# Auditory-Perceptual Characteristics of the Voice of Nondysphonic School Children From 8:0 to 10:0 Years Old

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**Summary: Objective.** Describe and correlate the auditory-perceptual characteristics of the voice of nondysphonic school children from private and public schools from 8:0 to 10:0 years old, female and male.
**Methods.** Cross-sectional, quantitative and retrospective study of students from schools in a small city. Auditory-perceptual evaluations of 154 nondysphonic students were analyzed. Where considered nondysphonic those presenting overall severity bellow 34 mm using Consensus Auditory-Perceptual Evaluation of Voice.
**Results.** There was significantly higher strain in girls; significant positive correlation between age and the parameters overall severity, breathiness, and strain; significant differences in the mean values of the vocal parameters, with more evident roughness and breathiness in girls and breathiness in boys; in children from 8:0 to 9:0 years, all parameters were positively correlated; in children from 9:1 to 10:0 years, all vocal parameters except roughness increased and positive correlations became stronger.
**Conclusions.** The strain was higher in girls; roughness, and breathiness were higher in girls, and breathiness was higher in boys. As age increased, all vocal parameters except roughness increased, and positive correlations became stronger.
**Key Words:** Voice−Voice quality−Child−Speech−Language and hearing sciences.

## INTRODUCTION

Children with ages from 4:0 to 11:0 years are often diagnosed with dysphonia and the highest occurrence of childhood dysphonia occurs between 7:0 and 9:0 years.[1] For the diagnosis of childhood dysphonia, it is necessary to know the vocal characteristics of dysphonic children, an area in which studies have already been published, and of nondysphonic children, for whom there are few scientific reports. Many studies report the high rate of childhood dysphonia within this age range and describe their characteristics, but this study focuses on the nondysphonic voice of children with age ranging from 8:0 to 10:0 years. The voice is the main mean by which the communication occurs, and influences the social construction of the person. Vocal changes such as functional and organofunctional dysphonies in childhood may have negative effects on the development of the child's communicative ability. Dysphonia modifies the child's vocal self-perception, impacting on the child's ability to communicate as an adult. It is needed to perform early diagnosis of childhood dysphonia, avoiding future impairments in the socialization of the individual and, in cases of functional dysphonia, the evolution to an organofunctional dysphonia.[1,2,3,4]

The auditory-perceptual evaluation of the voice is traditional in the phonoaudiological clinical setting and considered the gold standard in the definition of the degree of vocal alteration. Being an essentially subjective assessment, it depends on several factors such as the utilization of a severity scale, and the skill of the evaluator.[5] The Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) is one of the vocal auditory-perceptual evaluation protocols that allows analysis of the glottal source, the filter and of other vocal parameters such as pitch and loudness. Samples of speech and sustained vowels are collected and examined to obtain these parameters, which are defined by visual analogic scale.[6]

Only three recent studies report on the auditory perceptual characteristics of dysphonic and nondysphonic schoolchildren.[7,8,9] This work will contribute with scientific evidence to the research area of the children's voice and to the speech-language clinical setting, by describing the characteristics of nondysphonic schoolchildren to be used in the auditory-perceptual evaluation of voice in children.

The objective of this study was to describe and correlate the auditory perceptual characteristics of the voice of nondysphonic schoolchildren from 8:0 to 10:0 years old, both male and female.

## METHODS

This is a cross-sectional, analytical, quantitative and retrospective study using data from students in public or private schools in a small city, previously approved by the Research Ethics Committee of the institution of origin (23081.016945/2010-76).

All children agreed to participate in the research, and their parents signed the Informed Consent, and all schools signed the Institutional Authorization Term, which was created as recommended by Resolution 466/12 of the Brazilian National Health Council, authorizing the storage and use of the information in scientific research, as long as the identity of the participants is not disclosed.

Accepted for publication June 6, 2018.
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Journal of Voice, Vol. 33, No. 6, pp. 946.e1−946.e5
0892-1997

https://doi.org/10.1016/j.jvoice.2018.06.002

Inclusion criteria were: children 8:0−10:0 years old; complete medical history taking; complete results of vocal auditory-perceptual evaluation.

Exclusion criteria were: children from 8:0 to 10:0 years considered dysphonic by vocal auditory-perceptual evaluation; report from parents or guardians of delayed neuropsychomotor development, chronic oral breathing, psychological alterations, psychiatric, hormonal, postural, pulmonary alterations, or any syndrome; structural alterations that could compromise phonation at respiratory, phonatory, and/or articulatory levels; being in speech-language therapy for the voice at the time of data collection or having done it previously; surgery in the orofacial region and/or head and/or neck that could compromise phonation at respiratory, phonatory, and/or articulatory levels; influenza and/or respiratory allergies that could limit performance in evaluations; failed audiological screening.

A sample of 154 records (85 boys and 84 girls) was stratified in two groups divided by age, from 8:0 to 9:0 years (60 boys and 54 girls) and another from 9:1 to 10:0 years (16 boys and 24 girls).

## Data collection

In the research that provided the database the municipal, state, and private educational institutions from a small city were randomized. Schools that agreed to participate in the study signed the Institutional Authorization Term. Therefore, the parents who authorized the participation of the children signed the Informed Consent and answered the medical history interview regarding the anthropometric data, health history, the development of the child. The child was free to choose whether or not to participate in the research.

Auditory screening was performed by speech therapist in the frequencies of 0.5−4 kHz in 20 dB, by air, in a quiet environment (Res. 274/01 - Brazilian Federal Council of Speech, Language and Hearing Sciences). For the classification of dysphonic voice and non-dysphonic voice, CAPE-V was used, which is composed of a linear analogue scale of 0−100 mm, which aims to describe the severity of auditory perceptual parameters of a vocal alteration, in a way common to clinical trials. Hearing the recordings, the speech-language pathologist registered the value of each of the parameters by evaluating: roughness, breathiness, strain, pitch, loudness, resonance and overall severity of dysphonia.[6,8,10]

For data collection, in an orthostatic position, the student was instructed to emit the Maximum Phonation Time (MPT) of the vowels /a/ and /i/, after a deep inspiration, in habitual pitch and loudness.[10,11,12] Furthermore, the sample of spontaneous speech and the CAPE-V phrases adapted to Portuguese were collected[6, 8, 10]: “Érica tomou suco de pêra e amora” (The blue spot in on the key again); "Agora é hora de acabar" (We eat eggs every Easter); "Sonia sabe sambar sozinha" (How hard did he hit him); "Minha mãe namorou um anjo" (My mama makes lemon muffins); "Olha lá o avião azul" (We were away a year ago); and "Papai trouxe pipoca quente" (Peter will keep at the peak).

To record the vocal emissions a professional digital recorder Zoom model H4n was used, with audio format pulse-code modulation with 16 bit of quantization, 96-kHz sampling frequency with a Behringer ECM 8000 omnidirectional microphone with a flat band frequency range from 15 to 20 kHz, positioned in front of the child's mouth at a 90° angle, at a fixed distance of 4 cm for the MPT recording,[13] and at a fixed distance of 10 cm for the spontaneous speech and phrases.

The recording sessions took place in a room with ambient noise of less than 50 dBNPS, measured using a digital sound pressure level meter model Dec-480.[8] The collections were performed before recess and physical education classes to avoid interference from the intensive and/or abusive use of the voice.[14]

Three judges, with more than three years of experience in the area of voice, performed individually the auditory-perceptual evaluation of the children's voices. The judges were instructed on the CAPE-V scale parameters and their marking.[7,10] As the judges only knew the age group and were not informed about the sex and the exact age of the evaluated subjects, the loudness and pitch parameters were not considered. The judges were instructed to access the digital storage device (Google Drive) via internet. They downloaded the recordings and protocols to fill in. The format of the recordings was PCM; 96 kHz; 16 bits; mono. Guidance was given to the judges to analyze the samples using intra-auricular earphones, in a quiet environment, and making rest breaks between evaluations.[15]

For the statistical calculations, the arithmetic mean among the evaluations of the judges in the linear analogue scale in mm in each of the CAPE-V protocol items was considered.[7,10] All judges were blinded as to the purpose of the research and the order of reproduction of voices in CAPE-V and did not participate as authors of the work.[14] The results of the evaluations were returned to parents and/or guardians. Children who had some voice impairment were referred for specialized evaluation and treatment. In the present research, the results of perceptual voice analysis were explored using the CAPE-V already performed and stored in the database.

From the identification data and CAPE-V results, the children were classified according to sex and the dysphonic or nondysphonic voice, and the voices were classified according to their characteristics and grades (roughness, breathiness, strain, and overall severity of dysphonia). Those children who presented an overall severity greater than 34 in the millimeter ruler, moderate to severe alteration, were considered dysphonic; and those with an overall severity up to 34 mm, a mild grade, were considered with a nondysphonic voice following the literature that understands as normal a mild grade of dysphonia in childhood.[7,16]

In the statistical calculations nonparametric correlation tests were used, as most of the data did not follow a normal

distribution. The variables used in the research were converted into continuous variables and the Spearman, Mann Whitney and Kruskal Wallis Correlation tests were used to verify differences between groups. In the Spearman correlation test, the correlation coefficient 1.0 (−1.0) was considered as indicative of a positive (negative) perfect linear correlation; 0.7−0.9 (−0.7 to −0.9) strong positive (negative); 0.4−0.69 (−0.4 to −0.69) moderate positive (negative); and 0.2−0.39 (−0.2 to −0.39) weak positive (negative). The significance level adopted for all tests was 5%.

## RESULTS

Table 1 shows the results of comparing CAPE-V according to sex. Table 2 shows the correlation results according to age, in table 3 as correlations of girls and in table 4 and the results of correlations of boys and CAPE-V.

## DISCUSSION

Few studies on both nondysphonic children and the use of CAPE-V exist to compare with our study, so papers that characterized the voice of children through the GRBASI scale were chosen. In GRBASI scale an auditory-perceptual evaluation protocol classifies the voice according to the parameters: grade of dysphonia (G), roughness/hoarseness (R), breathiness (B), asthenia (A), Strain (S) and instability (I, representing fluctuation in vocal quality). The severity level ranges from zero to four for each parameter.

In a study that correlated the CAPE-V visual analogue scale and the GRBASI numerical scale, the following numerical cutoff values were found: neutral (grade zero) = 0−34 mm; mild (grade one) = 34.1−51 mm; moderate (grade two) = 51.1−63.5 mm; intense (grade three) = 63.6−77.5 mm; extreme (grade four) = above 77.5 mm.[16] In our study, considering the GRBASI scale, all the children presented neutral (grade zero) in all the parameters of the scale, and were classified by CAPE-V as nondysphonic with an overall severity of up to 34 mm,[6] in accordance with authors who consider normal a 0−34 mm of overall severity for dysphonia in childhood.[7,16]

In Table 1, a significant difference was observed only in the strain parameter for boys and girls, and girls presented a higher grade of strain. This finding disagrees with the findings of other authors[17,18,19] who consider that the vocal behavior in boys favors a greater grade of strain, since boys are more involved in physical and social activities that demand excessive vocal use. There was a greater grade of strain in girls because currently both boys and girls participate in similar social activities, as reported in another study.[8]

In Table 1, there was a significant difference between the means of the CAPE-V evaluation parameters, in both boys and girls, with greater variation in boys. The vocal characteristics most evident in girls were roughness and breathiness, and in boys was breathiness, in accordance with study[20] which states that the most vocal characteristics present in childhood are hoarseness and breathiness in a mild degree.

Regarding the grades of breathiness and roughness it is emphasized that in the child's larynx the intraritenoid muscles suffer limitations in their laryngeal adduction function in some glottic configurations. This may cause difficulty in approaching the arytenoids resulting in a posterior triangular gap. The posterior triangular gap may cause air leak during phonation[1,21] and interfere in vocal quality to some degree.

T study presented in reference [22] characterized the voice of children subjected to child labor (study group) and children who did not work (control group). Although there were no significant vocal disorders; in the control group it was observed, in the lowest degree: overall dysphonia in 7% of children, hoarseness in 8%, breathiness in 12%, and strain in 9%, out of a total of 139 children.

In Table 2, there was a significant positive correlation between age and parameters overall severity, breathiness, and strain; this did not occur with roughness. These results corroborate those from another study[23] with dysphonic children, in which the vocal characteristics observed changed over the years and, as age increased there was a greater occurrence of childhood dysphonia. These results are also in accordance with study in reference[8] which showed the increase of breathiness (96.15%) and roughness (69.23%) in children with age.

The increase in the occurrence of dysphonia or auditory-perceptual parameters within the lowest range as in our study, could be justified by the vocal demand of younger children is smaller since they are inserted in

**TABLE 1.**
**Difference Among the CAPE-V Means of Nondysphonic-children from 8:0 to 10:0 Years**

| | Boys | Girls | *P* value |
|---|---|---|---|
| **Overall severity** | 11 mm | 13 mm | 0.31 |
| **Roughness** | 10 mm | 11 mm | 0.07 |
| **Breathiness** | 11 mm | 12 mm | 0.17 |
| **Strain** | 8 mm | 10 mm | 0.00* |

* Statistically significant values ($P \leq 0.05$)−Mann-Whitney test.

**TABLE 2.**
**Correlation Between the CAPE-V Parameters of Nondysphonic Children According to Age**

| Total | Correlation | *P* value |
|---|---|---|
| Age and overall severity | 0.16 | 0.00* |
| Age and roughness | 0.12 | 0.24 |
| Age and breathiness | 0.19 | 0.00* |
| Age and strain | 0.36 | 0.00* |

* Statistically significant values ($P \leq 0.05$)−Spearman correlation test.

**TABLE 3.**
**Correlation Between the Overall Severity and the CAPE-V Parameters of Nondysphonic Girls**

| Girls | 8:0−9:0 years | | 9:1−10:0 years | |
|---|---|---|---|---|
| | Correlation | *P* value | Correlation | *P* value |
| Overall severity and roughness | 0.82 | 0.00* | 0.81 | 0.00* |
| Overall severity and breathiness | 0.43 | 0.00* | 0.72 | 0.00* |
| Overall severity and strain | 0.44 | 0.00* | n/c | n/c |
| Roughness and breathiness | 0.63 | 0.00* | 0.30 | 0.14 |
| Roughness and strain | 0.38 | 0.00* | n/c | n/c |
| Breathiness and strain | 0.43 | 0.00* | n/c | n/c |

* Statistically significant values ($P \leq 0.05$)−Spearman correlation test.
*Abbreviation*: n/c:no correlation.

**TABLE 4.**
**Correlation Between the Overall Severity and the CAPE-V Evaluation Parameters of Nondysphonic Boys**

| Boys | 8:0−9:0 years | | 9:1−10:0 years | |
|---|---|---|---|---|
| | Correlation | *P* value | Correlation | *P* value |
| Overall severity and Roughness | 0.44 | 0.00* | 0.89 | 0.00* |
| Overall severity and Breathiness | 0.41 | 0.00* | 0.25 | 0.31 |
| Overall severity and strain | 0.48 | 0.00* | 0.01 | 0.95 |
| Roughness and breathiness | 0.44 | 0.00* | 0.00 | 0.99 |
| Roughness and strain | 0.58 | 0.00* | 0.04 | 0.85 |
| Breathiness and strain | 0.37 | 0.00* | 0.84 | 0.00* |

* Statistically significant values ($P \leq 0.05$)−Spearman correlation test.

another social context, whereas older children participate more in extra-curricular activities that may require greater vocal use.[8]

In Tables 3 and 4 it is observed that in the 8:0−9:0 age group for boys and girls all the vocal parameters were positively correlated. Differently, in the 9:1−10:0 age group, this correlation did not occur with all parameters. In addition, as the age increased the positive correlations among the parameters evaluated by CAPE-V became stronger. In our study, as the individual grows the voice changes due to development in the physical, psychological, and social spheres. The maturation and the experience of the children influence the characteristics of their voices.[21]

Vocal changes in the evaluated subjects may be influenced by their prepuberty age. They are on the onset of the hormonal influence. Puberty usually occurs within the 10:0−14:0 age range for girls or 12:0−16:0 for boys, but it can occur earlier.[24]

There have been few recent studies whose results characterize the voice of children according to sex, making it difficult to discuss our study. Another limitation refers to the size of the sample that prevents the generalization of our results to the children population within the 8:0−10:0 age range. This points out the need for further research on the subject.

## FINAL CONSIDERATIONS

The vocal strain was higher in girls than in boys; the roughness and the breathiness were more evident in girls, and the breathiness in boys. As age increased, all vocal parameters except roughness, increased and positive correlations became stronger.

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