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## Observation of language, visual and hearing function development in infants

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### ABSTRACT

#### Objective

To investigate language, visual and hearing function development among infants in a day-care center based on educators' assessments.

#### Methods

One hundred and fifteen infants who attended a day-care center at a university of state of São Paulo, Brazil, were assessed during the period between 1998 and 2001. The "Protocol for Observation of Language, Visual and Hearing Function Development," containing a total of 39 standardized tests, was utilized to assess infants from three to 12 months old. The protocol was applied by trained educators,

members of the day-care center staff. Statistical analysis was carried out using Chi-square test or Fischer's exact test at  $p < 0.05$ .

## Results

Infants showed different language development patterns as for polysyllabic babbling and production of first words. For visual function, infants showed a different pattern of imitation and initiation in gesture games and following commands with gestures.

## Conclusions

The day-care center setting is probably promoting a distinct pattern of language, visual and hearing function development. Prevention in day-care centers should aim at integrating education and health to achieve the common purpose of child welfare.

## Keywords

Child development. Language development. Vision. Auditory perception. Visual perception. Hearing. Child day-care- centers. Nurseries. Health promotion.

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## INTRODUCTION

Infant education is the first phase of basic education and is directed toward children from zero to six years of age. Day-care for infants is a necessity, particularly in large urban centers. The peculiarities of this age group require that education should carry out two indissociable and complementary functions: to care for and educate infants and small children. Society has influenced parents to place infants in educational institutions earlier on in life and for longer periods of time. Despite the fact that precise information is lacking as to the proportion of infants which go to day-care centers in the country as a whole, it is estimated that 40% of these infants are attending educational institutions.<sup>3, 14</sup>

The integrated development of the child depends upon both care, which involves the emotional dimension of growth, and biological aspects of the body, such as: the quality of food and health care and the way in which these are offered to the child.

Few instruments for screening early language and detecting disturbances among infants are mentioned in the literature. In contrast, there are a large number of studies that screen children aged three and older, but almost none that study the first year of life.

However, language acquisition occupies a central role in development during the first few years of life. Thus, one would imagine that it would function as a sensitive indicator of the general integrity of development. Screening for language development is a reasonable means of evaluating *"integrity of many neural subsystems, including hearing, central auditory processing, cognitive development, motor function (articulation, praxis, upper extremity motor function), vision, and central processing of*

*visual information*".<sup>4</sup> Children's difficulties in acquiring language according to normal patterns is almost always an indication of some kind of subjacent problem with respect to development.

Language may occur by means of two channels: the auditory channel, including speech and its comprehension and the visual channel, which is necessary for reading and writing, for gesticulating and for Sign Language, utilized by deaf people. Infants who hear make use of vocalization, hearing comprehension and gesticulation in order to communicate with others (social visual communication).

As to vision, it is acknowledged that it contributes a great deal to child development, for it is a factor which motivates guides and controls movements and actions. Visual development, as well as the development of other functions of the organism, is permeated by factors related to neurological maturation and learning. It is determined by genetic factors and influenced by environmental factors.<sup>6</sup>

The most important modifications in child development happen during the first year of life, when progress occurs in great leaps within shorter periods of time. Thus, in their reciprocal relationship within development, the transformations in the axial and appendicular motor abilities, which happen throughout the first year of life, contribute toward the refinement of visual capabilities.<sup>5</sup>

The health professional frequently overestimates children's capabilities in the development of language. This fact becomes clear when we take into consideration the small number of children up to 3 years of age which are counseled to seek language evaluation. It is estimated that approximately 2 to 3% of the children in this age group present some kind of delay in language development, excluding those with mental retardation, cerebral palsy and deafness.<sup>4</sup>

Prevention and early detection of alterations in infantile development are procedures that are rarely applied in Brazil. Considering sensorial deficiencies in particular, concern with respect to prevention and early detection are justified by the possibility of anticipating the process of intervention towards the beginning of the child's life, guaranteeing the necessary stimulation in all aspects fundamental to its global development. Within this area, screening procedures are utilized for they are characterized as low cost instruments which are efficient and easy to apply.

Therefore, the objective of this study was to investigate language, visual and hearing function development among infants attending at a day-care center during their first year of life.

## **METHODS**

One hundred and fifteen infants attending a day-care center for health care professionals working at a university in the State of Sao Paulo, sons and daughters of employees of this university who worked in shifts in the period between 1998 and 2001 were evaluated.

The 115 infants were divided in three groups according to age groups:

Group 1: 43 infants aged 3 months and 16 days to 6 months and 15 days.

Group 2: 46 infants aged 6 months and 16 days to 9 months and 15 days.

Group 3: 26 infants aged 9 months and 16 days to 12 months and 15 days.

Assessment was conducted by means of the "Protocol for Observation of Language, Visual and Hearing Function Development," consisting of 39 standardized tests, 10 of which are associated with language, 11 are designed to test the hearing function and 18 the social visual function.

The standardized tests of language, visual and hearing function development within the Protocol were selected by Lima<sup>8</sup> from the "Early Language Milestone Scale" while others were selected by Gagliardo<sup>6</sup> from the "Bayley Scales of Infant Development".

Considering that it was necessary to conduct the evaluation during a period of the day when the child was feeling at ease, engaged in daily, routine activities, among people who were familiar to him, the teachers of the day-care center responsible for caring for the infants, were trained to apply the tests and learned to observe the phases of development of each child.

Some items of the Protocol could be observed during informal interaction, while the infants were involved in activities carried out regularly in the day-care center or could be directly tested, as occurred with the tests undertaken to locate the sound of a bell on one of the sides or in the test which called for students to imitate gesture games.

The parents of the infants who were assessed signed a consent form when they registered their children in the day-care-center according to which they permitted their children to undergo routine assessments. Since this project has been incorporated into the infants' evaluation system, there was no need for a specific Informed Consent Form for this research.\*

\*Submission of the Project to an Ethics Committee of the Institution was not required due to the fact that this research was conducted in a Day-Care-Center.

The training program, administered to educators of the day-care-center in order to prepare them to apply the Protocol, consisted of five phases:

**First Phase:** In 1998, a meeting was held by one of the authors of the Protocol, a speech therapist, with the team of educators of the day-care-center "Area de Saúde" [Health Field], in order to inform and sensitize them with respect to the issues of language disturbances, auditory and visual problems. The significance of screening was discussed as well as the justification for undertaking this procedure. A member of the day-care-center staff, a pedagogue who was very familiar with the tests that were going to be applied, was chosen to teach her co-workers how to apply the Protocol.

**Second Phase:** The Protocol was demonstrated to the above mentioned pedagogue. The best place in the day-care-center to apply the Protocol was then chosen.

**Third Phase:** The pedagogue trained members of the day-care staff responsible for caring for the infants to administer the Protocol. Each test in the Protocol was demonstrated and the day-care workers were advised on how to apply each of them on infants within several age groups. Planning was undertaken so as to integrate these preventive measures into the educational program of the day-care-center.

**Fourth Phase:** The Protocol was administered by the day-care staff, without the supervision of the pedagogue, but utilizing the practical and theoretical orientations which they had received from her.

**Fifth Phase:** In order to certify that the staff had registered the results of the tests adequately, the authors of the Protocol assessed the training they had undergone. A random sample of infants who had been submitted to screening by the day-care staff was re-assessed by the authors of the Protocol and by the pedagogue.

The descriptive analysis of the data was undertaken utilizing the "Epidemiological Information 6.0" Program (Epi Info). Variables of interest within the study were compared by means of the Chi-Square or Exact Fischer tests, when necessary adopting 5% level of significance.

## RESULTS

Infant educators of the day-care center assessed 115 infants, subdivided in age groups ranging from three months and 15 days to 12 months and 15 days. Despite the fact that the Protocol is designed to screen infants one month old, in the present study only infants more than three months old were considered, for this is the age at which they begin to go to the day-care-center.

The results of the ELM<sup>4</sup> Scale tests for Group 1 are presented in Table 1.

**Table 1** - Tests from the Protocol based on the ELM Scale, infants from Group 1\* who performed the tests, frequency of successful performance and data reported by Lima.\*\*

Tests from the Protocol	Infants who performed		Data reported by Lima <sup>8</sup>		Level of significance
	each test				
	N=43	%	N=44	%	
Bubbles	35	81.4	44	100.0	P=0.0023
Localizes bell to the right	43	100.0	44	100.0	P=0.495
Localizes bell to the left	42	97.7	44	100.0	P=1.000
Follows object, horizontally, vertically	43	100.0	44	100.0	
Blinks to threat	43	100.0	44	100.0	

ELM – "Early Language Milestone"

\*Group 1 – Infants (N.43) from three months and 16 days to six months and 15 days

\*\*Lima<sup>8</sup> – Doctoral dissertation (See data listed in the References)

This group was also submitted to tests from the BAYLEY Scales: <sup>2</sup> lifts the hand towards the object, which was accomplished by 41 (95.3%) infants and hold an object in each hand, accomplished by 26 (60.5%) infants.

In Group II the results of the ELM<sup>4</sup> Scale tests are presented in Table 2:

**Table 2** - Tests from the Protocol based on the ELM Scale, infants from Group 2\* who performed the tests, frequency of successful performance and data reported by Lima.\*\*

Tests from the Protocol	Infants who performed each test		Data reported by		Level of significance
			Lima <sup>8</sup>		
	N=46	%	N=44	%	
Produces simple syllables	40	86.9	44	100.0	P=0.026
Produces the same syllable repeatedly	25	54.3	42	95.5	P=0.001
Locates bell below, indirect	45	97.8	44	100.0	P=1.000
Inhibits to "no"	41	89.1	41	93.2	P=0.714

Imitates gesture games	19	41.3	41	93.2	P<0.001
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\*Group 2 – Infants (N.46) from six months and 16 days to nine months and 15 days

\*\*Lima<sup>8</sup> – Doctoral dissertation (See data listed in the References)

In addition, infants were submitted to the BAYLEY<sup>2</sup> Scales test, transfer the object from one hand to the other, which was accomplished by 35 (85.4%) of them.

The results of the ELM<sup>4</sup> Scale tests for Group 3 are presented in Table 3.

**Table 3** – Tests from the Protocol, Children from Group 3\* who performed the tests, frequency of successful performance and data reported by Lima.\*\*

Tests from the Protocol	Infants who performed		Data reported by		Level of significance
	each test N=26	%	Lima <sup>8</sup> N=44	%	
Produces mama/papa	14	53.8	34	75.6	P=0.060
Localizing the Bell directly below them	26	100.0	44	100.0	-
Follows command with gestures	23	88.5	44	100.0	P=0.045
Initiates gesture games	15	57.7	44	100.0	P< 0.001
First Word	10	38.5	34	75.6	P=0.002
Points to desired objects	14 (53.84%)		16 (35.56%)		P=0.133

\*Group 3 – Infants (26) from nine months and 16 days to 12 months and 15 days

\*\*Lima<sup>8</sup> – Doctoral dissertation (See data listed in the References)

The BAYLEY<sup>2</sup> Scales tests to which the group was submitted were: opposing thumb and forefinger in a pincer grip and placing one cube on top of another.

The prehension thumb/index finger test was accomplished by 10(38.5%) of the infants. The test which involved placing one cube on top of another one was accomplished by 5 (19.2%) of the infants.

In order to verify the administration of the tests by the day-care educators, the authors re-assesses a random sample of 5 infants from submitted to screening each year between 1998 and 2001. The assessments corresponded in 100% of the evaluations undertaken by the educators.

## DISCUSSION

Ten of the sixteen tests to which infants in the three Groups were submitted were accomplished within the expected age group. These were: produces simple syllables, locates a lateral sound, locates a sound on the diagonal, inhibits to “no”, visual tracking, blinks to threat, points to desired objects. The six remaining tests (bubbles, repeating syllables, says mama and papa, produces the first word, imitates, initiates gestures games) presented statistically significant results when compared to

previous studies, particularly those of Lima<sup>8,9,10</sup> (1997), Coplan<sup>4</sup> (1983), Azevedo<sup>1</sup> (1995) and Gogliardo.<sup>6</sup>

A different pattern of language development was observed among the infants with respect to the production of polysyllabic babbling and the first words.

Furthermore, a reduced number of children imitated others and produced spontaneous games involving social gesticulation, which indicates that, although no evidence was found that there was a modification in language development (oral and expressive), the environment of the day-care-center probably propitiates conditions for a different pattern of development than that described by other authors<sup>5,8,10,12</sup> who studied infants which spent most of their time with one caregiver, usually the mother in one to one interaction. Another element that should be taken into consideration is the quantity of visual and auditory stimulants that are found in a collective environment, like a day-care-center. Perhaps language development among infants does not follow a universal pattern.

Auditory assessment, by testing infants' response to auditory stimuli, detected disabilities in two infants, which was confirmed by the presence of otitis media.

In Group 1 (see Table 1) when the test "making bubbles" was administered at six months, a smaller number of infants were able to do so when compared to Lima's study<sup>8</sup> in which all infants the same age were able to make bubbles. Coplan<sup>4</sup> found that most infants in his study produced lip vibrations in the middle of their first year of life.

As to the visual function tests, "visual tracking and blinks to threat", in Group 1 the responses obtained corresponded to findings in the literature<sup>4,7,11</sup>, that is, these are behaviors presented by the majority of infants studied at 4 months.

The tests which involved locating a bell placed at a lateral position, to the right and to the left were successfully performed by all infants, corresponding to findings in the literature. From three months on, responses emerge, such as searching for the source of a sound and lateral localization on the same plane as the ear, which characterize an evolution in responses as a result of the development of the Central Nervous System.<sup>1,4,12</sup> One child did not localize the bell to her left which was explained by the presence of Otitis Media, diagnosed by an ear, nose and throat specialist to whom he/she was indicated by the day-care-center for evaluation.

In Group 2, Table 2, the infants who were submitted to tests associated to language, that is, when they begin to produce the simple syllable (monosyllabic babbling) and to repeat the same syllables (polysyllabic babbling), performed below the expected level for their chronological age.

However, by analyzing the results month by month, it was observed that five infants did not produce simple monosyllables at seven months, one infant at eight months and another one at nine months, being that the latter was a child presenting recurrent Otitis Media. It should be noted that monosyllabic babbling occurred, in fact, within the same age group as the group studied by Lima,<sup>8,10</sup> for the majority was babbling simple syllables at eight months. Coplan<sup>4</sup> found that monosyllabic babbling was produced among infants who were over eight months old.

As to polysyllabic babbling, 25 (54.3%) infants did not repeat the same syllable until they were nine months old, a proportion much smaller than that found in Lima's,<sup>8,10</sup> investigation, wherein 100% of the infants were producing polysyllabic babbling at nine months and in Coplan's<sup>4</sup> study, in which 75% of the infants were performing this test at the same period. This number was maintained among the 15 infants who had completed the ninth month, for only eight (53.4%) of them emitted polysyllabic babbling.

As to imitates gesture games, 19 (41.3%) of the children in the day-care-center were performing this test until they were nine months old. On the other hand, the majority of the infants studied by Lima<sup>8,10</sup> were performing this test at nine months.

Both the tests mentioned in which there were significant differences between this and other studies, production of polysyllabic babbling and imitation of gesture games, depend upon stimulation and perhaps a greater amount of interaction between an adult and the baby. Rubino<sup>14</sup> states that, from the moment in which the baby is capable of vocalizing sounds with characteristics similar to those of adult speech, the mother begins to repeat the sounds made by infants. The mother reflects the image of his vocal gesticulations back to the child. Furthermore, she begins to interpret the child's vocal productions. The fact that an adult is not performing this activity with the infant may lead to this differentiated development presented by infants at the day-care-center, with a smaller number of them performing polysyllabic babbling at nine months.

A similar situation occurred with respect to games involving the imitation of gesticulations. Probably the fact that the infant does not have an adult who is close to him available to play games involving the imitation of gestures such as clapping one's hands and blowing kisses leads to the emergence of this behavior at a later period than that found in previous studies.<sup>4,8,9</sup>

The infants presented consistent replies with respect to auditory stimuli, that is, locating a bell in an indirect manner, which is compatible with other references from the literature.<sup>1,12</sup> At eight months all the children were capable of locating sounds situated below or above ear level, indirectly.<sup>1</sup> One of the children did not respond to the bell, but later it was verified that she/he had Otitis. The responses to the test "becomes inhibited when confronted with a 'no'", that is, initial comprehension of a simple command, were compatible with Lima's,<sup>8</sup> findings, according to which, the majority of infants investigated understood a "no" at nine months.

In group three, it may be observed (see Table 3) that, as to the use of expressive language, 14 (53.8%) infants were saying mama/papa and 10(38.5%) were saying their first word. Performance with respect to this last test was worse among these infants than among those in Lima's study, 75.6% of who were emitting their first word at 12 months. Among the five infants who had completed 12 months, none had yet emitted their first word. Coplan<sup>4</sup> found that 70% of the infants emitting their first word at 12 months. It would be expected that more than half of the infants, even in a situation in which they are imitating the word enunciated by an adult, would incorporate part of this enunciation, with the modifications appropriate for his own level of development.

In the tests related to sound reception, that is, locating the bell directly below them, 100% of the infants were performing the test, in conformity with data from other studies.<sup>1,8</sup>

The test, "initiates game involving gesticulations" was performed by 15 (57.7%) infants, a proportion that was lower than that reported by Coplan<sup>4</sup> and Lima,<sup>8</sup> in which the majority of infants performed this test at 11 months.

The test "points to desired objects" was performed by 14(53.8%) infants, a proportion greater than that found by Lima,<sup>8,9</sup> which was 35.6%.

Educators at the day care center who participated in this research acquired knowledge concerning the process of development as well as prevention and detection of developmental disabilities, particularly those involving auditory and visual functions, within the area of infantile education. This implied in an investment in the education of the day-care-center's caretakers. An integration of the areas of health and education was required so as to accompany the infants' language development, particularly with respect to auditory and visual functions.



In conclusion, a reduced number of children performed certain tests related to language development. However, no evidence was found of developmental disabilities among these infants. Most probably, the day-care-center environment is propitiating conditions for a different pattern of language development that does not follow the universal pattern.

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