# Interpretation of ambiguities by schoolchildren with low birth weight from Embu das Artes, São Paulo state, Brazil

## Interpretação de ambiguidades de escolares de Embu das Artes (SP) nascidos com baixo peso

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## ABSTRACT

**Purpose:** To assess the development of language regarding the ability to recognize and interpret lexical ambiguity in low-birth-weight schoolchildren enrolled at the school system in the municipality of Embu das Artes, Sao Paulo state, compared with that of schoolchildren with normal birth weight. **Methods:** A case-control, retrospective, cross-sectional study conducted with 378 schoolchildren, both genders, aged 5 to 9.9 years, from the municipal schools of Embu das Artes. Study Group (SG) comprising 210 schoolchildren with birth weight < 2500 g. Control Group (CG) composed of 168 school children with birth weight ≥ 2500 g. Participants of both groups were compared with respect to the skills of recognition and verbal interpretation of sentences containing lexical ambiguity using the Test of Language Competence. Variables of interest: Age and gender of children; age and schooling of mothers. Statistical analysis: Descriptive analysis to characterize the sample and score per group; Student's t test for comparison between the total scores of each skill/subtest; Chi-square test to compare items within each subtest; multiple regression analysis for the intervening variables. **Results:** Participants of the SG presented lower scores for ambiguous sentences compared with those of participants of the CG. Multiple regression analysis showed that child's current age was a predictor for all metalinguistic skills regarding interpretation of ambiguities in both groups. **Conclusion:** Participants of the SG presented lower specific and total scores than those of participants of the CG for ambiguity skills. The child's current age factor positively influenced the ambiguity skills in both groups.

## RESUMO

**Objetivo:** Observar o desenvolvimento de linguagem quanto às habilidades de reconhecer e interpretar ambiguidades lexicais, em escolares nascidos com baixo peso e inseridos na rede de ensino do município de Embu das Artes (São Paulo/SP) em comparação a escolares nascidos com peso adequado. **Método:** Estudo retrospectivo, transversal, caso-controle de 378 escolares, de 5 a 9,9 anos, de ambos os gêneros, da rede municipal de ensino de Embu das Artes (SP). Grupo Pesquisa/GP de 210 escolares, nascidos com peso inferior a 2500 gramas/g. Grupo Controle/GC de 168 escolares, nascidos com peso maior ou igual a 2500g. Por meio do Test of Language Competence, os grupos foram comparados quanto às habilidades de: reconhecer e interpretar verbalmente sentenças que contenham ambiguidade. Variáveis de interesse: idade e gênero das crianças; idade e escolaridade maternas. Análises estatísticas: descritiva para a caracterização da amostra e pontuação por grupo; t-Student para a comparação entre as pontuações totais de cada habilidade/subteste; quiquadrado para comparação por itens de cada subteste; e regressão múltipla para análise das variáveis intervenientes. **Resultados:** o GP teve menor pontuação em sentenças que continham ambiguidade, quando comparado ao GC. Na análise de regressão múltipla, no GC e no GP a idade atual da criança foi fator preditor para todas as habilidades metalinguísticas de interpretação de ambiguidades. **Conclusão:** O GP teve menor pontuação do que o GC para habilidades de Ambiguidades no total e em item específico. O fator idade atual da criança interferiu positivamente no GC e no GP para as habilidades de Ambiguidades.

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## INTRODUCTION

Low birth weight has been defined by the World Health Organization (WHO) as weight at birth of less than 2500 grams[1]. Increased attention has been paid to this birth condition considering that it is an important risk factor for several developmental changes.

Many studies and discussions have shown that low birth weight is a risk factor for development and is the most important determinant of neonatal, perinatal and infant mortality. It is related to a number of biological, psychosocial and demographic factors, such as inadequate intrauterine growth, prematurity, pregnancy at age less than 20 or more than 35 years, multiple pregnancies, smoking mothers, malnutrition during pregnancy, reduced number of antenatal visits, absence or inadequate monitoring during pregnancy, low maternal education, families living under poor social conditions, or families living in underdeveloped countries[2,3].

Birth weight and gestational age have been considered important predictors to the prognosis of child development, presenting important outcomes in the first years of life[4]. Low birth weight, associated with prematurity or not, and its implications on language acquisition should be considered.

There is substantial amount of research on low-birth-weight infants which report that they would be considered at risk for global or specific changes regarding language, motor skills, and learning[4,5].

Concerning the typical development of oral language, it is known that children begin to realize more subtle features of language, such as the use of proverbs and metaphors, around the age of six. In this phase, children develop their metacommunication process, which is the knowledge of how communication occurs[6].

The abilities developed from the understanding of the dynamics of communication between humans (often permeated by subtlety, irony, puns, etc.) are called metalinguistic skills; they reflect the ability to think about language in its abstract form - the ability to understand metaphors, inferences, ironies, jokes, and ambiguities can be highlighted[7].

It is through metalinguistic skills, such as recognition and interpretation of ambiguities, that the recognition of speakers' intentions in a given context will be developed, enabling the social inclusion of individuals who master this skill. The correct interpretation of two ambiguous sentences is directly correlated to efficient language processing, formal schooling, and cognitive development (the use of executive functions and inhibitory control)[8].

Ambiguity is defined as doubt, uncertainty, and irresolution, as something that can have more than one meaning[9]. Therefore, ambiguity occurs whenever the same word or phrase can be interpreted in different ways. There are different types of ambiguity: phonological, lexical, syntactic, and pragmatic.

Considering the risks to development presented by children with low birth weight, especially the risk to language, in this study, we hypothesized that children with low birth weight would present a differentiated performance in activities that demand the use of metalinguistic skills to recognize and interpret ambiguity.

The main purpose of this study was to assess the development of language regarding the ability to recognize and interpret lexical ambiguity in low-birth-weight schoolchildren enrolled at the school system in the municipality of Embu das Artes, Sao Paulo state, compared with that of schoolchildren with normal birth weight. Specifically, we sought to correlate the language performance of these children to the variables gender, birth weight, and gestational age, as well as associate language development with age and maternal education.

## METHODS

The data analyzed in this study were obtained from the project "Morbidity, Growth and Development of of low-birth-weight Schoolchildren aged 6-10 years - Integrality and Intersectorality in Child Care in the Local Health System of Embu das Artes, Sao Paulo state", conducted between 2010 and 2012 by the interdepartmental team of the Federal University of Sao Paulo - UNIFESP, with support from the Sao Paulo Research Foundation - FAPESP and the Research Program for the National Health System - PPSUS. The project aforementioned was approved by the Research Ethics Committee of UNIFESP under no. 1142/09.

The purpose, at that time, was to know the frequency of growth and development changes and the attention to health and education of low-birth-weight children aged 6-10 years, enrolled in the public schools and attended at the basic health units of the municipality of Embu das Artes, through a data survey conducted at the Live Births Information System between 2000 and 2005, with subsequent collection between 2010 and 2012, for the application of assessment protocols by a multidisciplinary team to 1500 children born with less than 2500 g - Low Weight, during their school years. Permission had been given by the participants' parents and/or guardians, by Informed Consent Form, to use the information collected.

With the participation of 14 schools, the previous study had included a description of the presence of chronic diseases and physical, sensory and/or cognitive disabilities, connection with and use of municipal services since birth: Basic Health Units (BHU), specialty outpatient clinics, rehabilitation services, preschools, and schools for special education. The following had also been conducted with the sample: nutritional assessment, blood pressure measurement, collection of laboratory dosages, and assessment of school performance through school history.

In that study, the clinical assessment had been conducted with a sample randomized by schools, and it considered, in addition to the 306 children with low birth weight, a control group of the same size and with the same socioeconomic, education and gender characteristics.

The language assessment had been conducted through interviews with mothers and/or guardians to collect information on the children's development; auditory acuity; reading, writing and arithmetic abilities; and oral metalinguistic skills had been verified. In this context, this is a case-control study subsequent to the PPSUS Project, including the 5-year-old

children evaluated at that time; all enrolled in the municipal schools in Embu das Artes. The present study aimed to assess, specifically, the metalinguistic skills to recognize and interpret lexical ambiguities. Regarding the data analysis of the present research, the Project's administration granted permission for their use prior to the beginning of the study by means of a Letter of Authorization for Research in Database. The present study was approved by the Research Ethics Committee of UNIFESP under no. 569.609.

Considering the complete assessment protocols, inclusion criteria were as follows: both genders, age between 5 and 9 years and 11 months, and low birth weight (< 2500 g) (Study Group – SG) and children at the same age range born with adequate weight (≥ 2.500 g) (Control Group – CG). Children presenting abnormalities or morbidities were excluded from the study. Therefore, the study sample comprised the protocols of 378 schoolchildren (210 in the Study Group; 168 in the Control Group) of both genders, aged 5 to 9 years and 11 months. The language development of the children was assessed with respect to verbal expressive aspects by means of their skills of interpretation and recognition of lexical ambiguities. To this end, the researchers had selected, at the time of the evaluation, the subtest on the skills to recognize and verbally interpret ambiguous sentences from the Test of Language Competence – Extended Edition (TLC-E)[10], translated and adapted to Portuguese (level 1)[11]. The material adopted assesses the language competence of each individual with regard to semantics, syntax, and pragmatics. The subtest in question provides a measure of the ability to recognize and interpret the alternative meanings of lexical and structural ambiguities previously selected through the presentation of one sentence and four pictures. For instance, in the Portuguese sentence "*O menino e seu irmão encontraram um balão*" (The boy and his brother found a balloon), the recognition and interpretation of the correct pictures should consider the meanings "*bexiga*" (rubber balloon) and "*balão de festa junina*" (a hot-air paper balloon similar to a sky lantern). The individual must first create two contexts in which the phrase could be used and then select these contexts portrayed in the pictures[10]. The score for each of the items is achieved by: a) number of interpretations made by the participant, that is, the total of correct explanations composes the score *Meaning*; b) identification of two pictures among the four presented after the explanation, i.e., the total of correct identifications of pictures composes the score *Number of Pictures*. The responses of each individual were computed and analyzed according to the proposed criteria described in the TLC-E manual[10]. For the score *Meaning*, 0 (zero) point was given if the child could not respond verbally or provided no correct meaning to the sentence in question; 1 (one) point, if the child provided, verbally, only one correct meaning; and 3 (three) points were given if the child provided, verbally, both correct meanings. All of the scores were then added to obtain the *Total score - Meaning*. For the score *Number of Pictures*, 0 (zero) point was given if the child selected no or one picture correctly and 1 (one) point, if the child recognized both pictures correctly. All of the scores were then added to obtain the *Total*

*score - Number of Pictures*. The *Total* raw score was obtained by adding the points of the scores *Total score - Meaning* and *Total score - Number of Pictures*.

For the accuracy and quality desired, the groups constituted for the research (CG and SG) were compared by means of raw score in the subtest in question, and the conversion to the international standard score included in the TLC-E manual was not performed. Weight at birth and the scores on the subtest of ambiguous sentences were considered as main variables of the study. The means for child's age, gestational age, and birth weight, as well as child's gender and audiometry were related to the scores and compared intragroup and intergroup. The variables maternal age and maternal schooling were considered as external factors and compared with the study variables. The Student's t-test was used to compare the scores of the skills between the two groups in the "Ambiguous Sentences" subtest. The Chi-square test was used to compare both groups regarding the performance on each item of the "Ambiguous Sentences" subtest. In addition, multiple regression statistical analysis was conducted to assess the variables the influenced the total score of the subtest, and the variables introduced in the model were as follows: gestational age, child's birth weight, child's current age, child's gender, auditory assessment of children/audiometry (both right and left ears), maternal schooling, maternal age. As a first step into analysis, the intervening variables were identified, but no multicollinearity was observed between the variables used in the study; therefore, all the variables of interest were used in the models. $R^2$ indicates the quality of model adjustment; the closer it is to 1, the better the model fits the data. All analyses were performed using the SPSS 12.0 software.

Significance level of 5% was considered for all the analyses mentioned. Significant coefficients were highlighted with an asterisk in the tables.

## RESULTS

The study sample was quite homogeneous, with participants from both groups presenting similar characteristics.

As for the internal variables, the Study Group (SG) (low birth weight) was composed of 210 schoolchildren aged 5.7 to 9.9 years (mean = 7.9 years), all born with < 2500 g; of these, 44.7% were male and 55.3% were female. The mean birth weight of participants of the SG was 2,107.1 g, with a minimum weight of 670 g and a maximum weight of 2495 g. Regarding weight distribution in the SG, five children (2.3%) were born with less than 1000 g, 13 (6.1%) from 1000 g to 1499 g, and 192 (91.6%) with 1500 g or more. Proportionality was observed between the children born with 32-36 weeks (39.52%) and 37-41 (48.57%) weeks of gestation. Audiometry conducted with participants of the SG showed mean results of 26 dBHL for the right ear and 26.2 dBHL for the left ear. As for the external variables, maternal age in the SG averaged 25.7 years, with minimum and maximum of ages of 13 and 45 years, respectively. Maternal schooling averaged 3.7 years, with minimum of 1 and maximum of 9 years.

With respect to the internal variables, the Control Group (CG) (adequate birth weight) was composed of 168 schoolchildren

aged 5 to 9.9 years (mean = 8.2 years), all born with ≥ 2500 g; 45.2% were male and 54.8% were female. The mean birth weight of participants of the CG was 3,293.3 g, with a minimum weight of 2,500 g and a maximum weight of 5,000 g. Most children (94.6%) were born between 37 and 41 weeks of gestation. Audiometry performed with participants of the CG showed mean results of 25.2 dBHL for the right ear and 25.8 dBHL for the left ear. Regarding the external variables, maternal age in the CG averaged 25.8 years, with minimum and maximum of ages of 15 and 40 years, respectively. Maternal schooling averaged 3.6 years, with minimum of 2 and maximum of 9 years.

Table 1 shows the comparison between raw scores for the Control and Study groups. Statistically significant difference was observed between the groups regarding total score for the *Meaning* and *Total* scores *(Meaning + Number of Pictures)* ($p<0.05$), indicating that individuals in the CG presented, on average, higher scores both for the *Meaning* item and for the *Total* score (*Meaning + Number of pictures*), that is, they showed better performance than individuals in the SG both in

the phase of free interpretation and in the total of the two phases (interpretation without pictures together with interpretation with a choice between the pictures). Table 2 shows that statistically significant difference was found between the groups only with respect to *Item 1* ($p<0.05$), indicating that only in this item there was a statistically significant higher number of children in the CG who chose both meanings correctly compared with those of the SG. Multiple regression analysis applied to the CG showed that the final model can be adjusted ($p<0.05$), but with low $R^2$. The results are presented in Table 3. It was possible to observe that for each year increased in the child's age, fixing the other variables in the model (individuals with the same other characteristics), the score of the subtest increased by 3.98. In turn, multiple regression analysis applied to the SG showed that the final model can also be adjusted ($p<0.05$), but again with low $R^2$. The results are presented in Table 4. Similarly to what was observed in the CG, for each year increased in the child's age, fixing the other variables in the model (individuals

**Table 1.** Comparison of total scores for the Control and Study groups

| | | Group | | p value |
| --- | --- | --- | --- | --- |
| | | Control | Study (low birth weight) | |
| Total score - Meaning (m1) | N | 168 | 210 | **0.035*** |
| | Mean | 22.3 | 19.8 | |
| | Median | 25.0 | 23.0 | |
| | Standard deviation | 11.0 | 11.1 | |
| | Minimum | 0.0 | 0.0 | |
| | Maximum | 39.0 | 39.0 | |
| Total score - Number of Pictures (m1) | N | 168 | 210 | 0.278 |
| | Mean | 7.7 | 7.4 | |
| | Median | 8.0 | 8.0 | |
| | Standard deviation | 2.9 | 3.0 | |
| | Minimum | 0.0 | 0.0 | |
| | Maximum | 13.0 | 13.0 | |
| Total score - Meaning + Total score - Number of Pictures (m1) | N | 168 | 210 | **0.038*** |
| | Mean | 30.0 | 27.2 | |
| | Median | 31.0 | 30.0 | |
| | Standard deviation | 12.9 | 12.7 | |
| | Minimum | 0.0 | 0.0 | |
| | Maximum | 52.0 | 52.0 | |

*p value < 0.05
**Caption:** Student's t-test

**Table 2.** Comparison of each subtest item for the Control and Study groups

| | | Group | | | | p value |
| --- | --- | --- | --- | --- | --- | --- |
| | | Control | | Study (low birth weight) | | |
| | | N | % | N | % | |
| Item 1 - meaning (m1) | No correct meaning | 23 | 13.7% | 39 | 18.7% | **0.040*** |
| | One correct meaning | 49 | 29.2% | 78 | 37.3% | |
| | Both correct meanings | 96 | 57.1% | 92 | 44.0% | |

*p value < 0.05
**Caption:** X²

**Table 3.** Multiple regression analysis for the Control group

|  | B | p value |
|---|---|---|
| Child's gender | 1.92 | 0.541 |
| Gestational age: from 32 to 36 weeks (reference) |  |  |
| Gestational age: 37 weeks or more | -11.97 | 0.059 |
| Child's birth weight (grams) | 0.002 | 0.525 |
| Child's current age | 3.98 | **0.003***|
| Maternal schooling (years) | 1.94 | 0.202 |
| Maternal age (years) | -0.03 | 0.922 |

*p value of the model < 0.032
**Caption:** $R^2 = 0.232$

**Table 4.** Multiple regression analysis considering the Study group

|  | B | p value |
|---|---|---|
| Child's gender | 1.79 | 0.310 |
| Gestational age: from 22 to 27 weeks (reference) |  |  |
| Gestational age: from 28 to 31 weeks | -6.38 | 0.219 |
| Gestational age: from 32 to 36 weeks | -6.33 | 0.159 |
| Gestational age: 37 weeks or more | -6.87 | 0.128 |
| Child's birth weight (in grams) | 0.005 | 0.081 |
| Child's current age | 2.47 | **0.006***|
| Maternal schooling (years) | 0.27 | 0.736 |
| Maternal age (years) | -0.03 | 0.836 |

*p value of the model < 0.001
**Caption:** $R^2 = 0.211$

with the same other characteristics), the score of the subtest increased by 2.47.

## DISCUSSION

Analyzing the results shown in Table 1, statistically significant difference can be observed with regard to the *Total* score between the groups, which indicates that participants in the CG presented, on average, higher scores both for the *Meaning* score and for the *Total* score (*Meaning + Number of pictures*), that is, they showed better performance than individuals in the SG both in the phase of free interpretation and in the total of the two phases (interpretation without pictures together with interpretation with a choice between the pictures). No statistically significant difference was found between the groups in the total score for the number of pictures presented after interpretation.

It is worth noting that the word ambiguity is defined as something presenting more than one meaning; amphibological[12]. Studies report that ambiguities are related to the lexical access, searching for words and their meanings organized in semantic networks, associated by similarity of sound or meanings[13,14]. The "Ambiguous Sentences" subtest analyzes the ability to recognize and interpret possible meanings of sentences that contain ambiguity between words (lexical ambiguity). The score considers the correct interpretations made by the participant, giving maximum score when the individual provides both expected meanings. Moreover, after interpretation, individuals must choose among the pictures posteriorly presented the two pictures that correspond to their interpretation. Therefore, there

are two scores: one for interpretation without the visual stimulus and one after the stimulus from the support pictures[10].

Children in the Study Group presented difficulties choosing from words with double meaning. Therefore, the difference in the *Meaning* score is evidenced in the autonomous explanation, that is, without the the visual stimulus provided by the support pictures; even so, when added to the score of *Meaning + Number of pictures* (*Total* score), participants of the SG continue to show results lower than those of participants of the CG. Lent[13] contend that the skills of lexical access and understanding of words are related to the angular, supramarginal gyrus. The middle, inferior, temporal gyrus also plays a role in this task, allowing the identification of words. Individuals with alterations in these brain regions might present changes to this skill. This finding is in agreement with previous studies[15] which reported that low-birth-weight individuals presented alterations in the central nervous system, such as tumors, epilepsy, and seizures. Reidy et al. [16] have reported correlation between changes in the white matter and language disabilities in low-birth-weight infants. Expressive language disorders would be related to difficulty in lexical access, and individuals with suspected language disorder would present difficulties to detect and interpret ambiguities[13]. Another study[11] underscored the difficulty of individuals in accessing both meanings of homonymous words, which led them to verbally express only one of the meanings, that is, the one that was activated first, probably the most familiar. Studies addressing the relationship between semantic networks for the lexical access in the task of detection of ambiguities[13,14] and in the restrictions of the lexical process assigned to semantic features[14] have demonstrated that individuals born with low weight may present, later in life, semantic difficulties in receptive vocabulary[17], differences in expressive language[18], and deficits in semantic verbal fluency[19], which would explain their difficulty in verbally expressing the ambiguous meanings of words given in oral sentences, observed in our SG. However, in the present study, we also observed that, regarding the score *Number of Pictures* (Table 1), the difference between the groups disappeared, that is, the groups presented equivalent results with the use of the visual facilitator. Studies have demonstrated that groups with and without language complaints present less difficulty to indicate pictures representing the ambiguities in sentences than to explain them orally[11]. A study from Bitar[20] conducted with children aged 4 to 6 years showed that pictures contribute to the acquisition of narrative competence and that pictographic representation acts as a facilitator and stimulator of this skill. Through the image reading provided, the child constructs, extends, and recreates meanings. Such findings show that pictures could, therefore, assist in the contextualization to abstract concepts such as the ambiguities assessed herein, and they would justify the similar results found for both groups for this ability after the presentation of the pictures. Sometimes, words with double (ambiguous) meanings do not allow for a conclusion, and their discrimination would depend on a broader context and on the previous and latter sentences related to them[13]. Thus the relationship between visual image

and verbal formulation allows new possibilities of expression by individuals[21].

As observed in Table 2, there was a statistically significant difference between the groups in relation to *Item 1* ($p<0.05$): in the Portuguese sentence "*A pasta está no armário*" (The tooth paste and/or folder is in the cabinet), which involves the *Meaning* response of tooth paste and folder, that is, it was possible to observe that only in this item there was a statistically significant higher number of children in the CG who chose both meanings correctly compared with children in the SG. Lexical ambiguity, the object of this study, is the ambiguity generated from the fact that one of the words enunciated may present more than one meaning[10,13].

As previously mentioned, the specific item features "*pasta*" as an ambiguous word. The difference between the groups could be justified by the distance in use of the words in both directions. Araújo[22] reasons that the further the use of a word, the greater the complexity of the cognitive process to identify its meanings. The identification would involve contextual analysis and the domain of linguistic experience, which could be more critical in children with language disorders[23], a fact that has been associated with low-birth-weight children by the specific literature[24,25].

Furthermore, the difference lies in the first item to be executed; such circumstances could be one of the hypotheses to explain the lower scores of the children in the SG. Despite the two previous demonstrations aiming to explain the task[10], some children may have needed more time or more examples to learn the activity and, therefore, have failed the item in the first execution, considering that no difference between the groups was found for the other items. According to the literature, children born with low weight may show signs of inattention and failure in executive functions[19,23,24,26] which entail greater response latency for certain tasks, leading to a slower information processing[27].

Analysis of the predictors of metalinguistic ability of the SG (Table 4) and CG (Table 3) showed that each year increased in the child's age in both groups, increased the possibility of identification of double lexical meaning (2.47 for the SG and 3.98 for the CG). This finding is consistent with the literature, which reports that brain structures develop with age[13]. Our findings also corroborate studies that show that, with increasing age, children expand their metalinguistic skills to interpret ambiguities[13], make inferences[21,28], construct acts of speech[18,21] and of understanding of figurative language[13], as well as their phonological awareness[28]. Metalinguistic skills are precursors to the acquisition of reading and writing[28]. Furthermore, this study corroborates research condcuted with low-birth-weight children which found that language and learning skills develop with increasing age[29].

## CONCLUSION

The present study demonstrated that low-birth-weight schoolchildren aged 5 to 9 years and 11 months enrolled in the municipal school system of the municipality of Embu das Artes, Sao Paulo state, showed differences in the development of their metalinguistic skills regarding expressive interpretation of ambiguities compared with schoolchildren born with adequate weight.

As for the variables studied, child's current age positively influenced the metalinguistic skills of interpretation of ambiguities both in low-birth-weight schoolchildren (Study Group) and in schoolchildren with normal birth weight (Control Group).

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## Author contributions