

Linguistic problems caused by anatomical alterations of the hard palate of speakers with Down syndrome

Andreia de Melo Costa Ferraz¹, Carla Salati Almeida Ghirello-Pires²

¹Master in Linguistics from PPGLIN, State University of Southwest Bahia – Brazil. Email: andreiademelo@yahoo.com.br

²PhD in Linguistics from UNICAMP – São Paulo, Brazil and professor of the Postgraduate Program in Linguistics at the Department of Linguistic and Literary Studies at the State University of Southwest Bahia. Email: carlaghipires@hotmail.com

Received: 13 Jan 2022,

Received in revised form: 10 Mar 2022,

Accepted: 20 Mar 2022,

Available online: 30 Mar 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Speech alteration. Phonetic disorder. Articulation disorders. Hard palate. Down Syndrome.*

Abstract — *This study deals with dimensional changes in the hard palate of individuals with Down syndrome; which can cause impairments in the movement of articulators and make it difficult to program the speech sounds that are produced with alterations. Objective: to characterize the production of consonant sounds in Brazilian Portuguese (BP) in a group of young adults with Down syndrome, by correlating changes to the dimensions of the hard palate. Our hypothesis is that this occurs, the greater the speech alterations, the smaller the palatal width and length and the greater the height of the palate. Methodology: data collection was performed using the Speech Assessment Instrument for Acoustic Analysis with transcriptions made by three speech-language pathologists and palatal dimensions were obtained by measuring the participants' plaster models. The correlation coefficient with significance ($p < 0.05\%$) was used. Results: the most prevalent alterations were substitutions and distortions, and the phone [s] was the most altered. The substitution presented a statistically significant correlation with the palatal dimension, according to the hypothesis of the study. Changes in phones [d], [z], and [l]-coda and in syllabic structuring [bl] also had a statistically significant association with palatal dimensions. Conclusion: There were some correlations between speech alterations and the dimensions of anterior width and length of the hard palate, as proposed in the hypothesis, and thus, the hard palate may be a factor that contributes to the alterations in the consonant production of the group of people with Down syndrome studied.*

I. INTRODUCTION

The speech production is one of the important aspects involved in language production; difficulties in this area considerably affect the communication, self-image and autonomy of individuals in society. In order for speech to be intelligible and for there to be a full understanding of what was said by the speaker, coordination of oral neuromotor movements is necessary, involving a complete integration of cognition and/or language with the neuromuscular and skeletal muscle systems, giving an important role to the aspects anatomical/functional aspects

of oral structures and linguistic aspects. (cf. Ferraz et al. 2020; Ferraz, 2021).

In individuals with Down syndrome, we can find problems related to the anatomy of their vocal apparatus that cause certain impairments in the movement of articulators, such as those that make it difficult to program the motor speech sounds and cause the unintelligibility of some linguistic occurrences in these speakers throughout their lives (Ferraz, 2021). From a social point of view, these changes can make socializing with other people difficult, as these speakers often cannot be understood by most of their

interlocutors. Why does this happen in those born with Down syndrome? Individuals with Down syndrome have three 21st chromosomes in all or most of their cells. Because of this fact, they have some anatomical alterations like the one we find in the hard palate.

Based on this reality, this study seeks to understand the origins of these speech disorders, having as main objective to characterize the production of consonant sounds in Brazilian Portuguese in a group of young adults with Down syndrome and to correlate the alterations to the dimensions of the hard palate. of these people. Thus, the problem encountered led us to the hypothesis that changes in consonant production may be related to certain dimensional characteristics of the hard palate. In this case, it can be observed that the smaller the dimensions of the hard palate are in width and length, and larger in height, these changes will occur. As we said earlier, the individuals with Down syndrome have three 21st chromosomes in all or most of their cells. Because of this, they have some anatomical alterations like the ones we find in the hard palate. As it is a linguistic study, here we will focus only on these changes that occur in the speech of these individuals, speakers of Brazilian Portuguese.

The version of this article is the result of studies that constitute a master's thesis in linguistics in the Postgraduate Program in Linguistics of the Department of Linguistic and Literary Studies (DELL) at UESB (Brazil).

II. METHODOLOGY

This qualitative-quantitative work, whose cross-section was carried out after approval by the Research Ethics Committee of the *Universidade Estadual do Sudoeste da Bahia* (UESB)¹ with opinion 3,821,070 (cf. Ferraz, 2021: 126), obtained its results from information concerning the research objective, presented here. In this way, all individuals and their legal guardians agreed to use them, signing the Free and Informed Assent Term (TALE) (cf. Ferraz, 2021:137). Those responsible and participants signed the Terms of Authorization for the Use of Image and Testimonials (cf. Ferraz, 2021: 131) and the Free and Informed Consent Term (FICT) (cf. Ferraz, 2021: 133), according to resolution no. 466/2012 of the National Health Council (CNS).

Fulfilling these requirements and requirements of the aforementioned ethics council and the CNS (Brazil), the investigation was carried out at the Laboratory of Studies and Research in Neurolinguistics at the State University of Southwest Bahia (UESB), where data were collected from

6 young adults with Down syndrome (mean age 22 years and 10 months, ranging from 15 to 28 years) using the Speech Assessment Instrument for Acoustic Analysis, which was transcribed by three speech-language pathologists.

In view of the data obtained, the alterations found were classified as: distortion, substitution and omission. The final judgment of the consonant production of the participants was given by the agreement of the majority of the judges, and regarding the width, length and height of the hard palate, the participants' impressions were carried out so that we could obtain the plaster models that were measured with digital caliper.

After obtaining the data, some statistical analyzes were performed with a significance level of 5% ($p < 0.05$).

III. RESULTS AND DISCUSSION

The study of the literature has shown in several descriptions that any alteration of the Stomatognathic system (SS) may lead to an imbalance of the entire system, causing speech alterations (Cunha, 2004; Tomé et al., 2004; Douglas, 2002; Marchesan, 2005).

Our study also agrees with Capelozza Filho and Silva Filho (1992) when they attribute lateral and anteroposterior atresia (narrowing) of the dental arch to frequent dento-occlusal articulatory impairments, with fricative consonants and linguolvelar plosives /t/ and /d/ between the most frequently changed. In turn, the work by Hu, Zhou and Fu (1997) found that, due to a discrepancy in the size of the area of the dental arches, in which the lower arch is in front of the upper one, the most common speech alterations were in the consonants /s, z, ʃ, ʒ/, with distortion and substitution also appearing, as in our investigation.

In the case of the high hard palate, which, in the occurrences performed by our participants, were in evidence; we confirmed the palatal depth with the frequent positioning of the tongue on the floor of the mouth as hindering the production of lingual-palatal phonemes, according to Braga et al. (2006) emphatically verified. In Costa, Cunha and Silva (2004), the high palate also appears as a difficulty in the accommodation of the tongue in this structure, that is, "both at rest and in the execution of functions, articulation disorder may occur" (Ferraz, 2021: 103).

However, our study also took into account the work of Martinelli et al. (2011) who verified a significant correlation between the distortion/ anterior lisp in the fricatives /s/ and

¹In English: State University of Southwest Bahia (SUSB).

/z/ and occlusion data, noting that the anteriorization of the inferior bone base in relation to the superior one contributed to the low and anterior positioning of the tongue, justifying the correlation of parallelism with the previous lisp.

The results found in our study are also similar to those that appear in research with individuals with Down syndrome undertaken by authors such as Kent and Vorperian (2013), Bhagyalakshmi, Renukarya, Rajangam (2007) and Carlstedt, Henningsson, Dallöf (2003) who mention the narrow, short and high palate, so present in DS as a factor that affects the speech production of these people. Wood et al. (2009) finds in individuals with Down syndrome a high number of inconsistent errors, especially in /s, z, ʃ, tʃ, dz, ʒ/.

In general terms, the most prevalent alterations were substitutions and distortions, with distortions having a prevalence of 100% of occurrence in the 6 participants, and the phone [s] the most altered (cf. Ferraz, 2021). Replacement showed a statistically significant correlation with the palatal dimension-anterior width, according to the study hypothesis.

The relevant occurrences of alterations in the phones [d], [z], obtained a statistically significant association with the palatal dimensions-anterior width and length and [l]-coda and in the syllabic structure [bl] also obtained a statistically significant association with the palatal dimensions - previous width (cf. Ferraz, 2021).

Therefore, articulatory difficulties, in speakers with Down Syndrome, are related to distortions, which may cause certain representations of signifiers of words with these sounds to be imprecisely incorporated into the lexicon of these speakers; as demonstrated by the study by Wertzner, Pagan-Neves and Castro (2007), in which speech alterations with distortions indicate the specific difficulty of production, and substitutions may suggest that, because the speaker is unable to produce the correct sound, the individual presents an altered phonological system, exchanging the target sound for another present in his phonetic inventory and of easier production, allowing the effectiveness of his communication (cf. Ferraz, 2021: 105).

IV. FIGURES AND TABLES

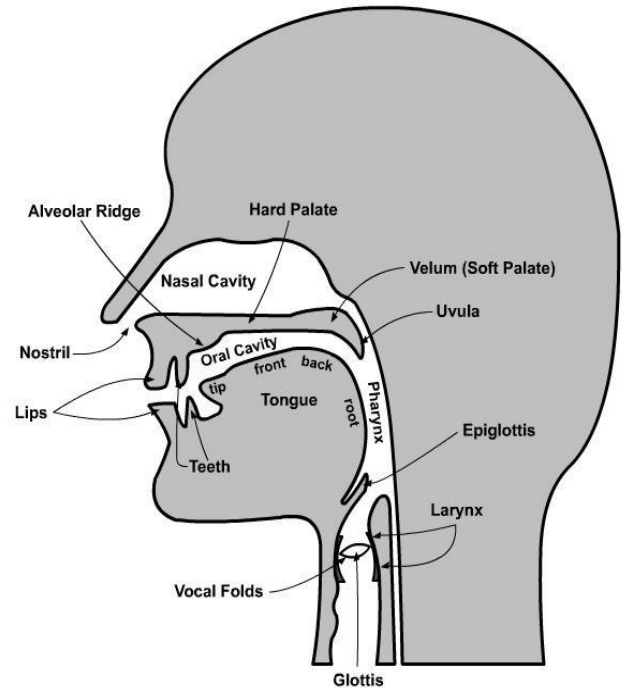


Fig. 1: Middle sagittal part of the vocal tract - main cavities - articulators and related structures

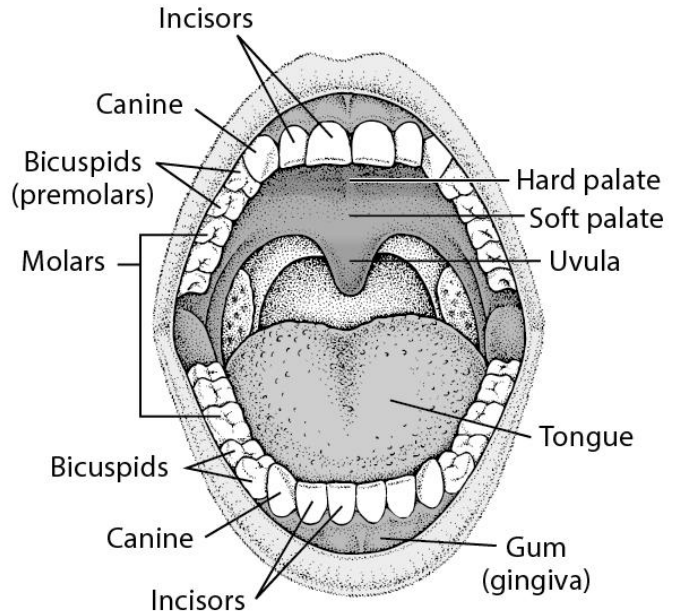


Fig. 2: Oral tract with its active (tongue, lips, soft palate) and passive (upper teeth, hard palate, alveoli) organs.

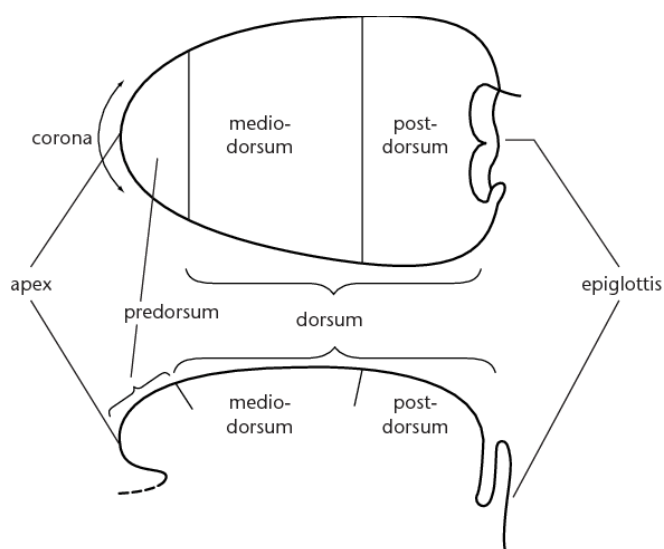


Fig. 3: Subdivisions of the active articulator: the tongue. De Catford, *Fundamental problems in phonetics*, 1977.

Table 1 - Distribution of research individuals

Individuals	B.N.	Age	Gender
FC	07/03/1992	28	M
EV	12/03/1997	23	M
GF	02/05/1993	27	M
MB	03/03/1997	23	F
MV	04/21/1999	21	F
RL	01/11/2005	15	F

Source: Prepared by the author (2019).

Legend: FC, EV, GF, MB, MV, RL – initials of the name and surname of the participants; D.N - date of birth; M - male; F - female.

V. FINAL CONSIDERATIONS

In this work, the data analysis found 25.52% of consonant alteration of the total of words produced by the participants of the group, where we identified some correlations between the speech alterations and the dimensions of anterior width and length of the hard palate, as proposed in the hypothesis, evidencing that the hard palate is a preponderant factor for the alterations in the consonant production of these speakers with Down syndrome observed here.

Additional future studies with a larger number of participants, use of instrumental measurement modalities, with a more compositional sample of speech, more control of variables, speech comparisons of groups with Down

syndrome before and after palatal disjunction will be necessary in order to that this relationship can be ratified.

However, the causal relationship and/or precise influence with which each risk factor contributes to speech alterations in individuals with DS is complex, and a detailed understanding of each of these factors is of fundamental importance, which together will contribute to the alteration of speaks throughout the lives of these individuals.

In short, this study sought to bring to light specific aspects in the production of speech sounds in people with DS, enabling an increase in the understanding of the generalized difficulties in the production of unintelligible speech experienced by people with DS, contributing and directing future research in order to promote interventions that could improve communication and, consequently, the psychological, social development and independence of people with Down Syndrome (DS). Therefore, this is a study that reinforces the importance of the idea of multidisciplinary between the different areas of knowledge, such as Linguistics, Speech Therapy, Dentistry, to undertake studies on the speech production of individuals with DS with the aim of knowing more to improve. their quality of life, in terms of sociability and interaction with others. In this way, we believe that we present some contributions to phonetics-phonology studies that can increasingly help in the various clinical practices of professionals in the aforementioned areas, so that they can act more assertively in the care of people with DS, offering individualized but grounded assistance in multi-professional cooperation and encouraging early stimulation, from birth, within the therapeutic scope, aiming at the structural reestablishment of the oral cavity-hard palate, especially in the craniofacial growth and development phase, contributing to the improvement of the communicative processes of these subjects and, consequently, improving their interpersonal relationships and autonomy.

ACKNOWLEDGEMENTS

To the State University of Southwest Bahia (UESB) and to the Postgraduate Program in Linguistics (PPGLin) for the opportunity to carry out my training at the master's level; to the Coordination for the Improvement of Higher Education Personnel (CAPES) for supporting and funding the activities of the PPGLin of the UESB; to the *Fundação de Amparo à Pesquisa do Estado da Bahia* (FAPESB) for financial support during the master's degree. And, finally, to the research participants and their mothers for their availability, collaboration, joy and encouragement, making the research possible.

REFERENCES

- [1] Amaro, L. Sotelo, M. B.; Wertzner, H. F. (2005). Analysis of Distortions in Children with and without Phonological Disorders. *Clinics*, v. 60, n. 2, pp. 93-102.
- [2] Bhagyalakshmi, G.; Renukarya, A. J.; Rajangam, S. (2007). Metric analysis of the hard palate in children with Down syndrome- a comparative study. *Down Syndrome, Research and Practice*, v.12, p. 55-59.
- [3] Carlstedt, K.; Henningsson, G.; Dallöf, G. (2003). A four-year longitudinal study of palatal plate therapy in children with Down syndrome: effects on oral motor function, articulation and communication preferences. *Acta Odontol Scan*, v. 61. p. 39-36.
- [4] Cunha, C. C. *Dificuldade para pronunciar e a relação com a avaliação miofuncional em usuários de prótese total*. (2004). Dissertação (Mestrado em Ciências) – Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto da Universidade de São Paulo, Ribeirão Preto, SP.
- [5] Douglas, C. R. (2002). C. R. *Tratado de fisiologia aplicada à saúde*. São Paulo: Robe Editorial.
- [6] Ferraz, A. M. C.; Ghirello-Pires, C. S. A.; Ladeira, R. T. L.R. et al. A literatura infantil e o desenvolvimento da linguagem oral: o relato de “os três porquinhos” por uma criança com síndrome de Down. *Revista Humanidades e Inovação*, v. 7 n. 22. Leitura. Retrieved from: <<https://revista.unitins.br/index.php/humanidadesinovacao/article/view/4783>>.
- [7] Ferraz, A. M. C. *Produção consonantal e características dimensionais do Palato duro em pessoas com síndrome de Down*. (2021). Dissertation (Master's) – State University of the Southwest from Bahia, Postgraduate Program in Linguistics – PPGLin, Vitória da Conquista, Brazil.
- [8] Ghirello-Pires, C. S. A.; Barroco, S. M. S. (2018). Linguagem e Síndrome de Down: Das Primeiras Aquisições ao Pensamento Abstrato. In: Beatón, G. A. et al. *Psicologia Histórico-Cultural: interfaces Brasil-Cuba*. Maringá: Eduem, pp. 215-240. 2 v.
- [9] Hu, W.; Zhou, Y.; Fu, M. (1997). Effect of skeletal class III malocclusion on speech articulation. *Chinese Journal of Stomatology*, v. 32, n. 6, pp. 344-346.
- [10] Jaroma, M. Laine; Linnasalo, A-L. (1985). Articulatory disorders in speech as related to the position of the incisors. *Eur J Orthod*, v. 7, p. 260-266.
- [11] Kent, R. D; Vorperian, H. K. (2013). Speech impairment in Down syndrome: a review. *J. Speech Lang Hear Res*, v. 56(1), p. 178-210, feb.
- [12] Marchesan, I. Q. (2005). O que são e como tratar as alterações de fala de origem fonética. In: Britto, A. T. B. O. (org.). *Livro de Fonoaudiologia*. São José dos Campos-SP: Pulso, pp. 285-296.
- [13] Martinelli, R. L. C.; Fornaro, E. F.; Oliveira, C. J. M.; Ferreira, L. M. D. B.; Rehder, M. I. B. C. (2011). Correlações entre Alterações de Fala, Respiração oral, Dentição e Oclusão. *Rev. CEFAC*, v. 13, n. 1, pp. 17-26, jan-fev.
- [14] Tomé, M. C.; Farias, S. R.; Araújo, S.M, Schimitt, B. E. (2004). Ceceo interdental e alterações oclusivas em crianças de 03 a 06 anos. Pró-fono: *Revista de Atualização Científica*, v. 16, n. 1, pp. 19-30, jan-abr.
- [15] Wertzner, H. F.; Pagan-Neves, L. O.; Castro, M. M. (2007). de Análise Acústica e Índice de Estimulabilidade nos sons Líquidos do Português Brasileiro, *Rev CEFAC*, São Paulo, v. 9, n.3, pp. 339-50, jul-set.
- [16] Wood, S.; Wishart, J.; Hadcastle, W.J.; Cleland, J. and Timmins, C. (2009). The use of electropalatography (EPG) in the assessment and treatment of motor speech disorders in children with Down's syndrome: evidence from two case studies. *Developmental Neurorehabilitation*, v. 12, p. 66-75.