

The Relationship Between Articulation Disorders and Auditory Discrimination in First Grade Primary School Children

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Abstract

Children who have difficulty recognizing and distinguishing phonemes often struggle with imprecise articulation of sounds, leading to incorrect pronunciation of words and impaired verbal communication. These children generally score lower on phonemic perception tests, suggesting that articulation disorders may be associated with underdeveloped auditory abilities. The aim of this research was to examine the relationship between articulation disorders and auditory discrimination difficulties in first-grade elementary school children. The study included 150 first-grade students of both genders ($M = 6.42$ years, $SD = 0.47$) from the “Dositej Obradović” Elementary School in Banja Luka, conducted during May and June 2023. Data were collected using a Screening Articulation Test and a Phoneme Discrimination Test. Articulation disorders were observed in 34% of participants, while 28.7% had difficulties with auditory discrimination of phonemes. The analysis showed a strong positive correlation between these two disorders. No gender differences were observed in auditory discrimination among children with articulation disorders. Articulation disorders in first-grade children are often associated with deficits in auditory discrimination. Early diagnosis and assessment of these abilities are important for preventing further speech and language issues. An integrated assessment should be an essential part of speech-language diagnostics during this developmental period.

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Introduction

Articulation disorders are the most common speech disorders both in our country and worldwide. Recent research results show an expansion, that is, a significant increase in articulation disorders among the child population, with reported prevalence rates of 20–40%, meaning that every third child starts school with some form of articulation disorder (Čolić et al., 2024; Čalasan, Dragičević, Dobrota, 2015; Grigorova et al., 2020; Madžar-Čančar, Čalasan, Vuković, 2024; Tasić et al., 2019; Umićević & Ljubić, 2015). Research findings also indicate a somewhat lower, yet still relatively high, percentage of articulation disorders in children of early school age compared to preschool age. This is a consequence of untimely elimination and lack of treatment of pathological speech sound patterns before starting school. Phonemic hearing has a direct impact on articulation as it enables the acquisition of phonological patterns specific to the native language. Children first develop the ability for auditory discrimination of phonemes, and then gradually integrate them into their own speech production (Boets et al., 2013). Insufficiently developed phonemic hearing can lead to articulation disorders because the child cannot adequately distinguish and produce certain sounds (Tsao, Liu, & Kuhl, 2004).

Early stimulation of phonemic hearing can significantly improve speech production and articulation in children, with phonological games, rhymes, singing, and word repetition proven to contribute to the development of phonemic discrimination and sound perception (Lonigan et al., 2009). Both acoustic impressions and articulatory movements are equally important for speech comprehension and production, and through careful selection of acoustic elements and articulation parameters, language is formed as the primary means of communication. Harmonious development of speech and language, in addition to preserved hearing in terms of auditory perception, implies the development of phonemic discrimination, which enables the differentiation of acoustically similar sounds (Boets et al., 2013). Unlike auditory perception, the fundamental characteristic of phonemic discrimination is its functional linguistic nature and it requires more specific auditory acuity, making it a more demanding process than auditory discrimination (Kuhl, 2021). The ability of phonemic discrimination enables the creation of an auditory representation of a phoneme as an abstract linguistic symbol, which is concretely realized as a sound, and its differentiation. These processes allow for the sharpening of sound perception, which guides the articulation process (Bjelić et al., 2024). Research has shown that auditory discrimination of sounds plays a key role in early language development and later reading and writing skills (Ziegler & Goswami, 2005). The connection between articulation disorders and auditory discrimination represents an important aspect of speech development. Auditory discrimination of phonemes is the ability to distinguish phonetically similar sounds, which is crucial for the development of precise articulation as well as for reading and writing (Anthony et al., 2011). Children with difficulties in recognizing and distinguishing phonemes often have problems with precise articulation of sounds, which can lead to incorrect word pronunciation and impaired communication. These children usually show lower scores on phonemic perception tests, suggesting that their articulation problems may result from less developed auditory abilities. Considering this, the primary aim of our research was to examine the relationship between articulation disorders and auditory phoneme discrimination disorders in younger school-age children.

Methodology

Participants

The total sample consisted of 150 first-grade primary school students, both male and female. The sample included 75 (50%) male and 75 (50%) female participants.

Location and time of research

The research was conducted during May and June 2023. The sample included children attending the first grade at the “Dositej Obradović” Primary School in Banja Luka. The study was carried out after obtaining written consent from the Ministry of Education and Culture of the Republic of Srpska, as well as verbal consent from the school administration. Parental consent was also requested and obtained for each child involved in the research. The researcher guaranteed the anonymity of the children involved.

Research Instruments

Two instruments were used for this research: the Triaging Articulation Test (Kostić & Vladislavljević, 1983) and the Phoneme Discrimination Test (Vladislavljević, 1983).

The Triaging Articulation Test examines the status of speech sounds at all ages. It is based on auditory stimulation and immediate repetition of individual words containing the target sounds. The test consists of 30 words, each containing the sound being observed and evaluated. The observed sound is represented by a corresponding letter placed before the word. Besides the column with words, the test includes four more columns. The first column, marked (+), is for correctly produced sounds. The second column, marked ($\pm$), is for sounds with barely noticeable deviations, i.e., distorted sounds or sounds closest to the correct pronunciation of a particular sound. The third column, marked (-), is for sounds that are substituted (replaced by another sound) or omitted (sound is missing). The examiner is a speech therapist, and the testing is conducted individually. After testing, the marks from columns (+), ($\pm$), and (-) are summed for each participant on an individual form. This allows assessment of how many sounds are correctly pronounced and how many are incorrect, distorted, substituted, or omitted, providing a precise insight into the child's pronunciation of all sounds in the native language. The Phoneme Discrimination Test assesses the status of phonemic hearing. The test consists of 40 pairs of words, accompanied by the same number of pictures, totaling 80 words and 80 pictures. Each pair of words is identical in every respect except for one phoneme. They are matched for accent, number of sounds and syllables, and the order of identical phonemes. The only difference in the phonological-suprasegmental structure between the word pairs is the phoneme that serves as the differential feature distinguishing one word's meaning from the other's (e.g., supa – šupa; prst – krst; maca – meca). The test is administered by presenting two pictures from a pair to the participant, naming one of them, and then asking the participant to point to the corresponding picture. This procedure is repeated for all picture and word pairs. The order of naming pictures should vary, sometimes starting with the first and sometimes with the second picture. Each correct answer is scored (+), each hesitant answer plus-minus ($\pm$), and each incorrect answer (-). Hesitant and incorrect answers indicate phonemes with low discriminability and should be targeted in auditory training exercises. At the end, the total number of correct answers is calculated relative to the number of requests.

Statistical Data Analysis

Statistical analysis was conducted using the IBM SPSS Statistics software package, version 26.

Spearman's rank correlation coefficient was used to assess the relationship between articulation disorders and difficulties in auditory phoneme discrimination, while the χ^2 test of independence was used to analyze differences in the presence of auditory discrimination difficulties between boys and girls with articulation disorders. Statistically significant results were interpreted at a significance level of $p < 0.05$.

Results

The research sample included 150 participants, first-grade primary school students, both male and female ($M = 6.42$ years, $SD = 0.47$). Table 1 presents the gender structure of the sample, i.e., the distribution of participants by gender. From the table, it can be seen that the gender structure of the sample is balanced, consisting of 75 boys (50%) and 75 girls (50%).

Table 1. *Distribution of participants by gender*

<i>Gender</i>	<i>N</i>	<i>%</i>
Boys	75	50%
Girls	75	50%
Total	150	100%

Table 2 shows the prevalence of articulation disorders among the participants, divided by gender. It can be observed that out of 75 boys, 25 (38.70%) have an articulation disorder, while 50 (61.30%) do not. Regarding girls, out of 75 girls, 26 (20.69%) have an articulation disorder, while 49 (79.31%) do not. When looking at articulation disorders across the entire sample, Table 2 shows that 51 children (34%) have an articulation disorder, and 99 children (66%) do not. The data indicate that articulation disorders are more frequent in boys than in girls.

Table 2. *Prevalence of articulation disorders among boys and girls and in the total sample*

	Articulation disorder		Total
	Articulation disorder	No disorder	
Boys	25 (38.70%)	50 (61.30%)	75 (100%)
Girs	26 (20.69%)	49 (79.31%)	75 (100%)
Total	51 (34%)	99 (66%)	150 (100%)

Figure 1 shows the distribution analysis of auditory discrimination disorders across the entire sample. From the figure, it can be observed that out of a total of 150 participants, 43 children (28.7%) have difficulties with auditory phoneme discrimination, while 107 children (71.3%) do not exhibit the disorder. These findings indicate that auditory phoneme discrimination disorder occurs in approximately one out of every four children in the examined sample.

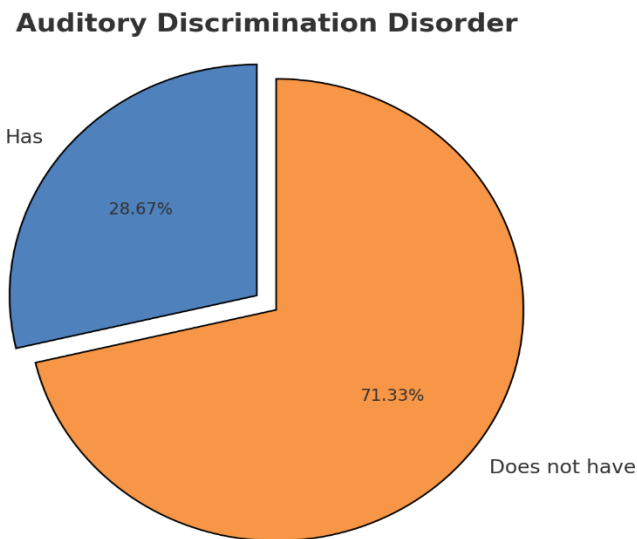


Figure 1. Distribution Analysis of Auditory Discrimination Disorder in the Entire Sample

Figure 2 shows the distribution of boys and girls in relation to the presence or absence of auditory phoneme discrimination disorder. A total of 150 children were examined, evenly distributed by gender (75 boys and 75 girls). Among the 43 children with auditory discrimination disorder, 21 were boys and 22 were girls. Among the 107 children without the disorder, 54 were boys and 53 were girls. The graph illustrates that boys and girls are almost evenly represented in both categories, with no significant differences in the prevalence of auditory discrimination disorder based on gender.

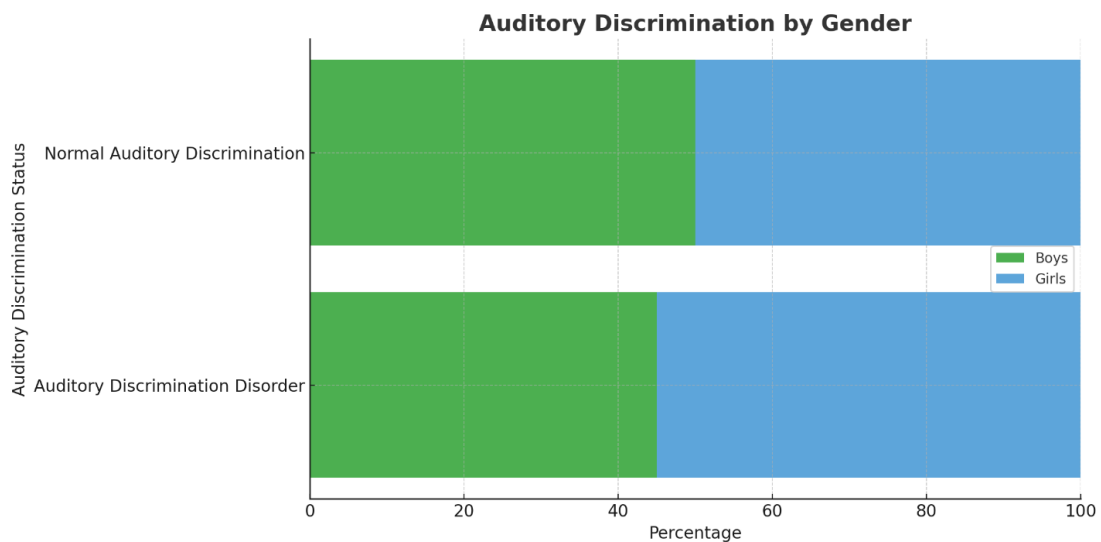


Figure 2. Distribution of Boys and Girls in Relation to the Presence or Absence of Auditory Phoneme Discrimination Disorder

The aim of our research was to examine whether children exhibiting articulation disorders also have phonemic hearing disorders, i.e., difficulties in auditory phoneme discrimination. To analyze the association between these two variables, Spearman's rank correlation coefficient was used, given that these are ordinal variables and the assumptions for parametric tests were not met.

There was an exceptionally strong positive correlation between articulation disorders and phonemic hearing disorders (Spearman's $\rho = 0.883$, $p < 0.01$). These results mean that children with more pronounced articulation disorders tend to have more significant difficulties in auditory phoneme discrimination.

Discussion

Our results showed that 34% of children of early school age have articulation disorders, which is consistent with the findings of numerous studies on the prevalence of articulation disorders (Čolić et al., 2024; Čalasan, Dragičević, Dobrota, 2015; Grigorova, Ristovska, Jordanova, 2020; Madžar-Čančar, Čalasan, Vuković, 2024). Also, regarding gender differences, our study results indicate that articulation disorders are more common in boys (38.7%) than in girls (20.7%). In the theoretical framework of speech-language development, it is often noted that girls, on average, develop language skills earlier and faster than boys. Our findings align with other studies reporting gender differences in the prevalence of articulation disorders, favoring females (Grigorova, Ristovska, Jordanova, 2020; Maldini, 2017; Vuković & Ilić, 2003). Analysis of the distribution of auditory discrimination disorders across the entire sample showed that 28.7% of children have difficulties in phoneme auditory discrimination, while 71.3% do not. Our findings indicate that phoneme auditory discrimination disorder occurs in about one in four children in our sample, with no significant gender differences. Other research also points to the presence of this disorder in early school-age children (Vuković, Ilić, 2003; Kantić, Banović, Smajlović, Radić, 2015; Kantić & Alić, 2020). Research on phonemic hearing in children with normal hearing is very rare, but there are studies examining phonological processes in children with hearing impairments. One such study examined phonological processes in early school-age children with mild to severe hearing loss who use hearing aids and cochlear implants, compared to their peers with normal hearing (Asad, Purdy, Ballard, Fairgray, Bowen, 2018). Results showed that developmental phonological disorders were not present in the speech of children with normal hearing, while children with hearing loss showed persistent disorders, indicating a slower development of phonological skills in this population. Although this study focused on children with hearing loss, its findings indirectly confirm that children with normal hearing, like those in our research, achieve relatively high scores on phonemic hearing tests, without significant gender differences. These data may serve as a reference point for further research and practice in the area of speech and hearing development in children. In research aimed at determining the prevalence of auditory processing disorders in children in lower elementary grades, a percentage of 5.7% of children with this disorder is reported (Kantić & Alić, 2020), while some international studies report 5-7% of children with auditory processing deficits (Bamiou, Musiek, Luxon, 2001; Jerger & Musiek, 2000). Differences in prevalence of auditory discrimination disorders across studies may be related to the testing methods and the specific characteristics of the children involved. It is also possible that these disorders often remain undiagnosed, especially when different assessment methods are used. Comparing our results with similar studies, it can be concluded that there is considerable variability in the prevalence of articulation and auditory disorders, which may result from different

methodological approaches, age characteristics of samples, and cultural factors. The results highlight the need for further research in this area, as well as the importance of early detection and treatment to reduce the impact of these disorders on speech and language development in preschool and early school-age children. The primary goal of our study was to examine whether children exhibiting articulation disorders also have phonemic hearing impairments, i.e., difficulties in phoneme auditory discrimination. Analysis of the relationship between articulation disorders and auditory discrimination deficits shows a very strong positive correlation between these two disorders. The results mean that children with more pronounced articulation disorders also have greater difficulties in phoneme auditory discrimination. Other studies also indicate that children with articulation disorders have poorer phoneme auditory discrimination abilities compared to children without articulation disorders, reflected in their lower scores on auditory discrimination tests (Bjelić, Isaković, Veletić, Kordić, 2024; Blaži, Vancaš, Prizl-Jakovac, 2000). In the study by Blaži and colleagues (2000), the sample included children aged five to seven, both genders. Data analysis showed significant differences in phonemic discrimination abilities between children with articulation disorders and those with typical speech-language development. Children with articulation disorders scored significantly lower on phonemic discrimination tasks. Our results contribute to understanding the connection between auditory discrimination and articulation disorders but also indicate the need for further research. Since auditory perception is crucial for the development of precise articulation, it would be useful to investigate whether improving auditory discrimination abilities could positively affect the reduction of substitutions and distortions in the speech of children with articulation disorders. Additionally, it is necessary to analyze whether certain types of auditory training can lead to more precise perception of sounds and consequently their correct pronunciation. The research confirms that auditory discrimination disorders have a direct impact on the type and frequency of articulation disorders in early school-age children. The dominance of substitutions and distortions, with the absence of omissions in our results, suggests that children perceive and attempt to articulate all sounds but make certain errors due to imprecise phoneme processing. Our findings have important practical implications, pointing to the importance of early diagnosis and targeted speech therapy that would combine the development of phoneme auditory discrimination and correction of incorrect articulation patterns. Further research in this area could provide additional insights into how different types of auditory and language interventions can help children with these disorders overcome existing difficulties in auditory discrimination and speech sound production.

Conclusion

Articulation disorders in children in the first grade of elementary school are often associated with deficits in auditory discrimination. Early identification and assessment of these abilities can help prevent further difficulties in speech and language development. Integrated assessment of speech-language and auditory abilities should be an essential part of speech therapy diagnostics during this developmental period.

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