Prospective Evaluation of Environmental and Temperamental Variables in Child Language Development

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Abstract

Background

The study analyses the involvement of multiple environmental and temperamental variables in the development of child language using a complex multivariate analysis as a statistical tool.

Methods

The involvement of certain demographic, socio-economic, developmental and temperamental variables in children’s language development was measured in a sample of 529 children between 36-42 months using multivariate chi-squared automatic interaction detection (CHAID).

Results

The main risk factor in the study for general language problems was a family history of language problems, \( p < .001 \). However, being male, \( p = .004 \), and being shy, \( p = .001 \), were the main risk factors for specific delays in speech. The other important risk factors were health problems in early childhood, especially recurrent otitis, \( p = .012 \), having a mother with a low educational level, \( p = .003 \), and having parents older than 35 years, \( p < .001 \). Worse pronunciation development was detected in those who were preterm, \( p = .045 \), suffered perinatal complications, \( p = .005 \), or belonged to families with many members, \( p = .005 \). Firstborns generally had better language development, \( p = .005 \). Bilingualism, \( p = .001 \), was a protective factor, especially in the context of a family history of language problems.

Conclusions

The study identified several risk factors in language development. CHAID discriminated which of these factors were reliable predictors: family history of speech problems, recurrent otitis and male gender. Temperament is important in the process of language acquisition and shy personalities are the most disadvantaged.

Keywords: Language Development; Language Acquisition; Specific Language Disorders; Temperament; Bilingualism; Screening Language Disorders

Introduction

Specific language impairment (SLI) is a complex and heterogeneous neurodevelopment disorder diagnosed when the child has difficulties with language development despite otherwise normal development [1]. Specific language impairment affects approximately 7% of preschool children [2]. The most important risk factors implicated in SLI are: male gender, perinatal problems, and health problems in early childhood, especially recurrent otitis. Low maternal educational level, a proxy for low socioeconomic status, is another major risk factor [3].

The first study that identified the influence of male gender was that of Yoshinaga-Itano et al. in 1990, which reported 150 cases of children with language disorders. The following year, Tomblin et al. (1991) conducted a similar study with a larger sample and also found a significant correlation. Since then, the majority of studies on the topic, including case studies and cohort studies with samples varying in size and in age between 12 and 36 months, concur that male gender seems to be a clear risk factor for delays in speech [2-18].

Another factor is perinatal problems, which include the need for resuscitation at birth, as described by [5, 6, 7]; low Apgar Test scores [4] or low birth weight [8,9], drawing on a large sample of 42.107 healthy 18-month-olds, reported a relation between being preterm, underweight or one of multiple births and having a worse score on a communication questionnaire.

Studied the relationship between suffering health problems in early childhood and subsequently developing language problems [19, 20]. Found that having hearing problems, such as recurrent otitis, predisposed children to develop linguistic difficulties. Subsequent authors [1, 8, 21, 22] have also studied this variable with similar results.

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Lower maternal education level is another of the most studied variables related to problems in the development of child language [18, 23].

Other variables studied as risk factors for developing SLI are a family history of language problems [4, 24, 25] or psychiatric problems [5, 26] such as maternal depression [9] high maternal age [6,13] large sib ship size and late birth order [1,16,18]. There are several articles published about the benefit of family bilingualism [20, 27, 28, 29] suggest that bilingual children develop speech in their first language at a slower rate than their monolingual peers but develop very quickly in their second language.

Buss & Plomin (2014) studied child temperament and described 4 major features of temperament: emotionality, activity, sociability and impulsivity.

Report that language disorders are associated with the development of more emotive and impulsive temperaments in clinical samples. More studies are based on the possible association between personality disorders and socialization in patients with communication disorders [26, 30, 31, 32].

To the best of our knowledge, there are no studies that integrate together an analysis of the role of multiple environmental and temperamental variables in the development of child language difficulties to determine which personality traits may be a risk factor for developing specific language impairment. For this reason, a cross-sectional, prospective study was conducted to assess the involvement of and interaction among familial, temperamental, demographic and socioeconomic variables in the development of child language.

Methods

Participants

A homogeneous sample of 529 children between 36 and 42 months was collected. Inclusion criteria were that children must be of Spanish origin and use the same health department. The exclusion criteria were that children could not be of non-Spanish origin or have neurological or anatomical hearing problems. Also excluded were children whose parents did not have enough knowledge to complete questionnaires or did not provide their informed consent.

Ethical Aspects

The ethics committee of the Medical University of Valencia approved the study and all participants gave their written consent.

Predictive Variables

A total of 20 environmental variables were collected using a data sheet that was filled in by the parents: gender, low birth weight (< 2500 grams), preterm gestation, perinatal complications, health problems in early childhood (including recurrent otitis), schooling received in the first year of life, family history of language problems, family history of psychiatric problems, maternal and paternal age, family size, birth order, primary caregiver, number cohabiting at home, paternal and maternal educational level, paternal employment status and family bilingualism.

The Denver II psychomotor development scale, widely used by primary care paediatricians for children between 32 and 42 months, was completed. The Emotionality, Activity and Sociability Inventory (EAS) [33] were used to measure temperament because a Spanish version validated for use in our study population [34] was available.

Outcome Language Variables

Questionnaire for the Screening of Language Disorders

A questionnaire to identify language disorders was developed based on model questionnaires used in other studies with similar objectives to ours [35, 36]. The 5 questions answered were:

- Has someone at day care or at preschool and school commented to you that your son/daughter has any speech or language problems?
- Do you think that your son/daughter has any difficulty or problem with language or speech?
- Does your son/daughter pronounce words well?
- Does your son/daughter mispronounce words?
- Do people other than his/her parents understand what your son/daughter says?

Language Development Scale (LDS)

This scale was validated for the study population, and only those questions corresponding to the rating of language for children between 36 and 42 months were used. Parents completed it.

The results of this scale are reported in percentages, which refer to the total number of positive responses and therefore linguistic skills developed by the child. The percentage obtained was transformed using a sheet of percentiles, and each child’s percentile rank is reported.

Statistical Analysis

Analysis of qualitative predictive and dependent variables was performed using chi-squared tests. Analysis of predictive qualitative and quantitative outcome variables was performed using ANOVA. Temperamental variables were analysed using linear regression. Finally, due to the large number of scales and clinical variables, we performed a multivariate analysis using a statistical segmentation tool called chi-squared automatic interaction detection (CHAID) to investigate which factors predicted poor child language development. CHAID was used to divide the sample into subgroups (segments) based on interactions between predictor variables identified using bivariate analyses, which predict each criterion variable. This method was selected over standard regression based on its ability to handle large numbers of variables, to identify numerous interactions, and to produce easy-to-read segmentation trees that can convey results visually [38].

Results

The results of the analysis of the predictive variables and outcome variables are initially presented (Table 1, 2).

The multivariate analysis results are presented later (Figure 1, 2 and 3).
The 9.1% had a history of psychiatric problems in first-degree relatives, and all outcomes variables were significantly worse in this group.

The 22% of the sample had a mother whose age exceeded 35, and 32.5% had a father whose age exceeded 35. Both groups were statistically associated with a worse LDS score, $p < .001$.

The 34.4% of the sample had mothers with low educational attainment, and this group had a higher rate of general language problems detected by parents and teachers, $\chi^2 = 8.3, p = .005, \chi^2 = 21.3, p = .005$, and worse LDS scores, $p = .010$. In contrast, the educational level of fathers did not significantly affect outcomes.

The 11.9% of the sample came from a family with 3 or more children, and this group had a higher rate of general language problems detected by parents and teachers, $\chi^2 = 8.3, p = .005, \chi^2 = 21.3, p = .005$, and worse LDS scores, $p = .010$.

The 5.3% of the sample came from homes in which more than 4 people lived. General language problems were detected by parents and teachers at a higher rate in children in this group, $\chi^2 = 8.5, p = .045, \chi^2 = 11.6, p = .005$ respectively.

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rate of altered pronunciation, $\chi^2 = 19.3, p = .005$.

The 40.3% of the sample came from a monolingual family, and all outcomes were worse in this group.

A significant statistical relationship was obtained between the psychomotor development scale and LDS, $p = .002$.

Simple linear regression (Table 2) examining the relationship between the temperament inventory (EAS) and the LDS revealed a significant relationship. The coefficient was positive for the...
emotionality, activity and sociability scales and negative for the shyness scale.

**Identifying Significant Correlations with Outcome Variables**

Language problems were detected by educators in 19.5% of the sample and by parents in 21%. Altered pronunciation was reported in 21.2% of the sample and word misuse was reported in 24.8%.

A strong correlation between language problems detected by parents and by educators was identified, \( \chi^2 = 11.3, p = .005 \).

The 23.8 % of the sample scored at a lower percentile on the LDS than expected for their age.

A strong correlation between language problems detected by parents and by educators and the LDS was identified, \( p = .005 \).

**What Factors Predict the Outcomes?**

The following risk factors variables were determined to be significantly related to all outcome variables: male gender, health problems in early childhood, recurrent otitis, history of language difficulties in first-degree relatives, and history of psychiatric problems in first-degree relatives. Only bilingualism was identified as a protective factor.

Statistically significant relationships between being born preterm and experiencing perinatal complications were found with worse pronunciation but with no other outcome variables.

Firstborn children enjoyed better pronunciation and higher LDS scores.

Statistically significant relationships were identified between parental age and maternal educational attainment and LDS score but no other outcomes.

**Analysis by Subgroup**

CHAID was used to divide the sample into subgroups based on interactions between predictor variables and outcome variables.

The analysis began with a total sample of 529 children. CHAID analyses identified multiple interactions between language problems detected by parents (Figure 1) and by educators (Figure 2) and LDS (Figure 3) and the following predictors: male gender, health problems in early childhood, recurrent otitis and history of language problems in first-degree relatives, parental age, and maternal educational attainment and EAS scores.

According to CHAID, the best predictor of language problems detected by parents and by educators was a history of language problems in first-degree relatives, \( p < .001 \). For LDS score, the best predictor was a shy temperament, \( p < .001 \). Subsequent results differ according to the outcome used for each tree.

As figure 1 shows for language problems detected by parents, health problems in early childhood appears on the second level for children with a history of language problems in first-degree relatives, \( p = .012 \). In contrast, as figure 2 shows for language problems detected by educators, male gender is a predictor at the third level for the group with no health problems in early childhood, \( p = .041 \). As figure 3 shows for the LDS, male gender appears at the second level for the group with low scores on the shyness temperament scale, \( p = .041 \). Shy temperament was a predictor only for low scores on the LDS, \( p < .001 \).

A negative relationship was identified between bilingualism and language problems detected by parents among children with a
history of language problems among first-degree relatives, \( p = .016 \). Likewise, a negative relationship was identified between bilingualism and low scores on the LDS among children with higher scores on the shy temperament scale, \( p = .046 \).

Overall, across the three models, among all predictor variables only a history of language problems among first-degree relatives, health problems in early childhood and male gender were positively related to language problems detected by parents and by educators and low scores on the LDS.

**Discussion**

This study represents the first attempt to use segmentation approaches to identify many environmental and temperamental variables as risk factors and protective factors in child language development.

Multiple outcomes and a specific statistical segmentation analysis (CHAID) were needed to identify which variables studied were reliably discriminatory and the best predictors of language development.

According to CHAID, four predictors of language development may be relevant, depending on the outcome selected. The best predictors of LDS scores were temperament and male gender. The best predictors of problems detected by parents and educators were a history of language problems in first-degree relatives and general health problems, particularly recurrent otitis, in early childhood.

The result suggests a direct relationship between temperament and scores on the LDS, with LDS scores positively related to scores on the emotionality, activity and sociability scales and negatively related to scores on the shyness scale. Interestingly, existing studies in this field [26, 31] are based on pathological subjects with speech problems and examine how speech problems make temperaments more reactive and emotional and less self-controlled. This study takes the opposite approach, identifying how personality traits predispose children to specific speech delays.

Previously, the literature had identified a history of language problems in first-degree relatives [4, 24, 25] as a risk factor for delays in language development. This study clarifies that the real importance of this factor is as the best predictor of general language problems identified by parents and by educators.

The finding that male children received worse general evaluations by parents and educators and lower LDS scores is similar to those of previous studies [9, 12, 15, 16, 17, 18]. This replication confirms the importance of gender in the development of child language. What is more difficult to distinguish is whether the influence of gender is due strictly to biological factors or to differences in education styles.

The general health problems and recurrent otitis in early childhood variable was linked to worse language development as has been described previously in similar literature [8, 39]. According to the CHAID analysis, this variable was the second best predictor of a worse general evaluation by parents and educators. Worse pronunciation and word deformation problems were identified specifically in this group.

Other variables were also identifying as relevant predictors of language problems although they did not figure significantly in the CHAID analysis.

Among the socioeconomic variables, the number of people living at home and the educational level of the mother were significantly related to poor language development.

Bilingualism appears in the literature as a protective factor in the development of language [28, 29]. The present results identified bilingualism as the best protective factor. The CHAID analysis identified that this predictor is most relevant when there is a family history of speech problems. It can be concluded that children with normal intellectual capacity and normal general development learn language better if the family environment is bilingual.

Worse pronunciation development was detected specifically in those who were preterm or suffered perinatal complications. Previously in the literature [4, 9] had shown this variable to be related with worse development of speech but not specifically with pronunciation.

The study identifies that, above all, pronunciation capacity is clearly better in firstborns, and they have better results on the LDS. It is speculated that the reason may be that the firstborn spends more time with adults and learns by imitation.

Moreover, we found a significant relationship with family history of psychiatric problems. This finding is in accordance with previous studies [9, 25, 26].

Finally, previous studies have reported that greater maternal age is associated with worse development of child language [26]. This study corroborates this finding and extends it to the father’s age, which is also a clear risk factor in the process of language acquisition and is thus reflected in the statistical analysis.

This study has several limitations. First, the sample size makes generalization these results difficult. Nevertheless, the sample is homogeneous and we use a large number of predictor and outcome variables to increase the internal validity of the results.

Although it is an advanced and very useful statistical method for this type of study, where large databases are analyzed and interactions need to be identified, CHAID is a forward stepwise approach. Thus, segmentation results depend upon the order in which variables enter the model. Despite this limitation, a thorough review of the literature was conducted prior to variable selection.

In summary, as far as we know, this is the first effort to identify predictors of language problems using a segmentation approach with environmental and temperamental variables. It opens the way to further research on this topic.

**Clinical Implications**

This study identifies socioeconomic, demographic, familial and emotional variables as risk factors and protective factors in the development of child language, creating the basis for future investigations and providing new evidence for the benefits of screening for speech and language delay and disorders.
Supporting information

Table 1: Results of chi-squared tests or ANOVAs analysing the effect of all predictor variables on outcome variables.

Table 2: Results of linear regression predicting language development scale outcome variable from the temperament predictor variables.

Figure 1: Decision tree for general language problems detected by parents.

Figure 2: Decision tree for general language problems detected by educators.

Figure 3: Decision tree for specific delays in language as measured by the LDS.

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Key Points

- A family background of language problems and general health problems and recurrent otitis in early childhood are the main risk factors for general problems in child language.
- Male gender and having a shy personality are important risk factors for specific speech delay.
- Bilingualism represents a protective factor, especially in children with a family background of language problems.
- Children whose mothers have a low educational level are at risk of developing delays in the acquisition of language.

References


