CoDAS
ISSN 2317-1782 (Online version)

Original Article
Artigo Original

Self-perception of tongue tip constriction in alveolar fricatives produced by young women with and without normal tongue positioning

Autopercepção do ponto de constrição da língua nas fricativas alveolares em mulheres jovens com posicionamento de língua normal e alterado

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Keywords

Speech
Speech Perception
Tongue
Adult
Phonetics

ABSTRACT

Purpose: This study investigated the self-perception of 49 women, monolingual speakers of Brazilian Portuguese, about their tongue position for the alveolar articulation of the fricatives [s] and [z]. **Methods:** The video recording of speech samples of these 49 women (ages 18 to 28) were analyzed by three Speech-Language Pathologists. They were classified into two groups: Group 1 (G1, n=25), with no alterations in the tongue position during the production of [s] and [z], and Group 2 (G2, n=24), with alterations in the tongue position during the production of [s] and [z]. The tongue position self-perception experiment required the participants to identify the specific tongue constriction point in the production of [s] and [z] (apical, laminal, or "other") during the reading of 24 words and 24 pseudowords. The Friedman test, with posterior paired comparisons, was used for the intragroup analysis. The Mann-Whitney test was used for intergroup comparisons. The statistical significance adopted was 5% ($p<0.05$). **Results:** G1 reported apical and laminal tongue constrictions while GE reported these constrictions plus other tongue adjustments. The presence of other tongue adjustments differentiated the groups, G1 and G2 (p=0,002). There were significant differences between [s] and [z] for G1, with the laminal position occurring more often in [s] compared to [z]. **Conclusion:** Women with and without alteration in the tongue position reported apical and laminal constrictions. Howerer, other tongue adjustments were self-perceived in the presence of altered tongue position.

Descritores

Fala
Percepção da Fala
Língua
Adulto
Fonética

RESUMO

Objetivo: Investigar a autopercepção do ponto de constrição da língua na produção de [s] e [z] por jovens monolíngues com posicionamento de língua normal e alterado. **Método:** Três fonoaudiólogas analisaram gravações de fala em vídeo de 49 mulheres, com idades entre 18 e 28 anos (média=20 anos e 7 meses), classificando-as em: Grupo 1, (G1, n=25), com ausência de alterações no posicionamento de língua na produção de [s] e [z] e Grupo 2 (G2, n=24), com alterações no posicionamento de língua nestes fones. A autopercepção do ponto de constrição da língua foi investigada questionando cada jovem sobre o local em que sua ponta da língua encostava (apical, laminal ou "outros ajustes") ao produzir [s] e [z] na leitura de palavras e pseudopalavras. O teste de Friedman, com comparações par a par posteriores, foi utilizado para análise intragrupo. O teste de Mann-Whitney foi utilizado para as comparações entre grupos. Adotou-se nível de significância de 5%. **Resultados:** Em G1 houve relatos de ponto de constrição apical e laminal enquanto em G2 houve estes relatos, e também de outros ajustes de língua. A presença de outros ajustes da língua diferenciou G1 e G2 (p=0,002). Em G1, houve diferença significativa entre [s] e [z], sendo que o ponto laminal ocorreu com mais frequência em [s] do que em [z]. **Conclusão:** Jovens com posicionamento de língua normal e alterado relataram pontos de constrição da língua apical e laminal em fricativas alveolares. Porém, outros ajustes de língua foram percebidos diante de posicionamento de língua alterado.

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Received: April 17, 2020
Accepted: October 20, 2020

Study conducted at Laboratório de Análise Articulatória-acústica, Faculdade de Filosofia e Ciências, Universidade Estadual Paulista "Júlio de Mesquita Filho" – UNESP - Marília (SP), Brasil.

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Financial support: nothing to declare.

Conflict of interests: nothing to declare.

INTRODUCTION

Speech production is highly dependent on the configuration of the tongue in the vocal tract. The alveolar fricative sounds, in particular, require precise positioning of the tongue and jaw to form a narrow constriction in the alveolar region and direct the airflow against the incisors[1]. Specifically, the production of the fricative [z] involves constriction of the airflow in the alveolar region while the vocal folds remain adducted for voicing; the production of the fricative [s] requires constriction in the alveolar region and abduction of the vocal folds[2]. When forming a constriction, the pattern of tongue contact on the palate and the groove on the midline of the tongue can vary between [s] and [z], as observed in studies involving electropalatography[3-7].

The position of the anterior portion of the tongue (raised tip versus lowered tip) when forming constrictions during the production of alveolar fricatives is a matter of discussion in the literature, as observed in studies involving individuals with adequate speech[8,9], altered speech (person with glossectomy) [1] or individuals who speak a second language[10]. In general, instrumental tools are used to provide information about the anterior region of the tongue in the production of [s][1,8-11].

Since the 1990s, evidence of variations in the point of constriction of the tongue tip in the production of [s] has been reported for English and French speakers, based on findings of palatograms and linguograms[8,9]. Findings of apical constriction (in which the tongue tip makes partial contact with the alveolar region) and laminal constriction (in which the tongue blade rises while the tongue tip moves towards the lower teeth) were documented for [s] using this instrumental tool for English speakers[9]. Laminal constrictions occurred more frequently in the productions of [s] by French speakers though apical constrictions also occurred in the productions of these speakers.

Using magnetic resonance images, a study confirmed the variability in the position of the tongue in the production of [s] for native English speakers (control group), with the use of the apical position by 55% of these speakers[1]. Ultrasound images of the tongue of Japanese natives indicated a predominance of laminal position in [s] for these speakers[10]. Ultrasound images of the tongue of Brazilian Portuguese speakers producing [s] showed the tip and blade of the anteriorized tongue, with or without the absence of a groove in the midline[12]. This suggests that the anterior portion of the tongue could be positioned upward or downward in the production of [s] by these speakers. Overall, studies using instrumental tools have suggested variability in the tongue position in the alveolar fricatives among languages and speakers. The impressionist method, which relies on self-reports by speakers, has also been proposed in the literature as an alternative for obtaining information on the tongue constriction point (apical or laminal) in the production of [s] and [z][2,13]. Based on this method, the prevalence of the tongue constriction point in [s] and [z] was estimated for a large sample of Hebrew speakers[2]. Most of these speakers (60%) reported self-perceived use of laminal constriction for alveolar fricatives. Specifically, the laminal constriction was more frequent in [s], with the prevalence of apical constriction in [z]. The study highlighted the need for speech-language therapists to be aware of the possibility of two tongue constriction points (apical and laminal) in alveolar fricatives in Hebrew speakers, suggesting the need of an individualized practice, in which the selected position of the tongue meets with the particularity of each patient[2]. In a previous study, the variability of the tongue constriction point in the production of [s] was also observed for native English speakers, using the same methodology[13], leading to further discussions on the need to consider such variations in the teaching of English as a second language[10].

Overall, the findings obtained for individuals with adequate speech (without structural changes) led to reflections on their therapeutic implications[2,13]. Some scholars, for example, suggested verifying which tongue constriction point is the most comfortable for the patient in the production of alveolar fricatives, within acceptable possibilities, guiding the therapeutic process[2]. The emphasis on a single point of tongue constriction for all patients can slow the therapeutic process, demotivating both patient and therapist[13]. The motivation for these reflections for therapeutic purposes lies in the fact that [s] is one of the commonly mispronounced sounds in speakers of different languages[2], and errors may be present even in adult speech[14-18].

Considering the susceptibility of alveolar fricatives to errors and/or compensations in the speech of adults, for clinical purposes, it is crucial to obtain information on possible variations in the tongue constriction point for these fricatives in speakers of a given language. Self-perception of the tongue constriction point in the production of alveolar fricatives for Brazilian Portuguese speakers has not yet been documented for adults with normal tongue positioning (with adequate speech) nor for adults with altered tongue positioning (as occurs, for example, when the tongue is low, between the teeth or against the teeth, but without moving beyond them). Information from these speakers' self-reports can contribute to the knowledge of speech therapists on possible variations in the tongue constriction points in the production of [s] and [z], leading to reflections in their clinical practice.

The main objective of the study was to investigate the self-perception of the tongue constriction point in the production of the alveolar fricatives [s] and [z] by young adults with normal and altered tongue positioning. The objective was also to verify differences in the self-perception of the point of constriction between the fricatives, according to the positioning of the tongue, normal or altered, as well as possible differences between the groups, for each fricative, in both, words and pseudowords. We speculate that the findings about self-perception may vary both for young adults who have normal or altered tongue positions and, especially, between these two groups of participants. Also, the hypothesis is that there would be differences in the self-perception of the tongue constriction points between [s] and [z] within each group, as well as intergroup differences, in each fricative, during the production of words and pseudowords.

METHODS

This is a cross-sectional, observational, analytical, and comparative study that is characterized as a subproject of a large study, approved by the Human Research Ethics Committee of the

Institution where the research was conducted (2,915,882/2018). The study included 49 young, female adults, aged between 18 and 28 years old (mean = 20 years and 7 months old), speakers of Brazilian Portuguese, from the Midwest region of the State of São Paulo, and monolingual. The young women were recruited from undergraduate courses at a higher education institution featuring a convenience sample. All young women signed the Informed Consent Form.

The young women initially filled out a questionnaire to obtain information about complaints of hearing and swallowing, history of previous speech-language therapy and orthodontic treatments speech-language therapy and orthodontic treatments, and surgery involving lingual frenulum and orthognathic surgery, in addition to the use of dental prosthesis. They also answered about changes in their speech such as the difficulty in producing some sound, increased speed, presence of stuttering and comprehension of speech by the listener. Then, a speech-language therapist with experience in the assessment of orofacial myofunctional changes (first author) conducted a brief interview to confirm the data collected in the questionnaire regarding changes in speech and to verify general aspects of speech such as the presence of possible speech errors and types, dialectal variations, and knowing about knowledge of the speech sounds production process. At that time, the lingual frenulum was also evaluated, as proposed by the MGBR protocol[19].

After this stage, we selected only those who did not have a history of orthognathic and/or lingual frenulum release surgery, speech-language therapy, use of an orthodontic appliance or with its removal for more than two years and in the case of orthodontic contention, only if using it for more than six months. The young women were also selected without complaints and/or history of hearing loss and without changes in speech and the lingual frenulum. We also included individuals who did not have previous theoretical knowledge about the production of speech sounds in typical and deviant conditions since they could interfere with the performance of the proposed test and compromise the results.

Finally, the selected young women underwent an orthodontic screening performed by an orthodontist, who verified the relationship of the dental arches and the individual dental position, the presence of a disocclusion guide, the profile and the facial type, and they answered about a possible condition of temporomandibular disorder (TMD). We only included in the study individuals with Class I occlusion, according to the Angle classification, and who did not show TMD signs/symptoms. We did not consider the presence of discrete individual dental changes (lateral diastema, crowding or rotation of the lower lateral incisor, or crossings of a tooth).

After applying the inclusion and exclusion criteria, we recorded the participants' speech samples for further analysis. For this, the participants answered the following questions: *What do you like to watch on television? What do you enjoy doing? What do you like to eat?* They also counted from 1 to 20, from 60 to 70, and said the days of the week. Three speech-language therapists with at least five years of experience in the clinical evaluation of speech disorders individually analyzed the speech samples, paying attention to the positioning of the tongue during the production of the alveolar fricatives [s] and [z]. We considered as altered tongue positioning, any atypical adjustment in the positioning of the tongue that could be visually identified by the evaluators, with or without prejudice to the perceptual-auditory correlate of the production of the target fricative performed. These adjustments included a tongue with a low position, a unilateral or bilateral tongue leak, a tongue that is excessively visible laterally, but without air leakage, or even the lisp presence (anterior or lateral), associated or not with mandibular deviations.

We recorded the observations of the speech-language therapists and the results of the individual analyzes showed total agreement (100% agreement) of the answers regarding the presence or absence of altered tongue positioning. This result formed two groups with the presence or absence of altered positioning of the tongue. Specifically, with the sole purpose of favoring the understanding of the types of atypical adjustments presented by the young women in the production of [s] and [z], when there was no agreement, we carried out another analysis with the three evaluators together, using the slow-motion feature to obtain consensual results regarding the characterization of atypical tongue adjustments. All the material presented obtained consensus results from the speech-language therapists.

From the analysis of speech-language therapists, we formed two groups of participants: G1, with normal tongue positioning (adequate speech) during the production of alveolar fricatives (25 participants); and G2, with altered tongue positioning during the production of alveolar fricatives (24 participants), with or without prejudice in the perceptual correlate of the production of the target fricative performed as a result of such positioning. A more detailed analysis showed that in the group with altered tongue positioning (n = 24), most of them (87%, n = 21) had subtle changes that resulted, in most cases, in impairment in the perceptual correlate of the production of the target fricative. More specifically, 12 participants had tongue leak (9 bilateral; 2 unilateral; 1 anterior), 6 had an excessively visible lateral region of the tongue (without air leak), 2 had a tongue in a low position, with or without mandibular deviation/anteriorization, and one had a tongue in a low position and an excess of visible lateral region. Only three participants had lisp, with two anterior and one lateral lisp, as described in the literature[20].

The procedures performed in this work were based on descriptions of a previous study[2] and involved two stages: training and testing. Before the beginning of the experiment, we confirmed, through a brief questionnaire, the absence of reports of any unusual condition in the oral structures (thrush, for example) or in the way of breathing, which could interfere in the stages of the experiment.

Training phase

Each participant had a brief explanation of how speech sounds are produced, addressing, particularly, the characteristics of the articulation point of the fricatives [m], [l], and [k]. For this, the evaluator showed the articulation point of these fricatives (bilabial, alveolar, and velar, respectively), using PowerPoint, presented in a notebook. The evaluator showed illustrative

figures of the articulators (lips, tongue, and palate) involved in the production of the target fricatives, with simultaneous presentation of video-recorded productions of the respective fricatives. After the explanation, he asked each participant to read each of the six words presented individually on the computer screen. The words consisted of the fricatives [l], [m], [k], in initial or medial position (***La****ta, Ta****la***, ***Ma****pa, Pu****ma***, ***Ca****rro, Ri****co***). After reading each word, the participant reported the movements of the articulators involved in the production of the target fricatives. The evaluator offered feedback on errors or successes after responses presented by the participant in the training phase. The test phase was applied only after the participant correctly reported the articulators and their respective movements during the production of the target sounds.

Test phase

To perform the test phase, we selected a total of 48 speech stimuli, with 24 dissyllable words and 24 pseudowords with the same phonological structure as the words (Chart 1). The speech stimuli presented the fricatives [s] and [z] in the onset positions (initial and medial) or coda (medial). The sounds before the target fricatives were alveolar or non-alveolar to control the coarticulation effect. The test phase was carried out right after the training, presenting each participant the 48 speech stimuli previously randomized, in standardized slides (PowerPoint), using a notebook. The slides included speech stimuli with highlighted target fricatives to favor the participant's attention to these fricatives.

We instructed the participants to read each speech stimulus out loud, paying attention to the production of the target fricative and then reporting where the position of the tip of the tongue when producing the fricative. In case of doubts, the participants could repeat the task, until they felt confident about their answer. At no time was any type of feedback offered on the accuracy of the production or the answer given. All productions and responses given by each participant were recorded for later confirmation of the findings, if necessary. We classified their reports into three types of tongue constriction points in the production of [s] and [z]: (a) apical (tip of the tongue in the region of the upper alveolus); (b) laminal (tip of the tongue behind the lower alveolar ridge and "other adjustments" (any other positioning of the tip of the tongue). The same participant could report the use of a single tongue constriction point (only apical, only laminal) in the total of their productions or, still, report more than one constriction point (apical, laminal, both, or other adjustments) in their productions.

Analysis of the results

The absolute and relative distribution of participants per tongue constriction point (laminal, apical, or "other adjustments") in each group (G1, with normal tongue positioning and G2, with altered positioning) was initially obtained. From the total of 1,200 reports (25 participants x 48 stimuli) expected for G1, we determined the occurrence of each type of tongue constriction point. Likewise, from the total of 1,150 reports (24 participants x 48 stimuli) expected for G2, we established the occurrence of each type of tongue constriction point. The average percentage of occurrence of self-perceived reports of each tongue constriction point (laminal, apical, or "other adjustments") was then calculated for each group, considering the following variables: total speech samples (n = 48), speech samples consisting of words with [s] (n = 12) and [z] (n = 12) and speech sample consisting of pseudowords with (n = 12) and [z] (n = 12). Comparisons of the means obtained within and between groups were analyzed using statistical tests.

The normality distribution was analyzed using the Shapiro-Wilk test and showed a non-parametric distribution. For the comparison of repeated measures for the reports of different points of tongue constriction (apical, laminal, and "other adjustments") in the same group of participants, the Friedman test was performed, with pairwise comparisons using the Wilcoxon test with Holm-Sidak's post-hoc correction. We compared two independent groups using the Mann-Whitney test. The level of significance adopted was 5% ($p \leq 0.05$) and the data were analyzed using the SPSS software (version 24.0).

Chart 1. Words and pseudowords with fricatives [s] and [z], in the position of onset (initial and medial) and coda (medial)

Words	Fricative [s] onset	(initial and medial)	SAPA	Words	[Z] onset fricative	(initial and medial)	ZAPI	Words	Fricative [s]	(medial coda)	CASPA
			SACA				ZAGA				MASCA
			SALA				ZARA				VASTA
			SINA				ZELO				BASTA
			PASSA				PISA	Words	Fricative [z]	(medial coda)	ASMA
			CAÇA				CASA				RASGO
			LAÇA				NASA				ASNO
			NASCE				LESE				ROSNA
Pseudowords	Fricative [s] onset	(initial and medial)	SAPI	Pseudowords	[Z] onset fricative	(initial and medial)	ZAPU	Pseudo-words	Fricative [s]	(medial coda)	COSPA
			SICU				ZAGUI				MUSCA
			SALI				ZARRU				VUSTA
			SINI				ZELI				BUSTA
			PUSSA				PUZA	Pseudo-words	Fricative [z]	(medial coda)	OZMA
			CUÇA				CUZA				RUZGO
			LUÇA				NUZA				UZNO
			NUCI				LUZE				RUZNA

RESULTS

Table 1 shows the absolute and relative distribution of participants by tongue constriction point (laminal, apical, or "other adjustments") in each group. The findings show that participants in G1 reported using laminal or apical constriction points while participants from G2 reported, besides the apical and laminal points, self-perception of "other adjustments" of the tongue during the production of alveolar fricatives.

Table 2 shows the comparison of the percentages mean of occurrence of self-perceived reports for laminal, apical, or "other adjustments" of tongue points, within each group. We observed significant differences between the constriction points, both for G1 ($p < 0.001$) and for G2 ($p < 0.001$) when producing the alveolar fricatives. In both groups, there were no differences between the apical and laminal constriction points, but both showed significant differences in the category "other adjustments" (without occurrence). When comparing the groups within each type of constriction, significant differences were observed only in the "other adjustments" category ($p = 0.002$), showing that this response category was different between the groups.

For the "words" stimulus, there was a difference between the means in the "other adjustments" tongue response category, than in the groups (G1 vs. G2) in both [s] ($p = 0.004$) and [z] ($p = 0.004$) (Table 3).

For the "pseudowords" stimulus, there was also a difference between the means for the "other adjustments" tongue response category in the groups (G1 vs G2) in both [s] ($p = 0.017$) and [z] ($p = 0.008$). There was also a difference between [s] and [z] for laminal constriction point ($p = 0.032$), in which there was a higher occurrence mean of the laminal constriction point for [s] than for [z], however only for G1 (Table 4).

Table 1. Distribution of participants according to the tongue constriction point (normal, apical, or both) in the groups with normal (n = 25) or altered (n = 24) tongue production in the production of alveolar fricatives

	Laminal	Apical	Laminal or Apical	Others
	(Total)	(Total)	(Total)	(Total)
G1: Normal (N=25)	6 (24%)	7 (28%)	12 (48%)	0 (0%)
G2: Altered (N=24)	3 (12.5%)	3 (12.5%)	10 (42%)	8 (33%)

Table 2. Comparison of the mean and standard deviation (SD) of the percentage of occurrence of reports of each tongue constriction point (laminal, apical, or "other adjustments") for the 48 speech stimuli, in the groups of participants with normal and altered tongue positioning

	Groups				
	G1: Normal (n=25)		G2: Altered (n=24)		p-value
	Total	Mean	SD	Mean	SD
Laminal	41.50a	41.84	40.62a	36.23	0.992
Apical	58.49a	41.84	52.69a	34.26	0.421
Other adjustments	0.00b	0.00	6.68b	11.08	0.002†
p-value	<0.001*		<0.001*		

† indicates a significant difference between groups within the same type of tongue constriction by the non-parametric Mann-Whitney test
*Significant difference in the tongue's constriction point (laminal, apical, and other adjustments) within the group (normal or altered tongue positioning) by Friedman's nonparametric test (<0.001). Different letters (a, b) indicate significant differences within the group by the Wilcoxon non-parametric test with Holm-Sidak post-hoc correction

Table 3. Comparison of the mean and standard deviation (SD) of the percentage of occurrence of reports of tongue constriction point (laminal, apical or "other adjustments") between [s] and [z], by group (normal and altered tongue positioning) and between groups, by alveolar fricative, in the production of words

	Group								Group		Fricative	
	G1:Normal				G2: Altered				N	A	/s/	/z/
	/s/		/z/		/s/		/z/		/s/ vs./z/		N vs. A	
Word	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p	p	p	p
Laminal	42.6	41.4	40.3	43.3	39.2	41.9	39.5	35.0	0.363	0.412	0.643	0.684
Apical	57.3	41.4	59.6	43.3	55.9	41.4	51.7	35.3	0.363	0.361	0.847	0.320
Other adjustments	0.0	0.0	0.0	0.0	4.8	9.8	8.6	18.0	0.999	0.249	0.004†	0.004†

† indicates a significant difference between groups (normal vs. altered) for each fricative for the same type of tongue constriction by the non-parametric Mann-Whitney test
Caption: N = normal; A = altered

Table 4. Comparison of the mean and standard deviation (SD) of the percentage of occurrence of reports of tongue constriction point (laminal, apical or "other adjustments") between [s] and [z], by group (normal and altered tongue positioning) and between groups, by alveolar fricative, in the production of pseudowords

Pseudoword	Group								Group		Fricative	
	G1: Normal				G2: Altered				N	A	/s/	/z/
	/s/		/z/		/s/		/z/		/s/ vs. /z/		N vs. A	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p	p	p	p
Laminal	45.0	42.1	38.0	44.2	43.4	39.4	40.2a	38.6	0.032‡	0.972	0.984	0.782
Apical	54.9	42.1	62.0	44.2	52.7	38.0	50.3a	38.7	0.032	0.346	0.708	0.302
Other adjustments	0.0	0.0	0.0	0.0	3.8	9.5	9.3b	19.6	0.999	0.108	0.017†	0.008†

‡ significant difference between fricatives within the group (normal or altered) and point of tongue constriction by the Wilcoxon nonparametric test;
† indicates a significant difference between groups (normal vs. altered) for each fricative (/ s / and / z /) for the same type of tongue constriction by the Mann-Whitney non-parametric test
Caption: N = normal; A = altered

DISCUSSION

This study investigated the self-perception of the tongue constriction point in the production of [s] and [z], by young females who speak Brazilian Portuguese, who presented normal or altered tongue positioning, using a methodology similar to previous studies, that is, based on the impressionist method[2,13]. Information from the self-perceived tongue is restricted to studies that investigated self-perception of the usual position of the tongue at rest[21], in the function of swallowing[22] or the pronunciation of trigrams or tetragrams, by populations with specific conditions (prosthesis users or with temporomandibular disorders)[23,24], without focusing the tongue position in the production of alveolar fricatives, in Brazilian Portuguese speakers.

The general results of the study showed that 48% of young women with normal tongue position used laminal and apical constriction points when producing [s] and [z], and the remaining used only the apical or laminal point. We observed a similar result in the group with altered tongue positioning, in which most of the young women (42%) reported the use of apical or laminal tongue constriction points with a small portion of reports with an exclusive use of the tongue apex (12.5%) or exclusive laminal point (12.5%). However, differently from the group with normal tongue positioning, in 33% (N = 8) of the young women with altered tongue positioning, we observed "other adjustments", such as positioning the anterior region of the tongue between the teeth or also touching them. Also, some of these young women noticed the apical and laminal constriction points (25%), or only apical (8%), or only laminal (4%).

In the literature, the variability of the tongue constriction point in alveolar fricatives was observed in a study that found that 30% of the speakers who had English as their first language, used a non-alveolar position (with the tongue blade creating constriction partial) when pronouncing [s], while the others used apical points[13]. In Hebrew speakers, 60% of the studied sample reported perceiving exclusive use of the laminal constriction point of the tongue in the alveolar fricatives, while the others reported using the apical point or both[2].

In the study, from the analysis of each tongue constriction point, within each group, we observed no difference between the means of occurrence of apical and laminal constriction point for participants with normal tongue positioning. There were no reports of "Other tongue adjustments", which confirms the possibility of using both apical and laminal constriction points on alveolar fricatives by young Brazilian Portuguese speakers, with normal tongue positioning. This corroborates studies that also suggest reports of laminal constriction point or apical by speakers of other languages[2,13].

Discrete variations in the contact points of the tongue are expected in individuals with adequate speech, since they have different facial structures and musculature. Therefore, even when these points are not the same, the final product can be perceived as correct[17]. Even clinical speech-language pathologists, speakers of Brazilian Portuguese, do not always easily identify their tongue position when producing the fricative [s] when questioned, albeit informally, in courses or classes, often resulting in different reports on tongue constriction point in the production of this fricative[17]. Interpolating variations in the positioning of the tongue in the production of [s] have been previously documented, based on instrumental findings, suggesting that aspects such as the height of the palate may influence the configuration of the anterior portion of the tongue during the production of [s][1,11]. A study[1] found that individuals with adequate speech with a low palate tended to use the apical point, while those with a high palate tended to use laminal point in the production of [s]. Therefore, there is a possibility that the variability in the tongue constriction points in the production of alveolar fricatives observed in the participants with normal tongue position in this study may be due, in part, to possible differences in the height of their palate. The analysis of each tongue constriction point also showed variability in the positioning of the tip of the tongue in the production of fricatives [s] and [z] for participants with altered tongue positioning, showing by the prevalent use of apical and laminal constriction points, however, with reports of "other language adjustments". When questioning individuals with changes in tongue positioning during the speech-language assessment process, we expect unusual constriction reports of the tip of the tongue in the production of [s] and [z]. A previous study emphasized to consider the tongue adjustments presented by a particular speaker to favor therapeutic planning[2].

The intergroup comparison showed a significant difference in the average occurrence of self-reports only for the "other tongue adjustments" category, observed only in the group with altered tongue positioning. This confirms that the presence of "other tongue adjustments" reports differentiated the two groups of participants. Therefore, that unusual more subtle positions of the tongue, and not the presence of lateral lisping, led the rest of the young women to report "other tongue adjustments", when producing the alveolar fricatives. Although the presence of a previous (mild) lisp was identified in two of the 24 participants, they did not report "other tongue adjustments".

The data from the orthodontic evaluation allowed us to verify that nine (37.5%) participants with altered tongue position had individual dental alterations (lateral diastema, crowding or rotation of the lower lateral incisor) or crossing of a tooth. Five reported the presence of "other tongue adjustments" when producing [s] or [z], while six reported exclusively apical or laminal constriction points. These findings suggest that the individual changes in the teeth do not seem to have favored the perception of "other tongue adjustments" in the production of alveolar fricatives. Also, a more detailed inspection of the speech-language therapists' analysis showed that of the 24 participants with altered tongue positioning, 8 had slight mandibular deviations and half of them (n = 4) reported "other tongue adjustments". Mandibular deviations also do not seem to justify the presence of "other tongue adjustments" reported by participants with altered tongue positioning.

The position that the tongue assumes when producing specifically the voiced or unvoiced alveolar fricative is of interest to clinicians and researchers[2]. We are also interested to know if the self-perception of the tongue constriction point between these fricatives varies according to the speech stimulus. The intra-group comparisons showed that, for the words, there were no differences between [s] and [z], unlike the pseudoword

findings in which there was a significant difference between these fricatives, with a higher occurrence of laminal tongue constriction point for [s] than for [z], for young women with normal tongue positioning. Although there was a tendency towards a higher occurrence of apical tongue constriction points for [z] than [s], the difference found was not significant. The hypothesis that there would be differences between fricatives [s] and [z] within each group was partially proven, since the difference occurred for one of the groups, only for pseudowords.

The fact that this difference is significant only in pseudowords can be justified by the higher level of attention required in the task of self-perception of the tip of the tongue when producing unusual speech stimuli, that is, stimuli that sound like words and are composed by the same phonological rules, but that do not carry meaning[25]. This may have led young women with normal tongue positions to perceive subtle differences in the position of the tip of the tongue between [s] and [z], resulting in a greater occurrence of laminal constriction in [s] than [z].

Differences between voiced and unvoiced alveolar fricatives have been previously documented by electropalatography. Overall, the findings show that the unvoiced fricative is slightly less anterior than the voiced fricative[5] with less tongue/palate contact (anterior) than its voiced counterpart[3-5], with wider anterior midline grove in [s] than [z] while the posterior groove is wider in [z] and narrower in [s][5]. Also, the articulatory time of the tongue-to-palate contact pattern is different, with a duration of [s] significantly longer than [z][6,7]. These differences between the alveolar fricatives may have favored a greater perception of laminal constriction in [s] than in [z], however, in stimuli that require greater attention to perform new articulatory movements (pseudowords). The findings of the study of the production of /s/ and /z/ in pseudowords agreed with those previously reported for Hebrew speakers[2], about laminal production being more frequent in [s] than [z]. However, they disagreed with the findings when not observing significant differences in the self-perception of the constriction point of /s/ and /z/ in words.

In this study, we also verified whether the findings differed between groups, for each fricative, in words, and pseudowords. The hypothesis that there would be differences in the self-perception of the tongue constriction points of the intergroup, for each fricative, in words and pseudowords, was partially proven. The results showed that for both fricatives, in words and in pseudowords, there was a significant difference between the groups only for the category of responses "other tongue adjustments", in [s] and [z]. Based on these findings, we can notice that the tongue position of each group (normal or altered) influenced the results, with similar behavior in [s] and [z], both in words and pseudowords.

The focus of this study was to offer information on the tongue constriction point in the production of [s] and [z] by young women with and without normal tongue positioning in the production of alveolar fricatives, based on findings from the impressionist method. This method is considered a simple, easy-to-use, and low-cost resource that can be used in speech-language therapy, as it offers important information about how the patient perceives the movements of the anterior part of the tongue when producing fricative sounds[2]. We expect that the information obtained in the study will allow reflections that can assist the speech-language assessment, directing the therapeutic process.

The literature shows that an individual can perceive and also measure variations in his pronunciation (reading of trigrams or tetragrams, that is, juxtaposed letters without meaning), in controlled conditions (use of dental prosthesis[23] or stabilizing occlusion plate[24]). Therefore, a patient's self-perception judgments can help and contribute to the speech-language assessment process[24]. We expect that the self-perception test of the tongue constriction point in [s] and [z], as proposed in the study, can be an additional resource used in the speech-language therapy assessment process, enabling to verify different self-reports of tongue adjustments in the presence of adverse conditions (altered tongue positioning). For clinical purposes, during the evaluation process, we suggest verifying the perception that the patient has concerning his tongue constriction point when producing [s] and [z]. For therapeutic purposes, we suggest to seek the tongue constriction point in the alveolar fricatives more comfortable for the patient[2], which, based on the findings of the study, can be apical or laminal, for adult women.

Some limitations of the study are the restricted number of participants in each investigated group, the lack of control over the severity of the alteration in the participants' tongue position, and also the vowel included in the speech stimuli. In future studies, we suggest increasing the number of participants to investigate the population of both genders, with different types of lisp, adding information from instrumental tools (ultrasound, for example) that allow comparisons with findings of tongue-self-perception in the production of [s] and [z].

CONCLUSION

Apical or laminal tongue constriction points during the production of the fricatives [s] and [z] were perceived by young women with normal tongue positioning. There was no difference in these reports in words. Contrary, for pseudowords, the laminal point occurred with more frequency in [s] than in [z]. For participants with altered tongue positioning, there was no difference for the reports of the constriction point in the production of [s] and [z], both in words and in pseudowords. The comparison of the findings between the groups showed that participants with normal tongue positions reported apical and laminal constriction points, while participants with altered tongue positions reported apical and laminal constriction points and other tongue adjustments.

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Author contributions

ACVA principal investigator, research elaboration, schedule elaboration, literature survey, data collection and analysis, writing of the article; JAG collaboration in the elaboration of the research, collection, and analysis of the data and writing of the article; LLR collaboration in the elaboration of the research, data analysis, and writing of the article; KFG collaboration in data analysis and research writing; DSA collaboration in the collection, the survey of literature and data analysis; EFBC collaboration in the analysis of the study design and data interpretation; VCCM preparation, data analysis, writing of the research, correction of the writing of the article, approval of the final version, submission and procedures of the article.