

# The relationship between the neuropsychomotor developmental skills, the auditory and expressive vocabulary and language development in children aged from 24 to 36 months

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## ABSTRACT

**Purpose:** to explore the relationship between neuropsychomotor skills, auditory and expressive vocabulary, and language development.

**Methods:** 30 volunteer parents and their children, children of both sexes, without auditory, neurological, psychiatric conditions, or syndromes. As materials, the Neuropsychomotor Development Checklist (NPDC, unpublished), 20 questions about the first milestones of child development; the Language Development Assessment (ADL), to assess overall developmental milestones; the Auditory and Expressive Vocabulary Test were used. Descriptive percentages and statistical analysis, the Chi-Square Test (as statistical significance  $p < 0.05$ ), were used to associate the results.

**Results:** of 30 participants, in the Vocabulary Tests, both auditory and expressive, 17 participants (56.7%) underperformed and it was less than expected for the vocabulary development, and there was no statistically relevant association to ADL. Children who did not meet the two of the development milestones of NPDC – pointing to body parts by 12 months and putting two or three words together – were associated to statistically relevant underperformance in the ADL ( $p = 0.018$ ,  $p = 0.015$ , respectively).

**Conclusion:** these findings highlight the critical role of global development, environmental stimulation, and social interaction in early language acquisition, suggesting the need for comprehensive assessment and early intervention.

**Keywords:** Child Development; Child Language; Neurodevelopmental Disorders



## INTRODUCTION

Childhood is a crucial period for nervous system development, and the first years of life are considered critical periods of development, requiring environmental stimulation for typical development<sup>1,2</sup>.

According to the neurophysiological development, brain maturation is a long process with variations in intensity and speed, according to age, i.e., there are anatomical, bioelectrical and morphological changes that take place from before birth to adolescence and propitiate the individual's global development<sup>1-3</sup>.

Child development, according to the literature, are composed by different aspects, such as physical-motor, affective-emotional, intellectual and social ones. The physical-motor aspect involves the organic growth, neurophysiological maturation, the ability to manipulate objects and the exercise of one's own body; the affective-emotional aspect is the way each one integrates his/her experiences, it is the feeling; the intellectual aspect consists on the capacity to think, to reason and the social aspect indicates the way people react in different contexts<sup>3-5</sup>.

Thus, it can be observed that the entire development process is influenced by intrinsic and extrinsic factors. Factors such as heredity, nutrition, infections, metabolic changes, traumatic injuries, radiation, toxic agents, systemic and maternal diseases, anoxia/hypoxia, neoplasms, environmental deprivation, among others, may influence the brain tissue, leading to neuropsychological disorders. These disorders may occur through intellectual, attentional, memory, motor deficits, language disorders and/or behavioral problems<sup>6-8</sup>.

Neurophysiological studies describe myogenetic development, i.e., the growth of the myelin sheath surrounding the Central Nervous System (CNS). With this, it is known that brain maturation does not occur homogeneously in all aspects (visual, auditory, motor, and somesthetics), because exposure to different types of stimuli, known as "radiation", occurs with different intensities at various stages of life. For example, during gestation, the myelination of optic fibers is not stimulated, and this leads to a slow maturation process during intra-uterine life. In contrast, after birth there is a drastic change in this stimulation as visual radiations increase intensely in speed and quality<sup>6-8</sup>.

According to their analysis, myogenetic development is related to language. The baby's first vocal behavior is vocalization, and at this stage it was seen that the myelin is not complete, but the cranial nerves - important responsible for phonatory movements

- are already mature. Thus, myogenetic development is related to language development<sup>6-8</sup>.

All the aspects described above show the importance of knowledge of the different global aspects in development and intervening factors in this process. Among the aspects described is language, the focus of this study, which may interfere and be influenced by motor, sensory, affective-emotional, and social issues. Knowing child development will help understanding the evolution of the communicative-linguistic aspects of the child<sup>8,9</sup>.

As far as language is concerned, the neural networks for language acquisition are already present before birth, and more than half of them develop in the first years of life, influenced by environmental stimulus<sup>10</sup>.

In early childhood, the brain is very plastic, that is, it is provided with a high intensity of brain plasticity, defined as the brain's ability to adapt to new demands and, consequently, allows the individual to have an increasingly precise and refined response to stimulus<sup>5,6</sup>. When this is reflected to language, it is shown that children who are more deprived of vocabulary, for example, during early childhood, tend to have more difficulty acquiring it in the future<sup>11</sup>.

During the oral language acquisition process, there is a change in word learning during the middle of the second year of life. Young children usually acquire their first words around 9 to 12 months of age and by 24 or 30 months, they may have acquired 500 words or more<sup>11-13</sup>.

Regarding word production and comprehension, it was noticed that when the child was able to produce 10 words (expressive vocabulary), he/she understood 110 words (auditory vocabulary) and by 16 months, they may be able to produce 45 words, but understood 180 words. It must be emphasized that all these numbers of words standards are based on typical children without any hearing, neurological, psychiatric issues and/or syndrome<sup>11-13</sup>.

In the period when the expressive vocabulary reaches around 50 words, there is a burst of vocabulary extension, in which the speed of word acquisition suddenly begins to speed up and the child may be acquiring 8 or more words per week. Children experience this lexicon increase after acquiring a vocabulary of more than 50 words, between the period of a 1:5 month and 1:7 month<sup>11-13</sup>.

Lexical acquisition and development are strongly influenced by the interactional process, and it is

surprising how quickly a child internalizes the properties of the language, which it is exposed to<sup>5,14</sup>.

Sociopragmatic aspects and cognitive skills are fundamental to the child's lexical development. Researches have shown that the timing of some linguistic milestones are associated with the development of numerous cognitive skills, including the concept of objects, spatial and numerical relations<sup>15,16</sup>. In view of the above, the first years of life are considered essential for the global and language development<sup>17</sup>. Furthermore, when all these aspects are analyzed and associated, it may help follow-ups and early interventions in preschool children<sup>14</sup>.

Based on the importance of studying language development and neuropsychomotor skills in children, this study aims at exploring the relationship between neuropsychomotor skills, auditory and expressive vocabulary, and language development.

## METHODS

### Ethical and Legal Aspects of the Research

Comprising 30 participants, the research project was approved by the Human Research Ethics Committee of the of the Pontifícia Universidade Católica de Campinas, SP, Brazil, under protocol 3.426.010/2019 and CAEE 15030719.0.1001.5481 which is part of the research work entitled "Adaptação e Validação do Questionário Language Use Inventory para o Português Brasileiro".

### Study Design

This is a cross-sectional prospective study.

### Study Location and Period

Carried out in three public full-time Pediatrics Service in the city of Campinas, from September of 2021 and June of 2022.

### Inclusion and Exclusion Criteria and Study Population

The inclusion criteria were children aged from 24 to 36 months, followed by a Pediatric Outpatient Clinic, and who have not been diagnosed with neurological, auditory, psychiatric pathologies and/or syndromes. It was just included those children whose parents sign the Free and Informed Consent Form and participated during the entire evaluation.

The Exclusion Criteria involved all the volunteers whose age was below or above the proposal and/

or there is any neurological, psychiatric, auditory, or syndromic diagnoses. Those who did not consent to participate in the research and did not respond and/or did not participate on all the steps of the evaluation were also excluded

The sample consisted of 30 parents/caregivers and their children, both sexes, who were aged from 24 to 36 months and followed by a Pediatric Outpatient Clinic. During the data collection, the sample consisted of 43 participants, however, according to the exclusion criteria, 13 of them were excluded.

### Data Collection

The data collection happened from August (2021) to June (2022) and the following instruments and material were used: Neuro-psychomotor Development Checklist (NPDC - in press); Language Development Assessment ("Avaliação do Desenvolvimento da Linguagem" - ADL); Auditory Vocabulary Test and Receptive Vocabulary Test.

The NPDC is a checklist of developmental milestones in early childhood. It consists of 20 dichotomous questions, which investigate aspects of motor skills, social cognition and language for children from 18 to 42 months. This instrument was developed by the Brazilian Pre-school Mental Health Study and the team developed this script based on the Bayley Scale and the Denver Test<sup>18</sup>. The scale was answered according to the observations of the children's caretakers and/or parents and the application took about 5 minutes. The items of the checklist were: (1) Smiled by 3 months; (2) Looked straight ahead by 6 months; (3) Alternated gaze by 6 months; (4) Paid attention and discriminated familiar sounds by 6 months; (5) Vocalized and babbled by 6 months; (6) Sat without support by 6 months; (7) Crawled by 9 months; (8) Walked without support by 16 months; (9) Spoke isolated words by 14 months; (10) Invited other children or adults to play by 18 months; (11) Pointed parts of their own body by 12 months; (12) Pointed to wanted objects by 18 months; (13) Understood simple questions by 18 months; (14) Made combinations of two to three words by 24 months; (15) Formed simple sentences - subject and verb - by 30 months; (16) Formed complete sentences - subject, verb, and complement - by 30 months; (17) Understood simple stories by 36 months; (18) Spoke the sounds of speech by 42 months; (19) Exchanged phonemes in speech; (20) Formed sentences of 4 to 5 words by 42 months.

The ADL<sup>19</sup> is a group of tasks which builds up a scale to assess the development of language content and structure in children's structure. It is possible to be applied in children aged from one year-old to six years and eleven months. The ADL<sup>19</sup> assesses individually and allows investigation of the receptive and expressive domains of language. The comparison between the scores of the scales separately makes it possible to determine whether the deficiencies observed are primarily of a receptive (comprehensive) or expressive, or even global. The material for application was composed of:

1. Manual of the examiner:

- a) *Concrete material*: a bag with a bell, a stuffed dog, a doll, a spoon, a plate, a cup, a cart and three tennis balls.
- b) *Figure manual*: seventy-five pages with color illustrations, fifty-one pages referring to language and twenty-four referring to the expressive language.

2. Protocol for Application and Scoring: eleven sheets, the first of which contains space to write down the child's data and the results obtained by applying the receptive and expressive language scales. Each sheet corresponds to an age group, containing the sentences referring to the task being evaluated. Below each item is the correction for the respective task. On the left of this protocol, there are the items referring to tasks to assess receptive language, while on the right there are the items referring to the expressive language. On each item, there is a space for scoring the answers: 1 (one) for correct answers and (0) zero for incorrect or no answers.

3. Table for analysis of the tasks of each item of the ADL<sup>19</sup> application protocol according to the theoretical development of language.

The Auditory Vocabulary Test<sup>20</sup> was composed by 165 images, divided into groups of five. The researcher spoke the name of one of the images of each group and the participant pointed which the image was corresponded to what it was listened to. There was no visual tip during the test, only the hearing one. At the end of the test, the participant listed to 33 images, which was considered the maximum quantity of points of the test.

The Expressive Vocabulary Test<sup>20</sup> includes by 100 images, divided into groups of two. The researcher pointed each one of the images and asked the participant "what is the name of this?", then the participant spoke the name of image corresponded to what it was seen and pointed.

There was no hearing tip during the test. At the end of the test, the participant could have named 100 images, which was considered the maximum quantity of points of the test. The Data Collection Routine happened at the Pediatric Outpatient Clinic where the responsible researcher for the study the family talked to caregivers/responsible and/or parents, who were at the reception, about the project and asked them to sign the Informed Consent Form.

After this procedure, the researchers asked the questions regarding the patient's global development (NPDC – in press). The instruments were filled out concomitantly with the answers. After this step, the child was invited for a language evaluation on a day and time, which was the most convenient for the parents. The evaluations occurred weekly, once a week, in the afternoon, at the Speech Therapy Clinic (PUC-Campinas). On the scheduled day and time, the researchers explained how the language evaluation would be conducted and they signed another Informed Consent Form for the Language Evaluation, which involves the ADL<sup>19</sup> and the Auditory and Expressive Vocabulary Tests<sup>20</sup>. Those children who presented risks and deviations during the whole process were referred for evaluation and speech therapy in the respective institutions.

## Data Analysis

Each question completed by the Neuropsychomotor Development Checklist (NPDC) evaluator was analyzed separately and then related statistically to the ADL<sup>19</sup> questionnaire by the Chi-Square Test (statistic significant when  $p < 0.05$ ).

For the ADL<sup>19</sup>, the analysis happened as follows:

1. The following was used for scoring each item: (1) one for correct answers; (0) zero, if the answer was incorrect or when there was no answer. In order to know the beginning and the end of the test, the Basal and the Ceiling was established for each child.
  - a) *Basal*: is the beginning of the score for each scale, receptive or expressive scale. It was determined when the child responded correctly to three consecutive items. If the child did not the first three items, the evaluator had to return to tasks of the back to the tasks of the immediately preceding age group, repeating the procedure until the three consecutive tasks were found.
  - b) *Ceiling*: The application of the ADL<sup>19</sup> was interrupted after five consecutive errors or absences of response. After applying and establishing each

child's Basal and Ceiling, Respective Scores were calculated. The Previous Score of each language scale - receptive and expressive – was calculated separately. To find the Previous Score, all items were added that scored (1) and then subtracted all items that scored (0). The result of this subtraction corresponded to the raw score of the scale in question. Subsequently, the Previous Scores were transformed into Standard Scores, which is the corrected score for each age group, according to their performance. For this procedure, the ADL<sup>19</sup> application manual was used. After the Standard Score of each scale was established, both were added to obtain the Global Standard Score and its results were classified, according to the mean obtained from both Receptive and Expressive Scores, as well as their standard deviation.

The table for global standard score classification and standard deviation was also analyzed according to the ADL<sup>19</sup> application manual.

For the Neuro-psychomotor Development Checklist (NPDC), the checklist was considered as a global measure of development without dismembering the specificities of possible domains and items.

For the Auditory Vocabulary Test<sup>20</sup>, the total of images (33) was considered as the maximum score the participants could get to. Thus, all the correct answers were (1) one point each and according to the age of the participant, this score could be considered over performed level, medium level, underperformed level

and extremely underperformed level. For the statistical analysis, it was considered “expected” for medium level and over performed level or “not expected” for underperformed level and extremely underperformed level.

For the Expressive Vocabulary Test<sup>20</sup>, the total of images (100) was considered as the maximum score the participants could get to. Thus, all the correct answers were (1) one point each and according to the age of the participant, this score could be considered over performed level, medium level, underperformed level and extremely underperformed level. For the statistical analysis, it was considered “expected” for medium level and over performed level or “not expected” for underperformed level and extremely underperformed level.

## RESULTS

A total of 30 parents and their children, ranging from 24 to 36 months, participated in the study. Thirteen of them (43.3%) were females and seventeen (56.3%) were males. All of them answered and participated on the three tests (Language Development Assessment, ADL<sup>19</sup>; Auditory and Expressive Vocabulary Tests<sup>20</sup> and the Neuropsychomotor Development Checklist, NPDC).

Nine children (30%) underperformed on the Language Development Assessment<sup>19</sup> which was statistically associated with the male sex ( $p=0.017$ ) according to the Chi-Square Test in Table 1.

**Table 1.** Statistical analysis between underperformed Language Development Assessment's results and the male and female sexes

		Females		Males		Test		(p value)
		N	%	N	%	N	%	
RESULTS	Underperformed	1	6.7%	8	53.3%	9	30.0%	0.017
(ADL <sup>19</sup> )	Normal	14	93.3%	7	46.7%	21	70.0%	
Total		15	100.0%	15	100.0%	30	100.0%	

Caption: ADL = Language Development Assessment  
Source: author.

In the Vocabulary Tests<sup>20</sup>, both auditory and expressive, seventeen participants (56.7%) were below the test normality standard and there was no

statistically relevant association with male or female sexes (Tables 2 and 3).

**Table 2.** Statistical analysis between the Auditory Vocabulary Test's results and the male and female sexes

		Females		Males		Test		(p value)
		N	%	N	%	N	%	
RESULTS	Underperformed	6	40.0%	11	73.3%	17	56.7%	0.141
(Auditory Vocabulary Normal Test <sup>20</sup> )	Normal	9	60.0%	4	26.7%	13	43.3%	
Total		15	100.0%	15	100.0%	30	100.0%	

Source: author.

**Table 3.** Statistical analysis between the Expressive Vocabulary Test's results and the male and female sexes

		Females		Males		Test		(p value)
		N	%	N	%	N	%	
RESULTS	Underperformed	7	46.7%	11	73.3%	18	60.0%	0.264
(Expressive Vocabulary Normal Test <sup>20</sup> )	Normal	8	53.3%	4	26.7%	12	40.0%	
Total		15	100.0%	15	100.0%	30	100.0%	

Source: author.

Regarding the NPDC, in order to organize the data for each of the skills, the questions were grouped into motor skills, speech and language skills and listening and social interaction skills.

Motor skills involve questions six, seven and eight in the questionnaire. Of the total number of participating children, ten (33.3%) did not sit without support by six months (question six); five (16.6%) did not crawl by nine months (question seven), and only one (3.3%) did not walk without support by 16 months (question eight). None of these questions was significantly related to the ADL<sup>19</sup> and the Auditory and Expressive Vocabulary Tests<sup>20</sup>. Questions five, nine, 11 and 13 through 20 of the NPDC were about speech and language skills. It is noteworthy that questions 18 and 20 were not considered because they dealt with milestones of child development up to 42 months and the study evaluates children up to 36 months, i.e., even with the answer "no", it is still expected that such skills would be developed, according to the standard time.

All the parents reported that the participants vocalized and babbled by six months (question five). Nine (30%) participants did not speak isolated words by 14 months (question nine) and did not make combinations of two to three words by 24 months (question 14). Twelve (40%) children did not point to parts of their own body by 12 months (question 11); four (13.3%) did not

understand simple questions by 18 months (question 13); eleven (36.7%) did not form simple sentences (question 15) and 13 (43.3%) did not form complete sentences by 30 months (question 16). In addition, ten (33.3%) children did not understand simple stories by 36 months (question 17) and 14 (46.7%) made speech exchanges (question 19).

Questions one, two, three, four, ten and 12 of the NPDC were about social interaction skills and listening. All the parents reported that the participants smiled by three months (question one); directed and altered their gaze by six months (questions two and three), paid attention and discriminated familiar sounds by six months (question four). However, six (20%) participants did not invite other children or adults to play by 18 months (question 10) and only one participant (3.3%) did not point to wanted objects by 18 months (question 12).

According to the statistical analysis of the relationship of ADL<sup>19</sup> results to the under expected results of all NPDC questions, children who did not point parts of their own body by 12 months (NPDC question 11) and who did not make combinations of two to three words by 24 months (NPDC question 14) were associated to those who underperformed on ADL 19 in a statistically relevant way ( $p=0.018$ , Table 4, and  $p=0.015$ , Table 5, respectively).

**Table 4.** Statistical analysis between question 11 of the Neuropsychomotor Development Checklist's (NPDC) results and Language Development Assessment's results

		(NPDC) Pointed parts of their own body by 12 months				Total		Chi-Square Test (p value)
		No		Yes				
		N	%	N	%	N	%	
RESULTS (ADL <sup>19</sup> )	Underperformed	7	58.3%	2	11.1%	9	30.0%	0.018
	Normal	5	41.7%	16	88.9%	21	70.0%	
Total		12	100.0%	18	100.0%	30	100.0%	

Caption: ADL = Language Development Assessment

Source: author.

**Table 5.** Statistical analysis between the question 14 of the Neuropsychomotor Development Checklist's (NPDC) results and Language Development Assessment's results

		(NPDC) Made combinations of two or three words by 24 months-old				Total		Chi-Square Test (p value)
		No		Yes				
		N	%	N	%	N	%	
RESULTS (ADL)	Underperformed	6	66.7%	3	14.3%	9	30.0%	0.015
	Normal	3	33.3%	18	85.7%	21	70.0%	
Total		9	100.0%	21	100.0%	30	100.0%	

Source: author.

As for the statistical analysis of the relationship between the results of the Auditory Vocabulary Test<sup>20</sup> and the NPDC questions, there was no significant relationship with any of the questions. However, children who did not understand simple stories by

36 months (question 17 of the NPDC) were more associated with the underperformed results of the Expressive Vocabulary Test ( $p=0.048$ ), shown in Table 6.

**Table 6.** Statistical analysis between question 17 of the Neuropsychomotor Development Checklist's (NPDC) results and Expressive Vocabulary Test's results

		(NPDC) Understood simple stories by 36 months				Total		Chi-Square Test (p value)
		No		Yes				
		N	%	N	%	N	%	
RESULTS (Expressive Vocabulary Test <sup>20</sup> )	Underperformed	8	80.0%	3	27.3%	11	52.4%	0.048
	Normal	2	20.0%	8	72.7%	10	47.6%	
Total		10	100.0%	11	100.0%	21	100.0%	

Source: author.

## DISCUSSION

Issues of the child's progressive history, such as the presence of neuropsychological and auditory disorders and/or syndromes, may influence on the neuropsychomotor developmental aspects and, consequently, language diseases<sup>1-3</sup>.

In the study population, males were statistically significant when associated with those who underperformed on the ADL<sup>19</sup>. According to the literature, the prevalence of language disease is more often associated with the male sex because this fact may be related to neurological (brain maturation is slower in males), hormonal (altered testosterone levels could make it difficult for the nervous system to make ideal connections), genetic and social factors (the demands of the social environment are more frequent and intense with boys, demanding that their speech is always correct)<sup>21-25</sup>.

The baby's first vocal behavior is vocalization, and, at this stage, myelination is not completed<sup>6,7</sup>. These vocalizations are performed because there are immature cortico-subcortical connections - which explains why vocalization is not intentional<sup>6,7</sup>. All children in the study vocalized and babbled by 6 months, according to their parents.

This data showed us that the myogenetic development occurred in a typical way and the children seem to be biologically prepared to develop language<sup>10</sup>. Even so, more than half of them were below expected standards in the Auditory and Expressive Vocabulary Tests<sup>20</sup>. However, in the Language Development Assessment (ADL<sup>19</sup>), less than half were below expectations.

According to the literature, motor development is the key for the child to explore the environment and interact with the adult who becomes the mediator and names the components of this environment, an issue that helps a lot in the development of language<sup>2,5,16</sup>.

The first milestone in motor development appears when the baby has control of the head, which is, when he or she is able to hold it, even for a short time, by three months. After that, the control over the limbs and trunk becomes essential for the child to interact, react and explore the environment<sup>2,4,9</sup>.

It was observed that almost all participants walked without support by 16 months, more than half of them sat without support by six months and crawled by nine months. Some other milestones of motor development, such as smiling by three months; directing and alternating gaze by six months; paying attention to sounds

and discriminating relative ones by six months were present in all participants, i.e., all of them seem to have had a good motor development.

Language, in the view of semiotics, is a system of linguistic signs and signals<sup>21</sup>. A linguistic sign is given by the set of a signifier and a meaning, because it refers to the object in question. Therefore, everything is based on the synchrony between the associative (paradigmatic) and the syntagmatic axis<sup>26</sup>.

The research has brought a statistically relevant data about the relationship between neuropsychomotor and language aspects. Children who did not point out parts of their own body by 12 months and who did not combine two to three words in a sentence by 24 months were more associated with underperformed results on the ADL<sup>19</sup>. In addition, children who did not understand simple stories by 36 months were more associated with those with under expected expressive vocabulary.

These relationships are in line with the literature because changes in the paradigmatic axis (such as changes in vocabulary tests) are related and associated with the syntagmatic axis (such as the ability to combine words to sentence formation)<sup>12,26</sup>.

One of the NPDC questions indicates the presence of exchanges in children's speech, and more than half of the caregivers reported that they notice this exchange. It is expected that, at this age, the child already has the phonemes [p], [b], [t], [d], [k], [g], [m], [n], [ɲ], [f], [s], [z], [ʃ] and [ʒ]. Therefore, parents who reported this complaint of speech changes were instructed to look for specialized speech and language evaluation<sup>27</sup>.

It is worth noting that, given the age of the participants, from 24 to 36 months, they have all passed through the milestones of early childhood during the period of the coronavirus pandemic. This pandemic, decreed on March 11th, 2020, was due to the severity and rapid geographical spread of the disease, Covid-19, caused by the new coronavirus (Sars-Cov-2)<sup>23</sup>.

Therefore, the world has determined health and epidemiological safety measures such as social isolation, the use of masks, and alcohol gel 70o<sup>28</sup>. Thus, the evaluated children have been going through the period of acquisition of language and vocabulary development (receptive and expressive) and were also submitted to isolation and social deprivation, which reduces their interaction with the world and may consequently be one of the reasons for the lower than expected results<sup>17,29</sup>. Moreover, the parents were also in social isolation, however they could work from



home, an issue that may have impaired the mediation and participation of the adult in the development of children's vocabulary<sup>29,30</sup>.

In both the Auditory and Expressive Vocabulary Tests<sup>20</sup>, more than half of the participants were below the expected range and less than half of them were below the expected range in the Language Development Evaluation<sup>19</sup>. This shows us how much isolation and deprivation of social interaction may have influenced the children's vocabulary, but - because they are in good biological condition - their language development, consisting not only of lexical elements, is less impaired<sup>29-31</sup>.

Although there is no specific speech and language assessment test for children who have experienced social isolation due to the pandemic, it was possible to observe the deficits they showed during the assessment, which are similar to each other and relate directly to the child's experience of the world and the mediator to stimulate the expressive and auditory vocabulary<sup>29</sup>.

The main limitation of the study was the time elapsed from data collection to evaluation of each one of the participants, because the parents were asked to return another day to finish the evaluation which cause a lack of absence. However, as the total number of participants was able to analyze and associate the results. Other limitations are related to the fact that the information got from the parents through the Neuropsychomotor Development Checklist is subject and memory bias.

Nevertheless, the inference of the results for children's development is strong specially because they have been through a pandemic time. This time of social isolation may have influenced on children, that is why more studies and protocols/specific evaluating with this population among their development is essential to build up strategies to help them improve their abilities.

## CONCLUSION

The investigation and association of neuropsychomotor skills with auditory and expressive vocabulary and language development in children, aged 24 to 36 months, showed statistically relevant relationships between developmental (neuropsychomotor) language skills and language assessment outcomes in children without relevant complaints and/or diagnoses.

The data and analyses exposed do justify the literature as to the importance of both biological maturation

and global development as well as environmental stimulation and social interaction for the process of acquisition and development of language and receptive and expressive vocabulary to be adequate. Isolation and social deprivation, in addition to the possible decrease in adult mediation towards the child and increased use of screens - factors arising from the pandemic period - are issues that may have led to the vocabulary deficit demonstrated by the research.

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JP, EO: Conceptualization; Methodology; Supervision.

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#### Data sharing statement:

All of the individual participant data collected during the trial will not be shared and/or available to public check. If the participants ask for, they might contact the corresponding author for 3 (three) years, after the publication of the article.