language development are as favourable as possible throughout this period. At the age of 2 the prevalence of language delay is high, although an estimated 60% may catch up again at later age [1]. Some language problems, if remaining untreated, can seriously affect later development in various areas [2-4]. Moreover, language problems can negatively influence children's daily life, even at preschool age [5]. Early recognition of language disorders is important in order to start treatment – if necessary - as early as possible [1].

Identifying high-risk children on the basis of a set of predictive factors would probably facilitate this early recognition. Several studies have found associations between specific risk factors and language delays [6-16]. Male gender, perinatal factors and family history of speech and language delay are those factors most consistently reported in the literature to identify children at risk [17]. Recent studies including large sets of possible predictors concluded that male gender, foreign language background, family history of speech and language problems and early neurobiological growth significantly contribute to language production or late talking status at age 2 [6,16]. However, they did not investigate the actual contribution of specific activities employed which are assumed to encourage language abilities, such as playing with other children, shared reading and singing together.

In addition, no predictors have been identified on the basis of which children might be selected into high risk groups for enduring language problems. The aim of this study was to assess the predictive value of early childhood factors for language performance and language delay, in an unselected group of more than 2,500 Dutch-speaking two-year olds screened for language disorders at child health care centres with follow-up measurements at age 3.

Methodology

In the Netherlands, a prognostic cohort study was conducted in six regions where children whose main home language was Dutch were being screened for language disorders at their 15/18 and 24 months routine visit at a child health centre (CHC) [18]. Parents received a postal questionnaire 2 to 3 weeks before the time that their child would be having the second screening. By that time, physicians reminded the parents to complete the questionnaire, providing them with a new form if necessary. Around the time of the child's third birthday, all parents of screened children received a second postal questionnaire, including validated language measures [19]. Written reminders were sent after one month. We included all factors that were known or suspected as predictive for language delay according to a systematic review for the US Preventive Services Task Force (USPSTF) [17,20] in our questionnaire at age 2. These USPSTF risk factors were male gender, prematurity, childhood illnesses, higher birth order, large family size, family history, low socioeconomic status (SES), young or old maternal age and minority status. In addition, we included variables for early neurobiological development and variables for language-stimulating social environment. Variables were measured as follows.

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Gender and prematurity

Male gender (yes, no), part of multiple births (yes, no), gestation indicated by number of weeks of pregnancy and birth weight in relation to gestation classified as normal, small for gestational age (<2500 g) and very small for gestational age (<1500 g).

Childhood illness

Parental judgment of children's general health (very good, good, fair/bad), length of any hospital stay (never, 1, 2-7, 8-14, ≥15 days), occurrence of seizures (never, once, more than once), seizures with fever (yes, no), cold lasting more than 3 days (never, 1-3 times, 4-6 times, >6 times), ear ache (never, 1-3 times, 4-6 times, >6 times), glue ear (never, once, more than once), use of medication (yes, no), having ear tubes (yes, no), whether tonsils had been removed (yes, no) and *result of Compact Amsterdam Pedo-Audiomatic Screener (CAPAS) hearing test*, classified in passed 1st time, passed 2nd time, passed 3rd time and failed 3rd time. The CAPAS is a behavioural observation test for children aged 9 months or older who have no developmental retardation or visual impairment [21].

Family variables

Child's birth order (1st, 2nd, 3rd, 4th or higher), number of siblings (1, 2, 3 or more), and one or both of the parents within household.

Maternal Age at Birth in Years

Family history of speech/language difficulties

Assessed for respectively mother, father, sister(s) and brother(s) by separate factors including: any language problems (yes, no), speech problems (yes, no), reading problems (yes, no), late talking (yes, no) or stammering (yes, no).

SES

Maternal and parental educational level defined by 7 levels according to the Dutch Standard Classification of Education (www.cbs.nl/en-GB), working situation defined by paid job, unpaid job, unemployment, working disability, housewife and student, type of profession and professional level, both based on the answers to an open-ended question and subsequently classified according to the Standard Classification of Professions (www.cbs.nl/en-GB), and number of working hours described by the categories full time job, part time job > 16 hours and part time job <= 16 hours.

Minority status

Parents speak foreign language, Dutch and/or Dutch dialect.

Neurobiological development variables

Age of first walking (in months) and hand preference (right, left, no preference yet).

Social environmental variables

Attending a day-care service (yes, no), type of day-care attending (daycare-center, preschool service, guest family, own family/friends, family and day care-centre, family and preschool service, no day-care), number of hours of day-care per week (<16 hours, 16-40 hours, 40 hours, no day-care), child's age at starting day-care attendance (<6 months, 6-12 months, 12-18 months, >18 months, no day-care), number of hours per day that adults were actively engaged in activities with the child such as feeding, bathing or playing), person most engaged in activities with the child (mother, father, both parents, different adults), number of days (per week) spent in activities together with the child including singing songs, reading out books, playing with toys, playing games, shopping, watching tv and going out, whether the child often plays with other children (yes, no) and whether it more often plays inside or outside the house (more often outside, more often inside, equally often outside or inside). Language outcome at age 2 was the final score of the screening, calculated by summing up the scores of the 15/18 and 24 months screenings (range 0-7) [19]. The clinician interviewed the parents during their routine visit at the Child Health Centre by means of the language screening instrument VTO ("VroegTijdige Onderkenning", early detection) consisting of a uniform set of questions for the parents and test elements for the child, regarding the child's language production, comprehension and communication skills, resembling the Early Language Milestone Scale, as earlier described [19]. The first screen at 15 or 18 months consisted of 4 questions, with scores ranging from 0 (no correct answers) to 4 (all answers correct). The second screen at 24 months consisted of 3 questions, with scores ranging from 0 (no correct answers) to 3 (all answers correct). A final score of 2 indicated a screen-positive result, leading to the child's referral to a general practitioner to have it assessed at a Speech and Hearing Centre (SHC). Details on the validity of VTO, which was proved to be satisfactory, have been published before [18]. In a large randomised controlled trial, it was found that early detection and treatment of language delays in preschool children by means of VTO resulted in a 30% reduction of special school attendance in these children at age 8 [19]. As outcome measures for receptive and expressive language at age 3, we used the Language Screening Instrument-Child Test (LSI-CT) and Language Screening Instrument-Parent Form (LSI-PF) [22,23] respectively. Both measures were included in the parent questionnaire at age 3 and earlier described in detail [24]. Reliability (internal consistency) of LSI-PF and LSI-CT was good (0.73, 0.90); test-retest reliability of LSI-CT was 0.82 [23]. Validity of the LSI-CT was confirmed in a group of children who visited a Speech and Hearing Centre and in a group of pupils from a school for the hard of hearing (correlation between norm scores and valuations of speech/hearing therapists and teachers was 0.60 and 0.40, respectively) [23].

To identify children with language delay, we used specialist report from a Speech and Hearing Centre or other specialist. Details of the data collection procedure and flow of data were earlier described [5,18]. By linking the databases of the four Speech and Hearing Centres within the six regions to the study database, 40 children were identified with language delay from ICD-10 classification expressive or receptive language disorder. In addition, all parents who indicated in the questionnaire at 3-years that their child had been attending a specialist because of language delay were asked to supply contact details of these specialists. After obtaining written consent from the parents, the specialists received a questionnaire to judge the child's expressive, receptive and communication skills (at the time of clinical examination) on a five point scale (from good to much below standard). From the specialist answers, 19 children were additionally identified with language delay if expressive, receptive or communication skills were below standard. So, in total 59 children were identified with language delay.

Statistical Analyses

All analyses were performed with SPSS Statistics, version 20. Differences in characteristics between children whose parents completed the 2-year but not the 3-year questionnaire, and those whose parents completed questionnaires at both ages were examined with independent samples t-tests (continuous variables) or chi-squared analyses (categorical variables) ($P < 0.01$).

Language performance

For each outcome of language performance, we conducted the following analyses. First, exploratory analyses were performed by univariable linear regression analysis to inspect the unadjusted relationship of each predictor variable (independent variable) with language performance (dependent variable). Then, multivariable regression analysis was performed to examine the relationship between language performance and the potential predictors. To select predictors for modelling we made use of prior knowledge on the candidate predictors whenever possible [24]. Therefore, we included the USPSTF risk factors gender, gestation, birth weight in relation to gestation, (at least) one variable for family history of speech and language, age of the mother at birth, levels of parental education, (at least) one variable for childhood illnesses, birth order, family size and foreign language family in the multivariable regression analysis. Besides the USPSTF variables, potential predictors from the remaining variables were selected, if they were statistically significant in the univariable regression. Because of our large sample size, we used P-value < .001 to reduce the probability of finding at least one of the variables significant by chance (type I error) [25].

Language delay

Based on the results of the univariable regression analysis (Appendix), predictors were selected for ordinary logistic regression analysis to investigate the relationship between these and language delay. As our sample of children with language delay is small in relation to the total sample, the number of predictors to be included in the logistic regression is limited [25]. Therefore, only those variables with at least a moderate effect on at least two of the investigated outcomes of language performance were selected (Appendix). From the USPSTF risk factors, gender was selected on a priori basis. The unstandardized regression coefficients were used to evaluate the effect of the predictor on the language outcomes, with the regression coefficient representing the rate of change in relation to one unit difference in the outcome score. If the score changes by 1 standard deviation of the outcome, this was considered to be a large effect size [26]. For predictors consisting of distinct categories this means that B > 1 SD of the scores. Similarly, B larger than 0.5 SD is a moderate effect size and B > 0.25 SD is a small effect size. As a clinically meaningful change in the continuous predictors, we assumed eight weeks for gestation, six months for age of first walking, four hours for number of hour's daily active with the child and five years for maternal age. The predictive value of each model was assessed by the percentage of total variance explained, using the eta-squared statistic for linear regression and Nagelkerke R Square for the logistic regression. Missing data were deleted case wise.

The Medical ethics committee (MEC) Erasmus MC did not consider that their approval was needed for this study.

Results

Participants

From 4222 eligible 2-years old children, there were 2542 children (60%) followed up at age 3 whose parents completed the questionnaire at both ages 2 and 3. The questionnaire at children's age 2 was completed by the parents of 3494 (83%) children. In total 19 children had not been (fully) screened, 173 were excluded for logistic reasons and 78 were lost-to-follow due to house moves, refusal, foreign language, secret address or unknown reasons. The parents of the remaining 3952 children received a questionnaire around their child's third birthday which was completed by those of 3227 (81%) children. Table 1 shows the characteristics of the participants.

Children with outcome data at both ages 2 and 3 had mothers who were: older (completed questionnaire at age 2 and 3 year: mean = 32.03, SD = 3.76; completed questionnaire at age 2 years only: mean = 31.50, SD = 4.03) (p = .002) and less likely to have primary education only (1.6%; 4,1%) (p < .001). There were no significant differences in VTO language scores between children whose parents completed the 2-year but not the 3-year questionnaire and those whose parents completed questionnaires at both ages (p = .37).

Predictors of language performance

The average percentage of missing values of the predictor variables was 2.4% (range 0-10%). Univariable linear regression analysis revealed statistically significant relations between language and several of the USPSPF risk factors, neurobiological and social environmental variables (Appendix). However, none of the variables had a large effect

Characteristic	%
Gender	
Female	50.5
Gestation (Mean, SD)	39.5 (2.0)
Birth weight in relation to gestation	
Normal	88.7
SGA[1]	9.4
VSGA[2]	1.9
Age (in months) of first walking (Mean, SD)	13.9 (2.3)
General health	
Very good	40.7
Good	52.8
Fair/moderate/bad	6.5
Child's birth order	
1st	49.7
Number of siblings	
≥1	63.4
Foreign language parents	
Dutch or dialect	68.4
dialect	26.8
One foreign language parent	4.8
Mother had history of language problems	
Yes	15.3
No	84.7
Maternal age at birth (Mean, SD)	32 (3.8)
Maternal education level	
Primary or less	1.6
Prevocational primary education	15.7
Prevocational secondary education	16.7
senior secondary vocational education	29.5
General secondary education	14.9
higher professional education	17.5
University	4.0
Attending a day-care service	
No	44.8
Yes	55.2
Total	100.0

[1]small for gestational age (<2500g)
[2]very small for gestational age (<1500g).

Table 1: Characteristics of children whose parents completed the questionnaire at both time points (children's age 2 and 3) (n= 2299 - 2542).

on any of the language outcomes. Variables that were moderately predictive for favourable language performance at age 2 were high birth order, large family size, early age of first walking, often singing and often reading with the child. These variables were also moderately predictive for receptive language skills at age 3. For this outcome, maternal and paternal education and often playing with toys together with the child were moderately predictive as well. The only moderately predictive variables for expressive language at age 3 were singing and often reading with the child and the child's having ear tubes. A priori selected USPSPF risk factors were included in multivariable regression analysis. From the remaining variables all those statistically significant in the univariable regression analysis were included as well (Tables 2-5). In the logistic regression analysis, we included gender, birth order, age of first walking, singing with the child and reading with the child, as these were the most predictive variables (moderate effect size) for at least two of the three outcomes in the univariable regression analysis.

At age 2, the total set of predictors explained 25% of the total variance in language scores (eta-squared=.248, $F(1, 81) = 6.21$; $p < .001$). Moderately predictive for better language were low birth order,

Language outcome	N	Mean	Standard deviation (SD)	Range	Number of children with scores ≥ 2 SD below the mean (%)
VTO score	2542	4,6	1,3	0-7	117 (5.7)
TSI-PF (receptive language)	2302	25,3	2,3	10-28	62 (6.9)
TSI-CT (expressive language)	2520	10,4	1,6	4-12	51 (4.1)

Table 2: Summary of language outcome scores at age 2 and age 3.

Predictor	Coefficient	95% CI	p
USPSTF variables [a]			
Gender (male = reference)			
Female	0.39 *	0.27 / 0.52	<0.001
Gestation	0.04	0.01 / 0.07	0.015
Birth weight in relation to gestation (VSGA = reference)			0.902
Normal	0.10	0.45 / 0.68	
SGA	0.10	-0.50 / 0.69	
General health (Fair/Moderate/bad = reference)			0.853
Very good	0.05	0.23 / 0.34	
Good	0.01	-0.24 / 0,27	
Length of hospital stay (≥15 days = reference)			0.122
Never	-0.27	-0.59, / 0.05	
1 day	-0.28	-0.74 / 0.19	
2-7 days	-0.36 *	-0.74 / 0.02	
8-14 days	-0.57 *	-1.02 / -0.14	
Result of hearing test (Failed 3rd time = reference)			0.058
Passed 1st time	0.30	0.03 / 0.50	
Pased 2nd time	0.17	-0.10 / 0.46	
Passed 3rd time	0.11	-0.22 / 0.46	
Glue ear (more than once = reference)			0.660
Never	-0.02	-0.30 / 0.29	
Once	-0.08	-0.39 / 0.26	
Having ear tubes (Yes = reference)			0.427
No	0.15	-0.21 / 0.53	
Number of times with a cold (7 times or more = reference)			0.660
Never	0.19	-0.16 / 0.54	
1-3 times	0.13	-0.12 / 0.37	
4-6 times	0.08	-0.17 / 0.32	
Child's birth order (4th or higher = reference)			0.052
1st	**0.74** **	-0.21 / 1.69	
2nd	0.51 *	-0.41 / 1.45	
3rd	0.31	-0.46 / 1.16	
Number of siblings (3 or more = reference)			0.742
0	0.17	-0.72 / 1.05	
1	0.15	-0.72 / 1.02	
2	-0.06	-0.86 / 0.69	
Foreign language family (yes = reference)			0.331
Dutch or dialect	-0.15	-0.40 / 0.13	
Dialect	-0.22	-0.51 / 0.07	
Mother had language problems (no = reference)			0.016
Yes	-0.21	-0.38 / -0.04	

Maternal age	0.01	-0.01 / 0.03	0.568
Maternal educational level (university = reference)			0.055
Primary or less	**-0.71** **	-1.40 / -0.03	
Prevocational Primary education	-0.34 *	-0.71 / 0.04	
Prevocational secondary education	-0.53 *	-0.90 / -0.16	
Senior secondary vocational education	-0.39 *	-0.74 / -0.06	
General secondary education	-0.34 *	-0.70 / 0.00	
Higher professional education	-0.20	-0.55 / 0.12	
Maternal type of profession (management = reference)			0.670
No profession	0.06	-1.00 / 0.95	
General	0.14	-0.88 / 1.08	
Didactic	-0.03	-1.08 / 0.93	
Agrarian	-0.19	-1.58 / 1.02	
Sciences	-0.26	-1.51 / 0.92	
Technical	0.03	-1.08 / 1.00	
Transportation/ communication	-0.61 *	-1.08 / 1.00	
Para-/medical	0.05	-1.00 / 0.99	
Economic / commercial	0.10	-1.00 / 1.00	
Juridical	0.44 *	-0.71 / 1.39	
Language and culture	0.46 *	-0.56 / 1.45	
Behaviour and society	0.41 *	-0.69 / 1.37	
Social care	0.05	-1.06 / 0.95	
Paternal education level			0.112
Primary or less	0.23	-0.28 / 0.72	
Prevocational primary education	0.15	-0.12 / 0.44	
Prevocational secondary education	0.38 *	0.09 / 0.66	
Senior secondary vocational education	0.03	-0.22 / 0.27	
General secondary education	0.10	-0.19 / 0.38	
Higher professional education	0.08	-0.15 / 0.32	
Neurobiological development			
Hand preference [b] (no preference yet = reference)			0.010
Right	0.21	0.08 / 0.35	
Left	0.21	-0.01 / 0.43	
Age of first walking [b]	-0.09 *	-0.12 / -0.06	0.015
Social environment			
Type of day-care [b] (Family and preschool service = reference)			0.010
None	-0.05	-0.42 / 0.34	
Day-care center	-0.20	-0.57 / 0.19	
Preschool service	-0.12	-.54 / 0.29	
Guest family	-0.23	-0.65 / 0.17	
Family/friends	0.19	-0.15 / 0.54	
Family and day-care center	0.04	-0.40 / 0.50	
Number of hours/week of day-care [b] (> 16 hours = reference)			0.255
No day-care	0	0	
1-16 hours	-0.12	-0.29 / 0.08	
How often singing with child [b] (6-7 days p week = reference)			<0.001
0-1 day p. week	**-0.81** **	-1.07 / -0.54	
2-3 days p. week	-0.35 *	-0.54 / -0.16	
4-5 days p. week	-0.17	-0.32 / -0.01	
How often reading with child [b] (6-7 days p week = reference)			<0.001
0-1 day p. week	-0.43 *	-0.68 / -0.15	
2-3 days p. week	-0.15	-0.33 / 0.01	
4-5 days p. week	0.21	0.06 / 0.35	
Person most engaged in activities with child [b] (different persons = reference)			0.152
Mother	-0.19	-0.38 / -0.01	
Father	-0.33	-1.06 / 0.34	
Both parents	-0.10	-0.28 / 0.08	
How often playing with toys together with child [b] (6-7 days p week = reference)			0.496
0-1 day p. week	-0.18	-0.52 / 0.17	
2-3 days p. week	-0.08	-0.29 / 0.10	
4-5 days p. week	-0.11	-0.27 / 0.04	

How often playing games with child [b] (6-7 days p week = reference)			0.415
0-1 day p. week	0.22	-0.06 / 0.54	
2-3 days p. week	-0.02	-0.19 / 0.16	
4-5 days p. week	0.06	-0.09 / 0.21	
Number of hours active with child [b]			
	0.01	-0.01 / 0.04	0.333
Playing with other children [b] (yes =reference)			0.035
No	-0.17	-0.32 / -0.02	

[a] Included in the multivariable regression analysis because these variables belonged to one of the identified risk factors by US Preventive Services Task Force.
[b] variable was included in the multivariable regression analysis because of a significant result in the unadjusted analysis (P<0.001)
* unstandardized regression coefficient is larger than 0.33 (0.25 standard deviation of the mean of scores), indicating a small effect size.
** unstandardized regression coefficient is larger than 0.66 (0.50 standard deviation of the mean of scores), indicating a moderate effect size.

Table 3: Predictors of language performance at age 2 (VTO score), multivariable linear regression.

Predictor	**Coefficient**	**95% CI**	**P**
USPSTF variables [a]			
Gender (male = reference)			
Female	0.35	0.15 / 0.56	0.001
Gestation	-0.01	-0.06 / 0.05	0.776
Birth weight in relation to gestation (VSGA = reference)			0.926
Normal	0.01	-0.75 / 0.76	
SGA	0.06	-0.74 / 0.89	
General health (Fair/moderate/bad = reference)			0.018
Very good	0.14	-0.31/ 0.59	
Good	-0.16	-0.60/ 0.28	
Fair			
Lenght of hospital stay (≥15 days = reference)			0.699
Never	0.06	-0.53 / 0.65	
1 day	0.31	-0.48 / 1.10	
2-7 days	-0.14	-0.78 / 0.52	
8-14 days	0.12	-0.63 / 0.87	
Result of hearing test (Failed 3rd time = reference)			0.072
Passed 1st time	0.58	0.09 / 1.08	
Pased 2nd time	0.44	-0.08 / 0.96	
Passed 3rd time	0.30	-0.32 / 0.92	
Child's birth order (4th or higher = reference)			0.262
1st	0.97*	-0.19 / -0.10	
2nd	**1.15****	-0.31 / 2.60	
3rd	0.67*	-0.69 / 2.03	
Number of siblings (4 or more = reference)			0.242
0	0.66*	-0.66 / 1.98	
1	0.37	-0.91 / 1.66	
2	0.86*	-1.11 / 1.283	
Foreign language family (yes = reference)			0.169
Dutch or dialect	0.49	-0.02 / 1.00	
Dialect	0.44	-0.09 / 0.97	
Father had language problems (no = reference)			0.127
Yes	-0.20	-0.47 / 0.06	
Maternal age	0.03	0.00 / 0.06	0.049
Maternal educational level (university = reference)			0.572
Primary or less	-0.73*	-1.80 / 0.35	
Prevocational Primary education	-0.34	-0.97 / 0.29	
Prevocational secondary education	-0.15	-0.77 / 0.46	
Senior secondary vocational education	-0.36	-0.93 / 0.22	
General secondary education	-0.14	-0.73 / 0.45	
Higher professional education	-0.20	-0.77 / 0.37	
Paternal education level			0.344
Primary or less	-0.37	-1.15 / 0.42	
Prevocational primary education	0.05	-0.40 / 0.50	

Prevocational secondary education	-0.04	-0.54 / 0.45	
Senior secondary vocational education	0.04	-0.37 / 0.44	
General secondary education	0.30	-0.17 / 0.78	
Higher professional education	0.26	-0.13 / 0.66	
Neurobiological development			
Hand preference [b] (no preference yet = reference)			0.054
Right	0.26	0.02 / 0.50	
Left	-0.01	-0.38 / 0.37	
Age of first walking [b]	-0.14*	-0.19 / -0.10	<0.001
Social environment			
How often singing with child [b] (6-7 days p week = reference)			0.003
0-1 day p. week	-0.39	-0.86 / 0.08	
2-3 days p. week	-0.58	-0.89 / -0.27	
4-5 days p. week	-0.11	-0.37 / 0.16	
How often reading with child [b] (6-7 days p week = reference)			<0.001
0-1 day p. week	-0.93*	-1.34 / -0.51	
2-3 days p. week	-0.47	-0.75 / -0.19	
4-5 days p. week	-0.07	-0.32 / 0.19	
How often playing with toys together with child [b] (6-7 days p week = reference)			0.477
0-1 day p. week	-0.41	-1.04 / 0.22	
2-3 days p. week	-0.17	-0.48 / 0.14	
4-5 days p. week	-0.10	-0.35 / 0.14	

[a] variable was included in the multivariable regression analysis because it belonged to one of the identified risk factors by US Preventive Services Task Force.
[b] variable was included in the multivariable regression analysis because of a significant result in the unadjusted analysis (P<0.001)
* unstandardized regression coefficient is larger than 0.58 (0.25 standard deviation of the mean of scores), indicating a small effect size.
** unstandardized regression coefficient is larger than 1.15 (0.50 standard deviation of the mean of scores), indicating a moderate effect size.

Table 4: Predictors of language performance at age 3 (TSI-CT, receptive), multivariable linear regression.

Predictor	Coefficient	95% CI	P
USPSTF variables [a]			
Gender (male = reference)			
Female	0.41*	0.27 / 0.54	<0.001
Gestation	0.02	-0.02 / 0.05	
Birth weight in relation to gestation (VSGA = reference)			0.860
Normal	-0.15	-0.67 / 0.38	
SGA	-0.15	-0.71 / 0.42	
General health (Fair/Moderate/bad = reference)			0.296
Very good	-0.11	-0.45 / 0.22	
Good	-0.20	-0.51 / 0.11	
Fair			
Lenght of hospital stay (≥15 days = reference)			0.052
Never	-0.19	-0.60 / 0.22	
1 day	0.21	-0.35 / 0.76	
2-7 days	-0.40	-0.86 / 0.06	
8-14 days	-0.39	-0.91 / 0.13	
Result of hearing test (Failed 3rd time = reference)			0.342
Passed 1st time	0.31	-0.04 / 0.66	
Pased 2nd time	0.25	-0.11 / 0.61	
Passed 3rd time	0.31	-0.12 / 0.74	
Glue ear (more than once = reference)			0.498
Never	0.14	-0.18 / 0.47	
Once	0.03	-0.35 / 0.41	
Having ear tubes (Yes = reference)			0.023
No	0.52*	0.07 / 0.97	
Number of times with a cold (7 times or more = reference)			0.107
Never	0.19	-0.22 / 0.61	
1-3 times	0.10	-0.18 / 0.38	
4-6 times	-0.11	-0.39 / 0.18	
Tonsils removed (no = reference)			0.165
Yes	0.25	-0.10 / 0.61	

Child's birth order (4th or higher = reference)			0.469
1st	-0.74*	-1.74 / 0.27	
2nd	-0.73*	-1.72 / 0.25	
3rd	-0.45*	-1.37 / 0.476	
Number of siblings (3 or more = reference)			0.074
0	**1.07****	0.19 / 1.96	
1	**0.89****	0.30 / 1.75	
2	0.79*	0.01 / 1.58	
Foreign language family (yes = reference)			0.184
Dutch or dialect	0.32	-0.03 / 0.67	
Dialect	0.33	-0.03 / 0.69	
Mother had language problems (no = reference)			0.596
Yes	-0.06	-0.29 / 0.17	
Mother stammers (yes = reference)			<0.001
No	**0.85****	0.39 / 1.31	
Father had language problems (no = reference)			0.039
Yes	-0.26	-0.50 / -0.02	
Father had reading problems (yes = reference)			0.194
No	0.22	-0.12 / 0.56	
Maternal age	0.02	-0.01 / 0.04	0.185
Maternal educational level (university = reference)			0.541
Primary or less	-0.19	-0.95 / 0.58	
Prevocational Primary education	-0.17	-0.61 / 0.28	
Prevocational secondary education	-0.10	-0.53 / 0.33	
Senior secondary vocational education	-0.19	-0.60 / 0.22	
General secondary education	-0.21	-0.62 / 0.21	
Higher professional education	0.02	-0.38 / 0.42	
Paternal education level			0.411
Primary or less	-0.09	-0.64 / 0.45	
Prevocational primary education	0.19	-0.13 / 0.50	
Prevocational secondary education	0.04	-0.30 / 0.39	
Senior secondary vocational education	0.21	-0.08 / 0.49	
General secondary education	0.22	-0.11 / 0.54	
Higher professional education	0.04	-0.24 / 0.32	
Neurobiological development			
Age of first walking [b]	-0.05	-0.08 / -0.02	0.002
Social environment			
Type of day-care [b] (family and preschool service) = reference)			0.041
None	0.15	-0.23 / 0.54	
Day-care center	0.10	-0.32 / 0.53	
Preschool serice	-0.24	-0.20 / 0.68	
Guest family	0.64*	0.15 / 1.13	
Family/friends	-0.32	-0.78 / 0.72	
Family and day-care center	-0.36	-0.17 / 0.88	
How often singing with child [b] (6-7 days p week = reference)			<0.001
0-1 day p. week	-0.61*	-0.93 / -0.30	
2-3 days p. week	-0.44*	-0.65 / -0.23	
4-5 days p. week	-0.19	-0.38 / -0.01	
How often reading with child [b] (6-7 days p week = reference)			0.001
0-1 day p. week	-0.54*	-0.82 / -0.26	
2-3 days p. week	-0.11	-0.31 / 0.08	
4-5 days p. week	0.01	-0.16 / 0.19	
Person most engaged in activities with child [b] (different persons = reference)			0.037
Mother	-0.26	-0.46 / -0.06	
Father	0.42*	-0.50 / 1.34	
Both parents	-0.12	-0.32 / 0.09	

[a] variable was included in the multivariable regression analysis because it belonged to one of the identified risk factors by US Preventive Services Task Force.
[b] variable was included in the multivariable regression analysis because of a significant result in the unadjusted analysis (P<0.001)
*unstandardized regression coefficient is larger than 0.40 (0.25 standard deviation of the mean of scores), indicating a small effect size.
**unstandardized regression coefficient is larger than 0.80 (0.50 standard deviation of the mean of scores), indicating a moderate effect size.

Table 5: Predictors of language performance at age 3 (TSI-PF, expressive), multivariable linear regression.

high education of the mother and often singing with the child (Table 3). We found that gender, length of hospital stay, age of first walking, mother's profession and reading with the child were predictive as well, although the effect sizes were small.

At age 3, the total set of variables explained 13% of the total variance in receptive language scores (eta-squared = .128, F (1, 47) = 5.40; p < .001). Like at age 2, low birth order was moderately predictive for better receptive language skills (Table 4). Again, small positive effects were found for high education of the mother, early age of first walking and often reading with the child. Small family size was predictive as well. The total variance explained in expressive language scores at age 3 was 14% (eta-squared=.137, F(1, 61) = 4.64; p < .001). A large family and a stammering mother were moderate predictors for worse expressive language at this age (Table 5). Birth order, singing and reading with the child were predictive again, although the effect sizes were small. Being a girl was also slightly predictive for better expressive language. If the child had ear tubes, then expressive language was slightly negatively affected.

Predictors of language delay

The total variance explained was 10% (Nagelkerke R Square = .095). Clinically diagnosed language delay was predicted by being a boy, high birth order and late age of first walking only (Table 6).

Discussion

We investigated the predictive value of early childhood factors for language performance and language delay, in a large sample of preschool children, by including all well-known risk factors as identified in a systematic review and the US Preventive Services Task Force [17-20] and an additional set of variables for language exposure and neurobiological development. The most important factors for favourable language outcome at age 2 were a low birth order, high education of the mother and singing with the child. Most predictive for favourable receptive language at age 3 was a low birth order and most predictive for favourable expressive language at this age were a small family size and a mother without stammering problems. At both ages, being a girl, early age of first walking and shared reading were predictive as well. Predictive for serious language delay were being a boy, high birth order and late age of first walking.

Strengths of this study are the large sample size, the population based sampling approach including all 2-years-old children in a large region of rural and urban areas, the high response rates and the inclusion of all risk factors recently identified [17-20] which we tested by a multivariable design. Moreover, we included an additional set of important variables for early neurobiological growth and language stimulation activities. There are some limitations. We found that lower educated were less likely to participate in the 3-years follow-up. However, there were no significant differences in the average language scores at age 2 between participants and non participants. So, we may assume that the observed relationships between predictors and language were not affected by sample attrition, and therefore the results can be considered representative of the total sample. We used validated language outcome measures for language performance [19,24]. However, these measures were designed for screening purposes, but not for clinical assessment. Strength is that language delay was identified by diagnoses obtained from specialists. Finally, we based the estimation of predictors on parent report. Consistent with earlier research were the observed predictive value for low language outcome of gender, birth order, family history and neurobiological development such as age of first walking [6,16,27] and the association of a stimulating social environment with better language performance [28]. However, in our study, social environmental factors such as shared reading and singing were not predictive for diagnosed language delay.

Of the identified USPSTF risk factors, we confirmed that male gender and birth order were predictive for language delays before age 3-years. Besides USPSTF risk factors, we studied the predictive value of neurobiological development variables (first age of walking and hand preference) and variables referring to language stimulation opportunities such as day-care attendance and adults' activities with the child such as shared reading. We found better language performance in early walkers, as was earlier found [29]. Zubrick et al. found significant associations between gross and fine motor development assessments as measured by the Ages and Stages Questionnaire and late language emergence at age 2 [6]. Probably, a delay in motor development may well be traced to a slower neurological maturing process [8,30]. Remarkably, we found that first age of walking is one of the main predictors of language delay. Low socio-economic status is often cited as a risk factor [10,13,14]. Higher socio-economic strata may provide a more favourable environment for children to learn language, including

Predictor	OR	95% CI	p
USPSTF variables			
Gender (male = reference)	0.23	0.12 / 0.46	<0.001
Child's birth order (4th or higher = reference)			0.021
1st	1.85	0.98 / 3.52	
2nd	2.58	1.15 / 5.79	
3rd	5.28	1.45 / 19.3	
Neurobiological development			
Age of first walking	1.17	1.05 / 1.30	0.006
Social environment			
How often singing with child [b] (6-7 days p week = reference)			0.912
0-1 day p. week	1.36	0.52 / 3.56	
2-3 days p. week	0.93	0.42 / 2.07	
4-5 days p. week	1.05	0.51 / 2.18	
How often reading with child [b] (6-7 days p week = reference)			0.405
0-1 day p. week	1.70	0.73 / 3.94	
2-3 days p. week	1.33	0.65 / 2.72	
4-5 days p. week	0.77	0.34 / 1.77	

Table 6: Predictors of language delay, logistic regression OR, Odds ratio.

more parental involvement in language stimulation activities. Parental education level and/or profession did not significantly contribute to language performance at these ages. However, singing and reading with the child on a daily basis as compared to no more than once a week appeared to improve the child's language performance significantly. This may indicate that these language stimulation activities are probably more or less equally distributed among socioeconomic classes at these young ages. At the age of 3, some variables were not predictive for language performance anymore. Apparently, children who seemed delayed at age two have been catching up by that time. We identified predictors of lower or higher levels of language performance and those of serious language delay. However, the total set of predictors could not explain much of the variance in neither of the language outcomes. This implies that high risk selection on the basis of a set of predictors might not be a valid strategy for early detection of language delays. Promoting language stimulation activities before the age of 2 should be recommended.

Conclusion

Language disorders – if untreated – can seriously affect children's later cognitive and socio-emotional development. Early recognition of language delay is important. Language stimulation activities in early childhood such as shared reading and singing together are one of the strongest predictors of better language performance in preschool children. Age of first walking is one of the most important predictors of language delay.

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