Language in Children with Neonatal Hypoxic-Ischemic Encephalopathy

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Abstract

Introduction Neonatal hypoxic-ischemic encephalopathy (NHIE) is a common neurologic injury, and it may compromise the child's language and cognition. Understanding the process of language acquisition becomes possible with concise knowledge about children's global development.

Objective The aim of this study was to observe if language acquisition and development are impaired in children with NHIE.

Methods Seventy children with NHIE from 1 to 24 months old were analyzed in a Pediatric Neurology Service of Hospital of Porto Alegre, South of Brazil using the Brunet-Lezine Scale. Statistical analysis used SPSS 13.0 software.

Results Twenty-four (60%) of the subjects were boys, with mean gestational age of 35.8 weeks (standard deviation of 4.6) and mean Apgar score of 6.0 at 1 minute and 7.1 at 5 minutes. The variables age versus language showed significant inverse correlation ($r = -0.566$; $p = 0.028$). As the subjects aged, language tasks became more specific and dependent on the subject's direct action, rather than the subjective interpretation of their guardian. This correlation seems to be closely associated with scale configuration and with consequences of neurologic disorder, evincing the delays in language development.

Conclusion This study achieved the goals proposed and highlights the necessity of greater attention by professionals to language skills during the initial period of child development.

Keywords
- language development
- hypoxia
- brain
- brain ischemia
- neurology
- speech
- language
- and hearing sciences

Introduction

Neonatal hypoxic-ischemic encephalopathy (NHIE) is a neurologic disorder that can cause disturbances in global development of children.[1,2] It is the most prevalent neurologic disorder in the neonatal period, and the deleterious effects of hypoxia and ischemia can affect the central nervous system of newborns.[1,3,4] This neurologic disorder occurs in ~33% of newborns with neonatal asphyxia.[5]

Language is a communication device that involves the use of verbal and nonverbal symbols. Language, in relation to the evolution of overall process of communication, is closely related to global development aspects, such as cognition and social skills.[6–8] In relation to language disorders, some factors are frequently associated: inadequate environmental stimulus, particular and individual rhythm of global development, emotional conditions, social maturity, hereditary factors, diseases, and sequelae before,

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during, and after birth affecting the neurologic system and other complications.[1,6,8,9]

Absence of language within expected chronological limits or a slow and difficult acquisition process can indicate global development disorders of children. One parameter to characterize language delay is related to the child's age. No language acquisition by about 2 years old can mean difficulties of language development.[6,10,11] A study showed that a difference of at least 12 months between the linguistic age and chronological age of children may indicate difficulties in language acquisition and development.[12]

Language skills of children can be perceived and understood even before its oral manifestations, based on some underlying mechanisms to normal language development. The analysis of communication in this period includes the observation of prelinguistic, cognitive, and social development.[6,13] Studies have been conducted with the aim of development of tests for early identification of children at high risk for development disorders.[14–16] This early detection and intervention of cognitive, linguistic, and social disorders is essential to prevent and minimize losses.[10,16]

This study intends to demonstrate the necessity that language be investigated in young children, because in the early period of child development, language is expressed, principally, by prelinguistic manifestations.[8]

The literature presents several studies relating language and neonatal intercurrences but still has few studies that relate newborn linguistic aspects and Brazilian children with NHIE, especially in early period of development. The aim of this study was observe if children with NHIE have language acquisition and development disorders.

Methods

Research data obtained from a large cross-sectional field study were collected individually in an Ambulatory of High Brain Function of the Pediatric Neurology Service in a children's hospital for advanced treatment, located in the city of Porto Alegre, Rio Grande do Sul, Brazil, over 2 years. All participants' parents or caregivers signed the informed consent, according to the source institution Ethics in Research Committee approval of the 607/10 project number.

The study sample was composed of 70 children diagnosed with NHIE. These subjects were referred by a pediatric neurologist at the moment of discharge from a neonatal intensive care unit, where the newborns were admitted due to the neonatal neurologic complications that caused brain hypoxia or ischemia. The patient follow-up initially consisted of anamnesis, medical consultation, and assessment of global neurodevelopment measured by the Brunet-Lezine Scale (Psychomotor Development in Early Infancy).[17] This test was administered by a pediatric neurologist.

The Brunet-Lezine Scale assesses children up to 6 years old. It has the aim of measuring the global neurodevelopment, observing the following main areas: posture and gross motor adaptation, fine motor skills, language skills, and social skills. The scale developed by Brunet and Lezine was translated to Portuguese and adapted to Brazil; although it has been internationally validated, it has not been validated in a Brazilian population. This scale was adopted for this study because it was a routinely used with all patients in this ambulatory setting and because the scale exposes good clinical results in NHIE patients' follow-up.

The scale was used until patients were 24 months old, totaling 15 tests (monthly between 1 to 10 months and then at 12, 15, 18, 21, and 24 months). Each level is composed of 10 items (6 tests observed in the neurologic examination and 4 questions directed to the caregivers).

Because patients were seen regularly according to the specific necessity of each case, data were tabulated monthly, according to the number of patients assessed at that specific age. It is important to highlight that the age considered in this examination is the corrected age of patient. Data were analyzed and verified by the Pearson correlation coefficient (r) and Fisher exact test, using the descriptive statistics. The maximum α level accepted was 5% ($p \leq 0.05$) and the SPSS 13.0, Inc. product, from Chicago, IL, USA, was used for statiscal analysis.

Results

Characterization data of this study sample were obtained by the pediatric neurologist in the first consultation (►**Table 1**). Thirty-eight (54.28%) of the subjects had gestational age less than 37 weeks, considered as preterm according to the literature.[18]

The studied sample obtained mean results of 84.63% in the language domain, 86.50% in social skills, 73.38% in psychomotor performance, and 74.35% in posture. These domains were also correlated to language. ►**Table 2** reveals the results of Pearson correlation test, which found no statistical significance among the variables with respect to the language domain.

Using the data, the executed tasks in the language domain and the sex of participants were compared (►**Table 3**). Fischer exact test verified that the language variable was not significantly related to the sex of children, although it visually demonstrated a trend toward better performance in girls.

It was further investigated whether linguistic performance paralleled the growth and the neurodevelopment of participants by crossing the variables of percentage of children who performed the language domain tasks versus age in months. Pearson correlation analysis found the higher the age of

Table 1 Characterization data of sample

Variable	*n*	%	Average ± SD
Sex Male Female	42 28	60 40	– –
Gestational age	70	–	35.8 ± 4.6
Apgar 1min	70	–	6.0 ± 2.3
Apgar 5min	70	–	7.1 ± 2.0

Abbreviation: SD, standard deviation.

Table 2 Results of correlation analysis with variable percentage of children who performed tasks of domain language

Variable	Correlation to language	
	Pearson *r*	*p*
Posture	0.009	0.974
Psychomotor performance	0.214	0.445
Social skills	0.236	0.398

children, the lower the percentage of executed tasks in the language domain ($r = -0.566$; $p = 0.028$).

►**Fig. 1**, a dispersion diagram, shows the percentage of children who performed the language domain tasks by age (in months). A negative dispersion was observed.

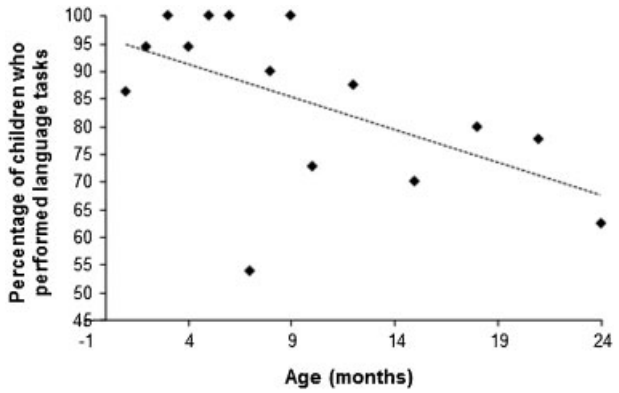

Fig. 1 Variable dispersion: percentage of children who performed the language domain tasks versus age in months.

Discussion

The prevalence of prematurity is highlighted in this sample. This can affect neurodevelopment,[19–22] increasing the risk of morbidity, mortality, and prolonged hospitalization[23] and interfering with brain maturation processes. It can lead to structural and anatomical disorders, occasionally resulting in functional, cognitive, and behavioral disabilities.[21] The literature also notes that children hospitalized for long periods are often deprived of environmental stimulation and maternal contact.[19] However, there are no studies in the Brazilian literature about the relation between delay in language acquisition in children with NHIE. In this context, it is believed that the delay in language acquisition may be influenced by these factors.

A meta-analysis demonstrated that premature infants have significantly lower scores on functional language tests

Table 3 Comparison between male and female in executed language tasks

Task		Sex						*p*[a]
		Male			Female			
	Month	*n*	Done	%	*n*	Done	%	
Produces guttural sounds	1	12	10	83.3	10	9	90.0	0.571
Produces some vocalizations	2	10	10	100.0	8	7	87.5	0.444
Chatter: prolonged vocalizations	3	7	7	100.0	3	3	100.0	–
Vocalizes when spoken to	4	12	12	100.0	6	5	83.3	0.333
Shouts in happiness	5	2	2	100.0	6	6	100.0	–
Babbles	6	8	8	100.0	6	6	100.0	–
Vocalizes several well-defined syllables	7	7	5	71.4	6	2	33.3	0.209
Participates in game of hide and seek	8	3	2	66.7	7	7	100.0	0.300
Speaks a word of two syllables	9	2	2	100.0	2	2	100.0	–
Repeat a heard sound	10	5	3	60.0	6	5	83.3	0.404
Speaks three words	12	12	10	83.3	4	4	100.0	0.550
Speaks five words	15	8	5	62.5	2	2	100.0	–
Recognizes a image or shows two images	18	3	2	66.7	2	2	100.0	–
Recognizes five body parts of doll	21	2	1	50.0	1	1	100.0	–
Associates two words	21	2	1	50.0	1	1	100.0	–
Asks to feed and drink	21	2	2	100.0	1	1	100.0	–
Nominates two images or shows four images	24	5	1	20.0	3	2	66.7	–
Produces sentences of several words	24	5	3	60.0	3	3	100.0	–
Nominates his- or herself by the first name	24	5	3	60.0	3	3	100.0	–

[a]Fisher exact test.

compared with children born at term, and these difficulties tend to persist throughout the child's development until early adolescence.[24] This study lacks the nonsubjective language measurement, because the study covers structural and instrumental aspects. The present study showed a high index of correct executions in language domains. This finding contradicts one study,[24] which showed significantly lower scores in functional language tests in preterm subjects. However, there is no denying the influence of prematurity on child development when combined with NHIE. It can increase the negative impact of this intercurrence in the acquisition and development of language.

The Apgar score is an important instrument of neonatal assessment that includes five components: heart rate, respiratory effort, muscle tone, reflex irritability, and color. Each aspect is scored 0, 1, or 2 and is assessed at 1 and 5 minutes after birth. According to the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists,[25] an Apgar score of 7 to 10 is considered normal, and to determine risk factors to neurologic disorders, it is necessary to relate this score with other health complications.[26] These study data do not support the current literature, which describes that Apgar score below 7 can be associated with NHIE.[27] The most significant data come from larger samples.

A better performance was seen in girls, showing that boys are frequently more affected in language disorders.[28,29] In the present study, no task was significantly related to this variable. However, it is important to observe that until 10 months, with exception of language task at 7 months (vocalizing several well-defined syllables), in which boys showed better performance in relation to girls, the performance of both sexes was quite similar. From this period, the performance of girls was clearly better than boys in this domain; ►**Table 3** presents the list of language tasks.

Researchers have suggested that organic, structural, and hormonal disorders may be the cause of this difference between gender.[28,30] It is also highlighted that the interference of differentiated attitude by adults in relation to boys' and girls' language acquisition is an environmental factor that can contribute to this difference.[31] It is believed that statistically significant differences in languages tests between boys and girls should appear in longitudinal studies; with increasing age, it is possible to observe the environmental interferences with more evidence.

As shown in ►**Fig. 1**, by the Pearson correlation, with increasing age, children start to present worse performance in language tests. This finding corroborates a study that assesses psychomotor development by Brunet-Lezine Scale. In this study, the development quotients in each area tended to decrease during the consultations,[32] revealing a progressively unsatisfactory development throughout the period.

Conclusion

The present study found statistical significance in relation to participants' language and age, indicating that children with NHIE tended to have delayed language skills, with more evidence shown with advancing age. In this context, the observation of the findings related to the language of children with NHIE indicates that deficits may become evident only with advancing age and stages of child neurodevelopment.

No relation between participants' language and sex was observed, although a trend toward better performance on language tasks by girls was noted. Also, it is necessary to validate the Brunet-Lezine Scale in Brazil, to standardize and provide greater reliability in the findings. In this context, disorder traces can be early identified, favoring diagnosis and interventions in children's early neurodevelopment. More scientific research is necessary in this area, with larger samples, to better understand the various processes related to language acquisition and development in these patients.

This study reinforces the importance of observing infant manifestations and intensifying investigations on this topic, seeking precise understanding of the processes involved. The essential function of the speech therapist allied with the hospital team is highlighted, following these patients from birth through adolescence.

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