

Original articles

Hearing, language, motor and social skills in the child development: a screening proposal

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ABSTRACT

Purpose: to analyze the hearing, language, motor and social skills of children and propose a screening of child development.

Methods: 129 preschool children of both sexes, aged between three and six years old, enrolled in educational institutions and 25 teachers of kindergarten from public and private institutions, with no history of hearing disorders, with type A tympanometric curves and the presence of acoustic reflexes participated. For the children, the neuropsychomotor test, Denver II, and the evaluation of sound localization and temporal ordination of three verbal and non-verbal sounds were applied. For the educators responsible for the children, the Scale of Auditory Behaviors (SAB), was used.

Results: most participants with normal SAB presented hearing abilities or standard Denver II; while in the amended SAB group, most participants presented alterations in Denver II or in the auditory abilities tests. It was found, also, that part of the children with standard Denver II were pointed, by the educators, as misbehaving in SAB.

Conclusion: the combination of the findings of the Denver II, hearing tests of sound localization and temporal ordination and the SAB Scale is useful in the characterization of child development and, thus, the use of these three instruments for screening in this age group is recommended.

Keywords: School Health; Speech Language and Hearing Sciences; Auditory perception; Child Development; Screening

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INTRODUCTION

Child development is a process determined by biological, environmental and socioeconomic factors¹. During the first three years of life, great advances are made in the motor, cognitive and social areas of the child, all interrelated and essential for global development, as well as for the process of acquisition and development of speech and language². Inabilities or impairments in this acquisition may trigger problems in school learning, since children with neuropsychomotor development delay tend to have lower functional performances than children without a history of delay^{3,4}.

One of the possible causes of developmental difficulties may occur due to alterations in the processing of auditory information, which need to be detected early, since a failure in this capacity can cause information to be interpreted in a distorted way⁴. Therefore, evaluation of auditory processing helps the early diagnosis and the orientations of the Speech, Language and Hearing Sciences intervention of children with disorders related to cognitive-linguistic, perceptual or speech-producing difficulties⁵.

Rapid and simple evaluation measures, such as screening programs, allow the early identification of children with atypical development who deserve attention and specific actions. For a diagnostic analysis of hearing disorders, the American Speech-Language-Hearing Association suggests using information from the client and his / her family / teachers about situations in their daily lives related to the functioning of the auditory system⁶⁻⁸. Nowadays, checklists in the area of auditory processing can be found in the literature. Among these behavioral questionnaires, the Scale of Auditory Behaviors (SAB), which allows the extraction of qualitative information that may be related to auditory processing disorder (APD) and language alterations⁹, can be cited.

The Denver II¹⁰ Development Screening Test is a widely used screening test for neuropsychomotor development, because it has good validity and reliability indexes, it is easy and quick to apply, presents low cost and allows easy training, being used in both research and clinical practice. As well as the simplified screening of central auditory processing (ASPAC)¹¹, it is also widely used in the literature, because it is easy to apply and indicates a possible alteration of the auditory function^{12,13}.

Considering the interrelation between child development and hearing processing, we aimed to analyze auditory, language, motor and social skills and to

propose a screening of children's development for preschoolers.

METHODS

The protocol of this research is based on the Resolution number 466/2012 of the National Health Council of the Ministry of Health - Conselho Nacional de Saúde do Ministério da Saúde – for studies with human beings and was approved by the Research Ethics Committee of the Federal University of Sergipe under the No 270.079 (CAEE No. 15735113.9.0000.5546). The parents or guardians signed the Free and Informed Consent Form authorizing the inclusion of the child in the research, as well as the participating teachers.

This is an observational, analytical cross-sectional study, comprising 129 preschoolers with ages between three and six years old, of both sexes, and 25 educators from five educational institutions (public and private) in a municipality in northeastern Brazil. Children with presence of alterations in the external or middle ear, such as obstructions in the external auditory canal or otitis, or with evidence in the life history of an intellectual disability were excluded from the study.

The children were submitted to meatoscopy and the immitance test, in order to select those that presented normal mobility of the tympanic-ossicle system and acoustic reflexes, which were considered as an inclusion criteria of the sample.

The imittance test (tympanometry and acoustic reflex research) was performed using the *Interacoustics* immittantometer ZA 235, with a 226 Hz probe tone. The acoustic reflex was ipsilateral and contralateral, for the frequencies of 500, 1000, 2000 and 4000 Hz. It was considered approved, in this stage of screening, the child who presented type A tympanometric curve and a presence of acoustic reflex in all frequencies.

After the selection of the participants who passed the immittancimetric evaluation, the children were submitted to neuropsychomotor development screening and simplified auditory processing screening. The Scale of Auditory Behaviors (SAB) was applied for the teachers responsible for the children.

For the neuropsychomotor development screening, the Denver Development Screening Test II¹⁰ was used. The Denver II consists of 125 items that analyze areas of development: a) Personal-Social: aspects of the sociability of the child inside and outside the family environment; b) Adaptive Fine Motor: visual-manual coordination, manipulation of small objects; c) Language: sound emission, ability to recognize,

understand and use language and; d) Coarse motor: body motor control, sitting, walking, jumping and other movements performed by the broad musculature. In the application of the Denver II, we considered some temporary exclusion factors that could affect the performance of the child (sleepiness, fatigue, illness, fever or fear). The test was interrupted if the child became tired or needed to participate in some activity planned at the institution, and resumed after, without loss to its validity. The results of each of the evaluated areas were considered as normal, risky or non-testable according to the test interpretation of each evaluated item, following the criteria below: 1) normal, when there were no delays or, at most, one care; 2) risk of delay when there were two or more cares or one or more delays; 3) Not testable, when the child refused to perform one or more items.

The screening of auditory processing was performed through the application of ASPAC¹¹. The sound detection and localization test (SL) was performed using a low intensity sound instrument, called rattle. The children were instructed to remain with their eyes closed during the presentation of the stimulus and, after the end of the stimulus, they indicated the direction where the sound came from.

For the non-verbal sequential memory test (NVSM), musical instruments such as the rattle, a bell, the agogô and a *black-black* were used. Before the screening itself, the evaluator presented the sounds of each instrument. The child, then, could identify them, and the evaluator performed a demonstration of the test, with the child positioned facing the instruments and pointing out the order presented. Then, three different sequences were offered, using three musical instruments in each, with the child unable to see them. Therefore, it was possible to verify if the child pointed the correct sequence.

The “pa”, “ta”, “ka” syllables were used for the verbal sequential memory (VSM) test, and, initially, the child was asked to produce each syllable separately to verify the possibility of phono-articulatory production of them. The evaluator, then, pronounced the syllables in three different sequences, without a visual clue, and the child was asked to repeat the sequence of syllables heard after the end of each sequence.

The responses were analyzed, separately, regarding their occurrence, based on pre-established normality criteria for the studied age group¹¹. In the SL test, the child had to answer correctly four out of five directions presented, from the age of three. The error could occur in the following directions: above, in front of, or behind

the head. In the NVSM test, children aged from four to six year old should answer correctly two sequences of three sounds in three attempts. From the age of six, they should answer correctly two sequences out of four sounds in three attempts. In the VSM test, the child, from the age of three, should answer correctly at least two of the three three-syllable sequences presented. At the age of six, they are able to repeat sequences of four syllables.

The cochlear-eyelid reflex (CER) was investigated with the musical instrument called agogô (109.1 dBA) and the responses were analyzed regarding the presence or absence of the reflex during the percussion of the instrument.

The SAB⁹ was answered by the teacher responsible for the class in which the child was enrolled during the school year of the research, with one SAB questionnaire per child. They were instructed to circle the number that best represented the child’s behavior that was analyzed. The questionnaire consisted of 12 questions regarding everyday events, such as: difficulty in listening or understanding in a noisy environment; not understanding well when someone speaks fast or “babbly”; difficulty following oral instructions; difficulty in identifying and discriminating speech sounds; inconsistency of responses to auditory information; poor reading ability; asking to repeat things; being easily distracted; having academic or learning difficulties; short attention span; dreaming awake; being inattentive; and being unorganized.

The evaluation of each item was classified as follows: for those that occurred very frequently, that is, for 100% of the occurrence of the respective event, it is assigned a value of 1.0 (one); for the one that occurs almost always, it is assigned a value of 2.0 (two), which is equivalent to 75%; for that which occurs sometimes, value 3.0 (three), which represents 50%. For those sporadic, the value assigned was 4.0 (four), which equals 25%; and those that never occur, 5.0 (five), which presents a 0% chance to occur, regarding the behavior of the evaluated. The score was given by the sum of the points in the 12 items evaluated, reaching a maximum of 60 points and a minimum of 12 points. We used the criterion of results from the cutoff point determined by the data of this study, such as: “adequate” behavior for those who presented an average of 33 or higher; and “inadequate” for those who scored below 33.

For statistical analysis, the data were tabulated and processed by the PASW *Statistics data editor*,

version 21.0, microcomputer application. For data description, were used tabular and graphical presentation of the percentages. The Mann-Whitney test was used to compare age between genders; the Pearson's Chi-Square test or the bivariate correlation test (Pearson's coefficient) for the analyzes of the association and correlation between the results of Denver II, the ASPAC and the SAB scale were also used, respectively. The values were considered as significant for $p \leq 0.05$ and the accepted alpha value of 0.1.

RESULTS

The sample consisted of 129 preschoolers, with 65 girls (50.40%). The average age was 4.91 ± 0.74 years old, with no difference between genders ($p = 0.09$) and school type ($p > 0.05$), whether public or private, for the test of *Mann-Whitney*.

Regarding the Denver II test, 24.8% of the children were at risk for developmental changes. It can be seen that the "personal social" aspect presented the highest amount of risk for changes (Table 1).

Table 1. Percentage of normality of the Denver II test, by aspects (n=129)

Aspects	Interpretation of the Results	
	Normal	At risk
Personal-Social	85.3% (110)	14.7% (19)
Adaptative Fine Motor	96.9% (125)	3.1% (04)
Language	93% (120)	7.0% (9)
Coarse Motor	96.9% (125)	3.1% (4)

In the analysis of the ASPAC, regarding the auditory ability evaluated, CPR was present in 100% of the sample. Percentage values for correct answers for each auditory ability assessed in subjects with normal development and at risk for changes in the Denver II test can

be visualized. There were co-occurrences of normal Denver II and normal hearing abilities (LS, NVSM and VSM) in more than 75% of the subjects, that is, the majority of subjects who were normal in Denver II also presented normal ASPAC (Table 2).

Table 2. Frequency of correct answers in the simplified screening of central auditory processing, by auditory ability, in subjects with normal development and at risk for developmental changes (n=129)

Denver II	Frequency of correct answers in the ASPAC		
	LS	NVSM	VSM
Normal	81 (75%)	52 (75.36%)	67 (78.82%)
At risk	27 (25%)	17 (24.64%)	18 (21.18%)
Total	108 (100%)	69 (100%)	85 (100%)

Legend: ASPAC = Simplified screening of the central auditory processing; SL = Sound Localization; NVSM = Nonverbal Sequential Memory; VSM = Verbal Sequential Memory

The analysis of association between Denver II and ASPAC data (independent of auditory ability), presented a co-occurrence equal to 76.06% between normal ASPAC and normal Denver II; however, there was a co-occurrence of only 25.86% between altered

ASPAC and Denver II risk. Applying the *Pearson's Chi-square* test, there was no association between the normal /at risk scores of Denver II and normal / altered of ASPAC, for p value equal to 0.06, with odds ratio equal to 1.11 (Table 3).

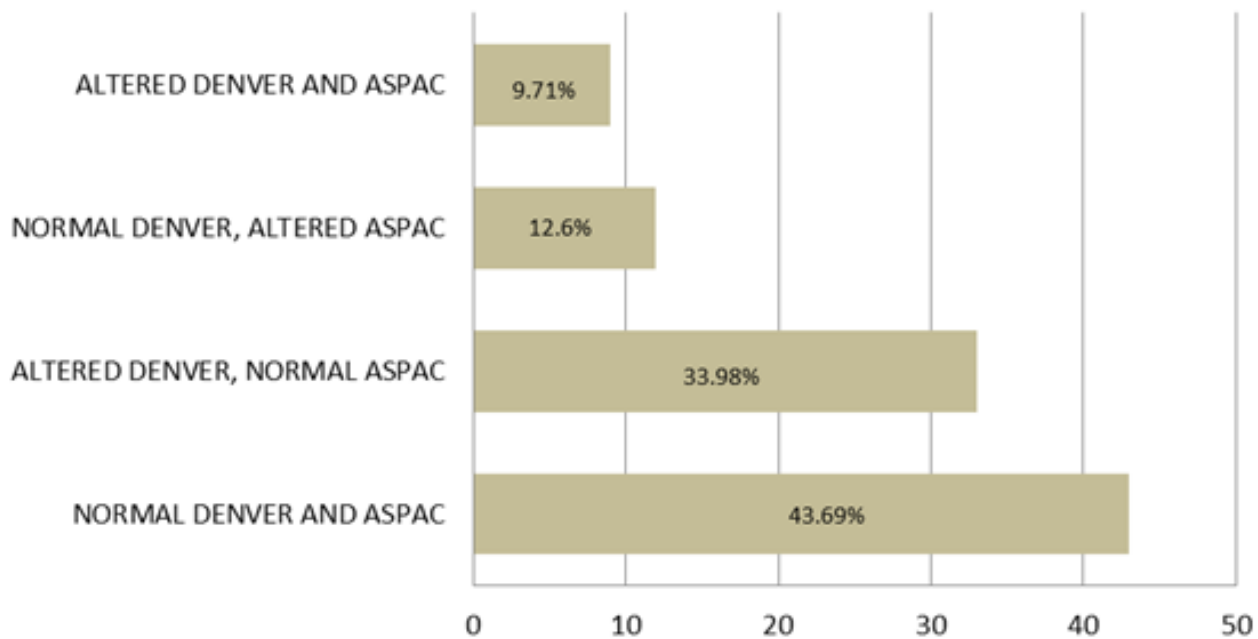
Table 3. Percentage of co-occurrence of the Denver II outcome and simplified screening of central auditory processing (n=129)

	<i>Denver II Normal</i>	<i>Denver II at Risk</i>	Total
Normal ASPAC	54 (76.06%)	17 (23.94%)	71 (100%)
Altered ASPAC	43 (74.14%)	15 (25.86%)	58 (100%)
Total	96 (100%)	32 (100%)	129 (100%)

Legend: ASPAC = Simplified screening of central auditory processing

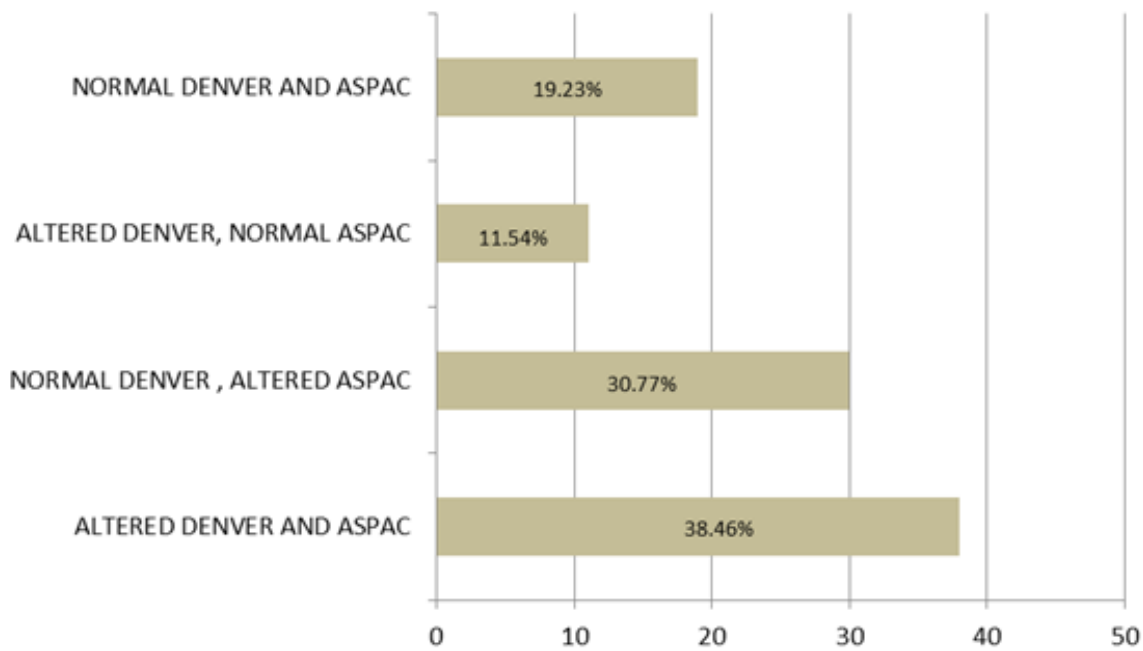
For SAB scale analyzes, it was necessary to determine a cutoff point of normality for children in this age group, based on the average SAB values (44.98 ± 11.84) in children who presented normality in central auditory processing screening and normality in the neuropsychomotor development. Therefore, average SAB values above 33 were considered for determination of adequate behavior. Values below 33 were considered as inappropriate behavior.

Thus, of the 129 children, 103 (79.84%) presented adequate behavior in SAB; while 26 (20.15%), were classified as inadequate. In Charts 1 and 2, the percentage distributions of the Denver II and ASPAC results of subjects with normal and altered SAB can be visualized, with 90.29% of subjects presenting normal SAB in at least one of the two tests (ASPAC or Denver II); while in the altered SAB group, 61.54% of the subjects presented at least one alteration in one of the tests (Figures 1 and 2).



Legend: ASPAC = Simplified screening of central auditory processing

Figure 1. Percentage distribution of subjects with normal Scale of Auditory Behaviors regarding the Denver II results and simplified auditory processing screening (n = 103).



Legend: ASPAC = Simplified screening of central auditory processing

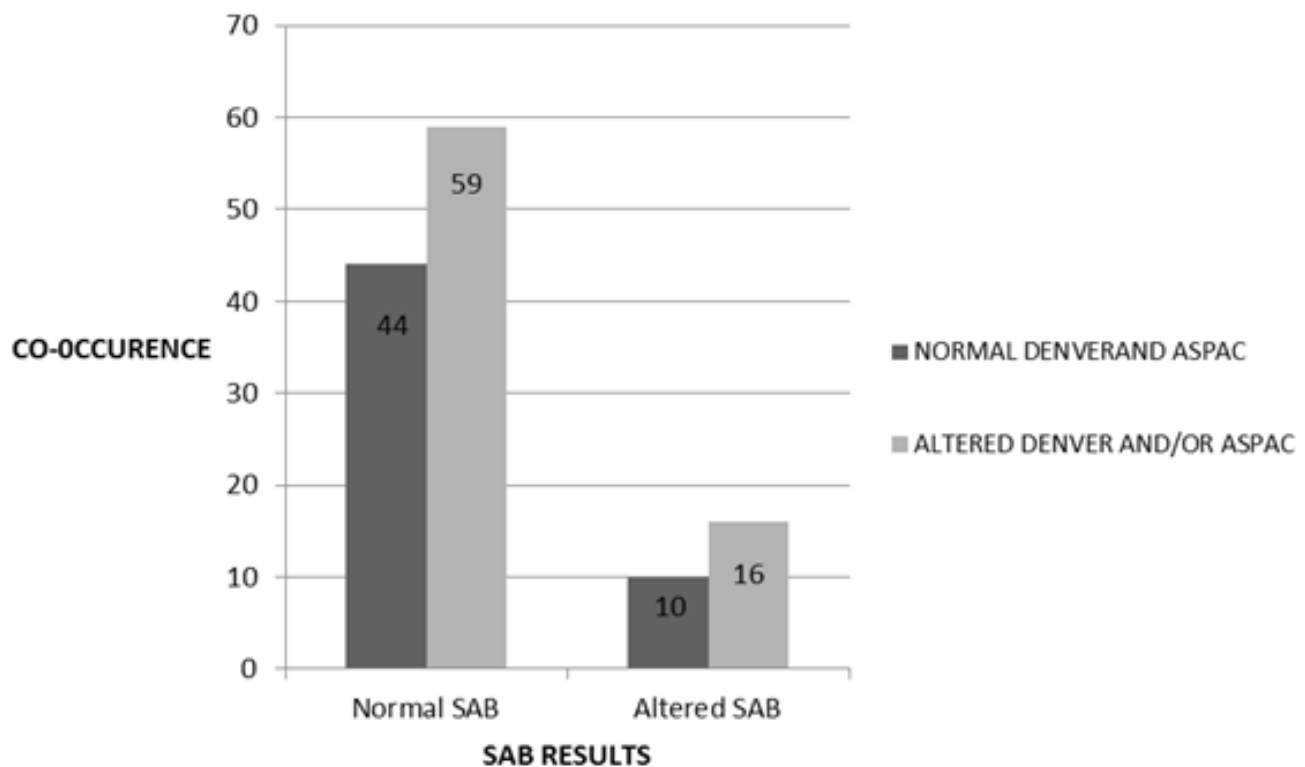
Figure 2. Percentage distribution of subjects with altered Scale of Auditory Behaviors for Denver II results and simplified auditory processing screening (n = 26)

Applying the Pearson Chi-square test, there was no relationship between the SAB results (normal / altered) and the Denver II and / or ASPAC (normal / altered) results, with p value equal to 0.69. Co-occurrence values of these analyzes can be visualized, with only 42.72% of association between normality in these tests (Figure 3).

In Table 4, it is possible to observe the co-occurrence between the SAB and ASPAC results in children who were approved (normal) and failed (risk) in Denver II. Approximately 20% of the sample with

normal Denver II presented alterations in the auditory processing screening; and 44.3% with normal Denver II were pointed out by educators as having inappropriate behavior in SAB.

Using the bivariate correlation test (Spearman's coefficient), no significant relationship was found between the results of the developmental screening (Denver II) with central auditory processing screening (ASPAC), p value = 0.804, and screening of the development with the educators' perception (SAB scale), for p value equal to 0,435.



Legend: ASPAC = Simplified screening of central auditory processing

Figure 3. Co-occurrence of normal / altered scores in the Scale of Auditory Behaviors (SAB) and normal / altered in Denver II and / or simplified screening of central auditory processing (N = 129)

Table 4. Co-occurrence of Scale of Auditory Behaviors and the simplified screening of central auditory processing in children with normal (n = 97) and at risk Denver II (n=32)

Denver II	SAB		ASPAC	
	Normal	Altered	Adequate	Inadequate
Normal	54 (55.7%)	43 (44.3%)	79 (81.4%)	18 (18.6%)
At risk	17 (53.1%)	15 (46.9%)	24 (75%)	8 (25%)

Legend: SAB = Scale of Auditory Behaviors; ASPAC = Simplified screening of central auditory processing.

DISCUSSION

The children of the present study were homogeneous regarding the age parameter and the institution of origin, with no difference of these variables between genders. This made possible a reliable analysis of the findings, since the age and the social and cultural factors in which they are inserted are variables interfering in the child development^{14,15}.

As for the Denver II test, there was a risk in 24.8% of preschoolers, with the “social personal” aspect being the indicator that presented the highest number of developmental changes. A study¹⁵ carried out with 113 children detected risks for developmental alterations in 37% of the subjects, being the language the most

affected area, followed by the personal-social aspect. In another study¹⁶, conducted with 66 children between two and three years of age, worse results were found in the language and personal-social areas, and the best findings were in the motor aspect, similar to the one found in this study.

For the ASPAC findings, due to the auditory ability assessed, a greater number of children with normal responses were found in SL tests (83.72%), followed by VSM (65.89%) and NVSM (53, 49%), in line with results of previous researches¹⁷⁻¹⁹. These studies did not consider the distribution of ASPAC findings by groups of subjects with normal / at risk Denver II, and it was not verified in the literature consulted.

The low success rate in the VSM and NVSM evidences the short-term memory difficulty in pre-school students participating in the research. Such memory is very important for reading and writing, since the read content must be kept in the short-term memory, so that, meanings can be accessed²⁰. Individuals with complaints of school difficulties usually present worse performance in auditory processing tests due to the delay in the maturation of auditory abilities, since such skills are fundamental for the learning process of reading and writing²¹. Thus, as temporal ordering skills have proved to be inadequate in most day care centers, it is important for health promotion programs to be developed in these environments, thus, avoiding further changes in the educational process.

Another aspect observed was the association of the presence of changes in ASPAC and presence of risk in the Denver II test in 25.86% of the children screened. Developmental changes may be associated with auditory processing disorder, resulting in impairment for school children regarding communication in noisy environments, understanding jokes and anecdotes, reduced attention, difficulty in understanding those who read with difficulty in expressive language, and in the production of certain speech sounds, in addition to low school performance, while presenting a normal intelligence level²².

However, it was possible to see that when sharing the use of ASPAC as a screening method, 23.94% of the subjects would not be detected in a developmental neuropsychomotor alterations screening (evaluated through the Denver II test). As there is no normal SAB cutoff point for children aged between three and six years old, it was determined, in the present study, that average values of SAB above 33 were considered as determining appropriate behavior; and below this value, as inappropriate behavior. Similar values were observed in another study⁸, which determined a cutoff point of 46 as a normal value and, below 46, as risky for APD in children between 10 and 13 years and 11 months old. In the following year, the same authors established a value of 30 for adequate behavior and, below 30, as inappropriate for children of seven years, 11 months and 29 days old²³.

In the present study, it was verified that with the application of only the SAB scale with the educators, 57.28% of the children with alterations in Denver II or ASPAC were not identified. Thus, only the teacher's view was insufficient to identify developmental

alterations and auditory processing, and there is a need for other instruments to complement the screening.

A study carried out with 51 children, between the ages of 10 and 13 years and 11 months old, found a correlation between the SAB Scale score and the results obtained in the behavioral auditory processing tests in Portuguese children, suggesting the use of this questionnaire in the screening of auditory processing²⁴.

The Denver II test, which is a screening test widely used for monitoring childhood development and frequently used to screen its deviations, was used to accelerate early intervention and facilitate the future development of these children²⁵. It was observed that with the exclusive use of Denver II, approximately 20% of the children would not be detected in the auditory processing alterations and 44.3% of the children with normal Denver II were pointed out by the educators, with inadequate behavior in the SAB, demonstrating that only the use of Denver II was not sufficient to detect changes in auditory processing.

Therefore, regarding these findings, screening for child development should be performed using Denver II, ASPAC and the SAB Scale tests together, since there is no significant association between the results found through these three screening instruments, and thus, in isolation, are not sufficient to screen for changes in child development with adequate sensitivity.

It is therefore suggested that the Denver II be first applied, and for children who failed and those who were approved, the ASPAC and the SAB be applied later. Since most of the subjects who failed in Denver II also presented altered ASPAC, a large number of children who passed through Denver II also failed in SAB.

CONCLUSION

The combination of Denver II procedures, auditory localization and sound localization tests, and the SAB Scale is useful in characterizing child development. These three instruments are, therefore, recommended as the most sensitive procedures for screening child development.

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