

Orofacial Praxis Abilities in Children with Speech Disorders

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Abstract

Introduction Phonological development occurs in a gradual manner until the age of 7 years. The phonological system is constructed in a similar way for all children, despite presenting some variations in terms of age, paths taken, or repair strategies used.

Objective To compare the orofacial praxis abilities of children with typical phonological development (DFT), children with phonetic-phonological impairment (DFoFe), and children with phonological impairment (DF), using two tests to assess the orofacial praxis abilities.

Methods The sample consisted of 82 subjects between 4 and 8 years of age who attended public schools (from preschool to the second year of secondary school) in the city of Santa Maria, Brazil. Of these, 29 were diagnosed with DFT, 29 with DF, and 24 with DFoFe; much of this sample was male. Two tests of praxis abilities and assessment of the stomatognathic system were administered. Statistical analysis was performed using the chi-square test, with a significance level of 5%.

Results Generally children with DFoFe underperformed in tests of praxis when compared with subjects with DF and DFT.

Conclusion The results showed that children with DFoFe have more difficulty in orofacial praxis abilities than subjects in the other groups studied. This result could be expected, because subjects with DFoFe show changes in both phonetic and phonological levels of speech.

Keywords

- ▶ speech
- ▶ child
- ▶ articulation disorder
- ▶ stomatognathic system
- ▶ speech disorders

Introduction

Children are exposed to their mother tongue from the time they are born through external stimuli, such as the parents' conversations and songs they hear, among others. By hearing the language, children construct their phonological system, in which some rules and patterns must be followed so to reach the typical pattern of language acquisition.¹

The phonological system is constructed in a similar way for all children, despite presenting some variations in terms of age, paths taken, or repair strategies used. During this devel-

opment, each child improves the articulatory movements so that around 6 years of age, speech is intelligible to people living outside his or her home environment.²

The phonological development occurs in a gradual manner until the age of 7. In the first year of a child's life, the phonological system is prelinguistic and is characterized by vocalization sounds present or not in the adult target language.³ The phonetic acquisition also happens gradually and quickly, completing at around 5 or 6 years old, at which time the child reaches maturity and has full articulation of the phonetic inventory.⁴

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During the development of speech, the child may have some impairments from the typical acquisition, such as phonological impairment (DF), which is defined as a difficulty speaking and is characterized by inappropriate use of sounds, which may involve errors in production, perception, or organization of these sounds.⁵ Although the cause of DF is the subject of many studies, it is not yet fully defined.⁶

Phonetic impairment (DFe) is characterized by a motor and sensory incompetency for the production of speech sounds or by a disorder in the anatomical mechanism of speech production.³ DFe is related to a difficulty in functionality and directly linked to the motor aspect of the execution of the speech sounds.⁷

In some children, these two changes can be combined, resulting in phonetic-phonological impairment (DFoFe), in which both aspects (motor and organizational) are changed.

For proper speech production, it is necessary for the vocal tract to present a minimal development of its structure and its motor abilities. Thus, a prior coordination of the phonological articulatory organs is crucial, so that there is a precise articulatory control by means of the movement of the orofacial structures in implementing the stomatognathic functions.^{8,9}

Early in development, motor control of speech is not fully established. The movements of the lips, tongue, and jaw are altered, enabling the child to achieve higher levels of precision and articulatory coordination. When this refinement does not occur, the output of speech becomes compromised.¹⁰

Orofacial praxis is defined as an ability to perform skilled movements of speech and of the muscles of the phonological articulatory organs after verbal command or demonstration.¹¹ The acquisition of the praxis occurs progressively along with the development of speech and is considered a functional learning and a result of interaction with actual speech production.⁷ The development of these motor abilities starts around 2 years of age, and by 12 years, children should present a complete development of these skills and should already be able to perform fine, efficient, and coordinated movements.¹²

A study performed in children with typical phonological development (DFT) and with DF assessed the praxis skills by means of two tests of praxis¹³: the Orofacial Praxis Test¹² and Protocol of assessment of the Articulatory and Bucco-facial Praxis.¹⁴ The results showed that with increasing age there was an improvement in the performance of tasks of praxis. Still, when the praxis tasks were performed after imitation, the results were better than after verbal request.¹³ The author observed that children with DF have more changes of orofacial, speech, and buccofacial praxis compared with children with DFT.¹³

Another study also observed that children with DF have more difficulty in moving the articulators during tests of praxis when compared with children without phonological deficit.¹⁵ Another study observed that the inclusion of the work with orofacial praxis abilities (activities drawn from tests of praxis in question) favors the improvement in changes in the speech of children with DF, suggesting that the levels may be related.⁹

Although this is a topic of great relevance for speech therapy clinical practice, there is a great lack of studies involving the speech-language pathology (DF, DFe, and DFoFe) associated with motor skills of speech sounds, among them, the orofacial praxis abilities. It is clear that there are not many studies in this area and that a lack of protocols and standardized scales exists in Brazil to assess orofacial praxis abilities, which necessitate further studies with these protocols and even creating others.

Thus, the aim of this study is to compare the orofacial praxis abilities in children with DFT, children with DF, and children with DFoFe. This comparison was performed by administering two tests of orofacial praxis abilities. These have not yet been validated for the Brazilian population; however, they are most often used in research in Brazil.

Methods

This research is part of a project duly registered and approved by the Research Ethics Committee of an Institution of Higher Education, on number 0093.0.243.000-9. All caretakers signed the informed consent form, as did those responsible for the participating schools.

The sample consisted of 82 subjects of municipal public schools, 18 girls and 66 boys with ages ranging from 4 to 8 years. The subjects attended grades from preschool to the second year of the elementary schools on the outskirts of the city of Santa Maria, Brazil. The participants were divided into three different groups: DFT consisting of 29 children; DF, with 29; and DFoFe, with 24.

For diagnosis, children were administered the Phonological Assessment of the Child¹⁶ and the articulatory exam, an assessment developed in an Institution of Higher Education, which includes all the phonemes of the Portuguese language in all positions. This test assesses the repetition, as well as stimulability to a particular sound. Subjects with DFT showed no change in speech, both in the phonetic as well as the phonological levels. Children of the DF group showed alterations only in the phonological level, and finally, DFoFe subjects had changes in both phonetic and phonological levels.

The criteria for inclusion of subjects in the study were:

- permission of parents or guardians by signing the consent form and the verbal agreement of the child to participate in the research
- hearing screening with no special peculiarities
- absence in the history of neurologic problems and psychological and/or cognitive changes (children underwent a detailed and complete anamnesis, and when any data were suggestive of alteration, the child was excluded from the sample)
- understanding spoken language appropriate to the age group, which was observed by means of an informal conversation in which there was consistency and organization of the child to tell a story and whether the vocabulary used was appropriate for age and education of the child

- adequate expressive language ability (except for phonological changes in the DF group and phonetic-phonological for the DFoFe group)
- no changes in the phonological development or articulatory production of speech sounds introduced in the DFT group

Children were excluded if they had a history of neurologic, psychological, and/or emotional changes, as well as agitated behavior and/or difficulty concentrating, evidenced during speech screening; previous history of hearing complaints and/or hearing screening suggestive of alteration; alterations evident in aspects of language other than the phonological; or previous speech therapy. The linguistic aspects were assessed in an informal conversation, in which the consistency and organization of the child to tell a story were assessed as well as whether the vocabulary used was appropriate for age and education of the child.

The following procedures were performed to collect data: speech anamnesis with parents/guardians; speech screening; hearing screening with Interacoustics AD-229 portable audiometer (Interacoustics, Assens, Denmark) in the frequencies of 500, 1,000, 2,000, and 4,000 Hz. Children with consistent responses in the frequencies tested at the level of 20 dB passed to the next step, and those with suspected hearing loss were referred for ear, nose, and throat examination and audiology; implementation of Phonological Assessment of Child¹⁶; assessment of the stomatognathic system; and two orofacial praxis ability tests: the Orofacial Praxis Test¹² and Protocol of assessment of the Articulatory and Bucco-facial Praxis.¹⁴

The Orofacial Praxis Test is independent from the language for its application and was standardized with Italian children aged 4 to 8 years.¹² The test assesses difficulties in performing movements and movement sequences using the orofacial muscles and makes the distinction between the type of gesture and type of verbal command. The test consists of 36 tasks, divided into 12 voiced and orofacial praxis and 6 motion sequences and parallel movements. The other instrument used for the assessment of the praxis was the Protocol of assessment of the Articulatory and Bucco-facial Praxis.¹⁴ This test aims to assess articulatory gestures, consisting of 24 buccofacial movements divided into six movements of lips, six of tongue, six of the face, and six articulatory movements.

The applications of both orofacial praxis testing and assessment of the stomatognathic system were conducted in an assessment session and lasted about an hour. The implementation sites were provided by the schools and were either a classroom or the library. The space provided by the school was quiet, and each child was assessed individually by the examiner to avoid embarrassment for the child.

The results were analyzed by comparing the praxis abilities of children with DFT, children with DFoFe, and children with DF from the two tests applied.

Statistical analysis was performed using descriptive statistics, using the frequency and percentages. The objective was to compare the groups regarding the variable

“praxis,” using the chi-square test and, when statistical significance was found, using the adjusted residues analysis. The level of significance considered was of 5% ($p < 0.05$).

Results

► **Tables 1, 2, 3 and 4** present only the statistically significant results obtained. The first analyses refer to orofacial praxis and the voiced praxis of the Orofacial Praxis Test for the DFoFe, DF, and DFT groups.¹² Significant results were not found for orofacial praxis in items “Cow noise,” “Sheep sound,” “Coughing,” “Tongue clicking,” “Buzz zzz,” “Whistling,” “Throwing a kiss.” Also, the groups satisfactorily performed the movements of the variables “Showing the tongue” and “Smiling,” and the variables “Blowing,” “Filling the cheeks,” “Biting the tongue,” “Breathing through the nose,” “Raising an eyebrow,” and “Blinking” did not show significant results.

Using adjusted residues analysis, all the voiced praxis variables were associated with the group with DF, showing that these subjects have the ability to perform these praxes (► **Table 1**). Also, associations were observed among the nonperformance of the motion “To say ‘ah’ with the mouth open” and “To blow a raspberry” for the DTF group and the performance of the motion “To blow a raspberry” for the DFoFe group.

► **Table 2** presents the motions sequences and the parallel motions of the Orofacial Praxis Test of the DFoFe, DF, and DFT groups, and all the subjects satisfactorily performed the sequence “Opening and closing the mouth” and the parallel movements.¹² The results showed no statistically significant difference for the sequence of movements in the variables “Sticking the tongue and closing the mouth” and “Filling the cheeks and releasing by the nose” and for the parallel movements “Closing the eyes and opening the mouth” and “Biting the tongue and closing the mouth, saying ‘ah.’”

Thus, significant results were found for the sequences of movements “Showing the teeth, opening the mouth and closing the eyes,” “Blowing, biting the lower lip and filling the cheeks,” and “Sticking the tongue, touching the cheek with the tooth and throwing a kiss.” There were significant results in the parallel movements of variables “Closing the teeth and raising the eyebrow,” “Opening the mouth, protruding the tongue and saying ‘ah,’” and “Closing the eyes, closing the mouth and breathing by the nose.”

The Adjusted Residues Analysis results show that there was an association for the performance of the movement in the DF group in the variable “Opening the mouth, protruding the tongue and saying ‘ah,’” and in the DFT group for the variable “Closing the eyes, closing the mouth and breathing by the nose” (► **Table 2**). Also, there was an association with the nonperformance of the movement in the DFoFe group in the variables “Closing the teeth and raising the eyebrow,” “Opening the mouth, protruding the tongue and saying ‘ah,’” “Closing the eyes, closing the mouth and breathing by the nose.” This shows that the children of the DFoFe group showed more difficulties in performing the praxis abilities.

Table 1 Voiced praxis and orofacial praxis in the Orofacial Praxis Test¹¹ in DFoFe, DF, and DFT groups

Voiced praxis and orofacial praxis	Groups			p Value ^a
	DFoFe, n (%)	DF, n (%)	DFT, n (%)	
To say "ah" with open mouth				
Yes	20 (29.0)	28 (40.6)	21 (30.4)	0.042
No	4 (30.8)	1 (7.7)	8 (61.5)	
To clear the throat				
Yes	8 (34.8)	14(60.9)	1(4.3)	0.001
No	16 (27.1)	15 (25.4)	28 (47.5)	
To blow a raspberry				
Yes	22 (36.1)	27 (44.3)	12 (19.7)	<0.0001
No	2 (9.5)	2 (9.5)	17 (81.0)	
To ask for silence				
Yes	17 (27.9)	26 (42.6)	18 (29.5)	0.049
No	7 (33.3)	3 (14.3)	11 (52.4)	
To grit the teeth				
Yes	6 (16.2)	19 (51.4)	12 (32.4)	0.011
No	18 (40)	10 (22.2)	17 (37.8)	
To bite the lower lip				
Yes	10(18.9)	24 (45.3)	19 (35.8)	0.008
No	14 (48.3)	5 (17.2)	10 (34.5)	
To touch the cheek with the tongue				
Yes	11 (19)	24 (41.4)	23 (39.7)	0.006
No	13 (54.2)	5 (20.8)	6 (25.0)	
To yawn				
Yes	7 (16.3)	22 (51.2)	14 (32.6)	0.003
No	17 (43.6)	7 (17.9)	15 (38.5)	

Abbreviations: DFoFe, phonetic-phonological impairment; DF, phonological impairment; DFT, typical phonological development.

^aChi-square, with adjusted residues analysis.

The following analyses refer to the test of articulatory and buccofacial praxis.¹³ Statistically significant results were not noted in the articulation of /p/, /t/, /k/, /f/, /l/ for none of the DFoFe, DF, and DFT groups (► **Table 2**). There was a significant result only for the variable "Pataka articulation."

Results in ► **Table 3** show that there is an association for carrying out the movement in the DFT group and for the nonperformance of the movement in the DF group. Therefore, to perform this sequence of sounds, greater phonological organization is required, which may be compromised in cases of DF.

► **Table 4** shows the movement of the lips, tongue, and face in DFoFe, DF, and DFT groups. Statistically significant results were not found in lip movement for the variables "Throwing a kiss," "Blowing," "Showing the teeth," "Biting the lower lip" and "Biting upper lip"; therefore, they are not shown in the table. Only the variable "Move lips forward and backward" will be presented, which showed significant results.

There was no significant association in movements of the tongue for the variables "Protrude the tongue without the

support from the lips," "Keeping the tongue for 4 seconds without the support of the teeth," and "Touching the 4 corners of the mouth"; therefore, they will not be presented in the table. Significant results occurred only for the variables "Lowering the tongue toward the chin" and "Licking the lips."

Here were no significant results in face movements for the variables "Frowning," "Blink alternately," "Mimic of crying," "Fill cheeks with air," "Push air in the cheeks from one side to the other." There was a significant result only for the variable "Sucking in the cheeks" (► **Table 4**).

The results (► **Table 4**) have evidenced the association from the adjusted residues analysis of the variable "Move lips forward and backward" to perform the motion in the DFoFe group and for the nonperformance of the motion in the DFT group.

Also, an association for the nonperformance of the motion for the DFT group is noted, and in the "Licking the lips" variable, there was an association for the performance of the motion in the DFoFe group and for the nonperformance of the motion in the DFT group. Also noted

Table 2 Parallel movements and sequence of movements of the test the Orofacial Praxis Test¹¹ in DFoFe, DF, and DFT groups

Praxis abilities	Groups			p Value ^a
	DFoFe, n (%)	DF, n (%)	DFT, n (%)	
Showing teeth, opening mouth and closing eyes				
Yes	9 (17.3)	22 (42.3)	21 (40.4)	0.007
No	15 (50.0)	7 (23.3)	8 (26.7)	
Blowing, biting lower lip and filling cheeks with air				
Yes	10 (18.2)	20 (36.4)	25 (45.5)	0.003
No	14 (51.9)	9 (33.3)	4 (14.8)	
Showing tongue, touching cheek with the tooth and throwing a kiss				
Yes	6 (13.6)	16 (36.4)	22 (50.0)	0.001
No	18 (47.4)	13 (34.2)	7 (18.4)	
Closing eyebrows and raising an eyebrow				
Yes	8 (17.8)	22 (48.9)	15 (33.3)	0.008
No	16 (43.2)	7 (18.9)	14 (37.8)	
Opening mouth, protruding tongue and saying "ah"				
Yes	9 (17.0)	23 (43.4)	21 (39.6)	0.004
No	15 (51.7)	6 (20.7)	8 (27.6)	
Closing eyes, closing mouth and breathing through the nose				
Yes	12 (20.0)	21 (35.0)	27 (45.0)	0.002
No	12 (54.5)	8 (36.4)	2 (9.1)	

Abbreviations: DFoFe, phonetic-phonological impairment; DF, phonological impairment; DFT, typical phonological development.

^aChi-square.

is an association for the performance of the motion in the "Sucking in the cheeks" variable for the DFoFe group. This praxis was performed satisfactorily by 39.2% of these subjects.

Discussion

The results showed that subjects in the DFoFe group underperformed in two tests of applied praxis, followed by subjects with DF and, finally, children with DFT, who performed better. This was observed probably because the DFoFe group has larger commitments that go beyond the organization of phonemes and include the motor realization of these.

Studies have mentioned that subjects with speech disorder (DF) showed poorer performance on tests of orofacial

praxis abilities compared with children with typical phonological acquisition.^{13,15} These findings are similar to the findings in this study that compared different groups of children with speech change and DFT.

Difficulty in performing some orofacial praxis abilities was found to occur along with DF and/or DFoFe, which is consistent with the literature.^{9,15}

Motor problems are a common comorbidity in children with speech disorders, suggesting an abnormality between planning and processing of motor movements that affect both speech and fine motor performance.¹⁷ Thus, the speech impairment is not an isolated event, but occurs with other phenomena, and the motor deficit may be one of them.¹⁷

A relationship exists between the maturation of the speech motor processing and the phonological development.

Table 3 Articulation point, task of the assessment test of the articulatory and buccofacial praxis¹³, in groups DFoFe, DF and DFT

Articulation point	Groups			p Value ^a
	DFoFe, n (%)	DF, n (%)	DFT, n (%)	
Pataka articulation				
Yes	17 (27.9)	16 (26.3)	28 (45.9)	0.001
No	7 (33.3)	13 (61.9)	1 (4.8)	

Abbreviations: DFoFe, phonetic-phonological impairment; DF, phonological impairment; DFT, typical phonological development.

Statistical test: Chi-square.

Table 4 Movement of lips, tongue, and face in the articulatory and buccofacial praxis assessment test¹³ in groups DFoFe, DF, and DFT

Movement	Groups			p Value ^a
	DFoFe, n (%)	DF, n (%)	DFT, n (%)	
Movement of lips				
To move lips forward and backward				
Yes	24 (33)	28 (38.9)	20 (27.8)	0.001
No	0 (0.0)	1 (10.0)	9 (90.0)	
Movement of tongue				
Lowering the tongue toward the chin				
Yes	23 (31.1)	28 (37.8)	23 (31.1)	0.047
No	1 (12.5)	1 (12.5)	6 (75.0)	
Licking lips				
Yes	24 (32.9)	27 (37.0)	22 (30.1)	0.014
No	0 (0.0)	2 (22.2)	7 (77.8)	
Movements of the face				
Sucking in the cheeks				
Yes	20 (39.2)	15 (29.4)	16 (31.4)	0.038
No	4 (12.9)	14 (45.2)	13 (41.9)	

Abbreviations: DFoFe, phonetic-phonological impairment; DFo, phonological impairment; DFT, typical phonological development.

^aChi-square.

Children with DF had more immature speech motor processing than children with typical phonological development.¹⁵ Therefore, children with impairments in speech and language may show speech motor control deficit.^{9,15,18} The fact was observed mainly in the group with DFoFe, in which a worse performance was obtained in both tests of praxis, as these subjects had changes in both phonetic and phonological levels.

A study showed that subjects with articulatory changes underperformed compared with a control group (children with no articulatory changes) for all the tasks in the Protocol of assessment of the Articulatory and Bucco-facial Praxis test.^{14,19} In this study, subjects with abnormal articulation of phonemes (DFoFe group) showed further structural change (the vast majority had anterior open bite) in addition to changes in the phonological level. Information contributes to the group with articulatory change presenting lower performance on tests of praxis abilities.

The research mentions that a correlation between the tone and nonverbal praxis of language is possible, suggesting that the muscle condition can interfere with the performance of the sequence of movements, which may influence the accuracy in the articulation of speech sounds.²⁰ In this study, there are children with DFT who had difficulty in performing the praxis assessed (– Tables 1, 2, 3 and 4); however, the majority of these groups show no changes.

One of the deficits found in children with speech impairments may be neuromuscular.²¹ The distribution of the muscle spindle in the articulators, such as the masseter, temporal, among others, are of great importance for the

performance of speech, emphasizing that the oral musculature is relevant to the articulation of speech sounds.²¹ Thus, the structures involved in phonation show changes of muscle tension and praxis and may interfere in the production of speech sounds.¹²

Oral motor learning can be impaired in many developmental disorders in which the speech is too. The oral musculature is relevant for the phonemes to be adequately articulated.¹⁹ Still, complex oral movements have a significant correlation with the language (i.e., children with good language abilities also have better oral motor abilities), which is in agreement with this study, as children with DFT showed the best results in the praxis abilities assessed.

In speech therapy clinical practice, when certain sounds are taught to children, some have difficulties in performing the phoneme, even if isolated. If the orofacial praxis abilities are assessed, it can be inferred that most of them have changed. When working with these abilities, along with the implementation of the sounds, there is the possibility not only to facilitate learning, as well as reducing the time of speech therapy, because the execution of phonemes is nothing more than a sequence of praxis abilities. This result was also mentioned in a study that tried to associate the therapy with an essentially phonological basis to the stimulation of the orofacial praxis abilities.⁹

Conclusions

This study, which aimed to verify the orofacial praxis abilities in subjects with DFT, DF and DFoFe, showed that children

with DFoFe had greater difficulties in performing the praxis abilities required during the two tests applied.^{12,14}

This study is significant in that it shows that other components may be altered in children with speech impairments, which should be focused on during the speech therapy. This further contributes to the effectiveness in the therapy of these disorders, as therapy may be planned to include all the child's difficulties.

Further studies on the topic are suggested, due to the extreme relevance for speech therapy clinical practice and the lack of studies in the area. In addition, new protocols should be created and/or existing protocols should be standardized and validated.

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