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RESEARCH ARTICLE

Enhanced coarticulatory labialization of /tˢ/ in Argentine Danish

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Abstract

This paper presents an acoustic study of coarticulation of Argentine Danish /tˢ/ using Centre of Gravity (CoG) as the acoustic measure. It shows that the articulation of /tˢ/ is affected by the roundedness of the following vowel, and that this is more prevalent among speakers of Argentine Danish than among speakers of Modern Danish as spoken in Denmark. The analysis also shows that within Argentine Danish, the speakers of the isolated settlement Eldorado have a larger effect of roundedness in their articulation of /tˢ/ than the speakers of the settlements in the Pampas and in Buenos Aires. The results are discussed from the perspective of phonological theory on enhanced coarticulation as a source of sound change and from the perspective of theory of language change in heritage languages.

Keywords: affrication; Argentine Danish; coarticulation; heritage language; labialization; phonologization

1. Introduction

Labialization of consonants in the context of rounded vowels is a well-known coarticulation feature in the world's languages. Coarticulation may be described 'as a constellation of orchestrated gestures that overlap with each other in time' (Harrington et al. 2019:402), and labialization of a consonant consequently as the anticipation of the lip rounding or protrusion inherent in a rounded vowel resulting in the pronunciation of the consonant with an extra labial feature. As an example, in Modern Standard Danish as spoken in Denmark (henceforth Modern Danish), /tˢ/ is articulated as an alveolar affricate, often rendered as [tˢ], in words such as *ti* [tˢiːˀ] 'ten' and *te* [tˢeːˀ] 'tea', but with lip rounding, [tˢʷ], in words such as *to* [tˢʷoːˀ] 'two' and *tø* [tˢʷøːˀ] 'thaw', hence manifesting contextually conditioned allophonic variation between [tˢ] and [tˢʷ].

Coarticulatory labialization (and other 'universal' coarticulation phenomena such as nasalization of vowels before nasal consonants and voicing of voiceless consonants between voiced sounds) often goes unnoticed in the description of sound inventories. Referring to findings of articulatory phonology (Browman & Goldstein 1992) and

action theory (Fowler 1984), Harrington et al. (2019:402) note that coarticulation phenomena are not normally 'blended in human speech processing … but perceptually associated or parsed with the source of coarticulation'. Listeners do so because 'there is a parity between the modalities of production and perception: listeners hear … the interleaving of the independently controlled gestures in speech production', that is, they are adept at normalizing for context. Following Ohala (1993a), a listener tends to ignore coarticulation and '*normalize* or *correct* the speech signal in order to arrive at the pronunciation intended by the speaker minus any added contextual perturbations' (Ohala 1993a:245; italics original). Perturbations may be contextual nasalization of a vowel before a nasal consonant, tonal variation depending on syllable structure, or labialization of consonants before rounded vowels. See also Abrego-Collier (2013:6), including references, for research that shows that listeners compensate for the variation that coarticulation expresses.

Automatically conditioned coarticulation ('low-level features', Solé 2014) can take on a characteristic of being 'enhanced' or exaggerated, and even give rise to sound change (Hyman 2015). A sound change may occur, for example, when the condition for a nasalized vowel, i.e. the following nasal consonant, is lost, but leaving the nasal vowel. Well-known examples are the historical development of nasal vowels in French and Portuguese. In the case of an enhanced feature, which this paper pursues, we may speak of a 'phonetic effect … exaggerated beyond what can be considered universal' (Hyman 2015:6). In such cases, the coarticulation stands out as particularly noticeable, systematic, and widespread, and as such, the coarticulation is an example of 'phonologization' (Hyman 2015:6). In Ohala's words, a change can take its origin in a 'pool of synchronic variation' (Ohala 1989) and eventually become phonologized if the listener fails to correct the perturbations in the speech signal. Thereby the perturbations will:

> be taken at face value and will form part of his conception of its pronunciation. Via such 'hypo-correction', as I call it, the phonetic perturbations, originally just fortuitous results of the speech production process, become part of the pronunciation norm. This, presumably, is what is meant by the term 'phonologization' (Ohala 1993a:246; see also pp. 263–264 and Ohala 1989:186).

1.1 Purpose and structure of the article

This paper argues that a case of 'phonologization' has taken place in the pronunciation of /t^{s}/ in Danish as spoken by descendants of Danish immigrants to Argentina (henceforth 'Argentine Danish'). The paper provides acoustic evidence for an enhancement, or 'exaggeration', of coarticulatory labialization of /t^{s}/. The enhanced coarticulatory feature has resulted in the allophone [t^{sw}] becoming a prominent characteristic of this variety of Danish. As will become evident from the analysis, Argentine Danish /t^{s}/ shows a much larger, 'exaggerated', degree of labialization in the context of a following rounded vowel than can be observed in Modern Danish. The paper argues that this change is likely to be language-internal rather than due to language contact with Argentine Spanish. The paper hereby showcases an example of internal language change in a so-called heritage language.

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The paper is structured as follows. Section 2 introduces the Argentine Danish speech community in Argentina. Section 3 describes the phonetic realizations of Danish /tˢ/. Section 4 describes the data and the speakers included in the study, and Section 5 describes the acoustic measure used for the analysis. Section 6 contains the analyses and Section 7 a discussion of the main results. Section 8 summarizes the conclusions.

2. Argentine Danes and Argentine Danish

The history of Argentine Danish goes back to the Danish immigration to Argentina that began in the late 1840s and continued until around 1930, peaking in the period 1890–1910 (Kühl et al. 2019). Although approximately 50,000 Argentinians can today claim Danish ancestry, the actual number of Danish immigrants was small; historical literature mentions numbers ranging from 8,000 to 13,000 (Bjerg 1991:12, 2000:32).

2.1 Three Danish settlements

The Danes settled primarily in the capital Buenos Aires, on the Pampas southwest of Buenos Aires between the towns Tandil, Tres Arroyos, and Necochea, and from the early 1920s in Eldorado in the province Misiones in the north of Argentina (see Map 1).

The settlement on the Pampas is the strongest in terms of network and maintenance of Danish culture and language. In this pioneer community, strong and dense social and religious networks were established. It became customary to provide work and financial support to newcomers from Denmark or of Danish descent so that they could establish their own farms or industry. The Pampas Danes established a boarding school outside Tres Arroyos for the children of the immigrants, where both Danish and Spanish were taught, as well as a so-called 'folk high school' for adult education. Club and sports activities also played an important role in maintaining Danish ethnicity among the immigrants on the Pampas (Hartling 2019:7–15, Kühl & Heegård Petersen 2022, Heegård Petersen & Kühl, submitted).

The Danish community in the capital Buenos Aires also has its roots in the early period of immigration. The Buenos Aires Danes also formed sports clubs and used the Danish church as a meeting place for social and religious activities, but the Danish community never came to be as strong and self-contained as on the Pampas. This had the linguistic consequence that the Danish language never came to play the same important role for the immigrants' identity as on the Pampas (Hartling 2019:9–34, Kühl et al. 2019).

Danes from the Pampas were among the first pioneers to cultivate the jungle around what would become the city of Eldorado in the province Misiones. Approximately 30 Danish families moved to Eldorado, mainly from the community on the Pampas in the south, and established themselves as farmers or in the expanding timber industry. The Danes in Eldorado never formed sport clubs, Danish schools, or churches (Hansen 2016). In the harsh climate in the jungle, where many other immigrants also settled in the pioneer period 1920–1930, it was customary to engage socio-economically and culturally with other ethnic groups. In contrast to the Danish community on the Pampas, it was socially acceptable to marry outside the community, with the consequence that integration and assimilation happened

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Map 1. Map of Northeast Argentina showing Danish settlements: Eldorado (to the north), Buenos Aires, and the Pampas settlements in the triangle. (Adapted from Google Maps).

quickly, leading to disintegration of the Danish network. The number of Danish descendants in Eldorado who can still speak Danish is restricted to 12–15 speakers, all over 65 years old (Kühl et al. 2019, Heegård Petersen, Kühl & Bakker 2021).

2.2 Danish in Argentina

The exact number of Argentine Danes who can still speak Danish is uncertain. Kühl et al. (2019) suggest that the number does not exceed 1,000, and all speakers are sequentially or simultaneously bilingual, having acquired both Danish and Spanish from early childhood or learnt Spanish from the start of school. There are very few speakers under 65 years, reflecting a discontinuance of language transmission that took place during the 1970s. Until that period, Danish in Argentina was transmitted to the following generations as a carrier of Danish ethnicity and ancestry. Historical records report that Danish was used in the churches up to the 1970s (in Necochea on the Pampas up to the 1990s); Danish was taught – along with Spanish – in the Danish boarding school; Danish was used in meetings and in organizations, and there were also Danish newspapers up to the 1960s. Today, though, even the oldest speakers of Argentine Danish use Spanish in their daily lives and at social occasions.

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2.3 Argentine Spanish influence on Danish

In the course of the transmission of Danish in a bilingual context, where Argentine Spanish over the years became the dominant language, it was inevitable that Argentine Spanish had an influence on the language. This can be detected in the vocabulary and in the grammar.[1] Two studies indicate that the Spanish-influenced Danish of the Eldorado speakers may differ more from Modern Danish in the lexicon (Heegård Petersen 2018) and morphology (Kühl & Heegård Petersen 2021) than the other Argentine varieties. Both studies suggest that this may be due to the particular sociolinguistic context of the Danish community in Eldorado.

Only a few phonetic features are mentioned in the literature as characteristic of Argentine Danish. Heegård Petersen, Hansen & Thøgersen (2020) show that some speakers have a tendency not to maintain a contrast between Danish /oː/ and /ɔː/. The authors suggest that this phonetic merger may be due to pressure from Argentine Spanish, which has only one mid back vowel, /o/. I discuss in Section 7.4 whether the distinct Argentine Danish pronunciation of /tˢ/ can also be explained as a result of this language contact.

3. Modern Danish /tˢ/

Modern Danish /tˢ/ is a voiceless, lenis alveolar plosive [d̥], which is affricated [ˢ] and aspirated, [ʰ], rendered strictly according to IPA as [d̥ˢʰ], or [d̥͡s] (Brink et al. 1991:1603, Basbøll 2005:60, Grønnum 2005:134).[2] In syllable-initial position /tˢ/ is part of a six-way contrast /pʰ tˢ kʰ b d g/; in syllable-final position the stop series neutralizes to /b d g/ (Basbøll 2005:60–65, Grønnum 2005:303–305, 310–316). The pronunciation of Danish *t* is believed originally to have been [t] or [tʰ]. The affrication began in, and spread from, the speech in and around the capital Copenhagen in the second half of the nineteenth century and is the standard pronunciation in all regions, except for those West or North Jutish speakers who maintain [tʰ] (Brink & Lund 1975:354). In traditional lower-class Copenhagen speech the affrication is reported to be strong, occasionally rendered as [ts] or [s̪s̪͡], but less so outside Copenhagen (Brink & Lund 1975:355), although this has not, to the best of this author's knowledge, been investigated acoustically.[3] While Grønnum (2005:161–162) notes the palatalization of Danish /s/ before high front vowels to [ɕ], there is no mention in the literature of palatalization of an allophone [tᶜ][4] before high front vowels. Nor is there any reference to a particularly noticeable coarticulatory labialization of /tˢ/ (and /s/ and /ɕ/). I shall therefore not pursue further the hypothesis that the enhanced labialization coarticulation of /tˢ/ in Argentine Danish is a dialectal relic.

4. Data and speakers

4.1 The CoSAmDa data

The data used in this study come from the Corpus of South American Danish (CoSAmDa), which consists of transcribed recordings of sociolinguistic interviews with 95 speakers from the three settlements mentioned in Section 2 (Kühl et al. 2019). The corpus contains 1,031,000 word tokens, including orthographic

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Table 1. Speakers distributed by gender, settlement, average age, and age span

	Buenos Aires	Eldorado	Pampas	Total
Women	4	5	17	26
Men	4	3	9	16
Total	8	8	26	42
Average age (span)	77 (68–85)	77 (65–94)	75 (62–89)	76 (62–94)

renderings of self-interruptions, filled pauses (transcribed as a hesitation word *oe*), back-channellings, etc.[5]

The recording equipment used was Sound Devices 633 and 722, with a DPA 4066 omni-directional condenser microphone. In most cases, the microphone (a headset microphone) was positioned close to the mouth. In a few situations, when this position was inconvenient, a lapel microphone was used. In group interviews, the microphone was placed on a table near the speakers.

All speakers from Buenos Aires and Eldorado were included in the dataset for the present study. The dataset was supplemented with as many speakers from the Pampas as the allotted time for the annotation allowed, resulting in a dataset with 42 speakers, distributed according to gender and settlements as shown in Table 1.

4.2 The baseline problem

The analysis compares the data with Modern Danish as represented by the speech in the LANCHART corpus of spoken contemporary Danish (Gregersen et al. 2014; see Section 6.4). This is not an ideal baseline for Argentine Danish as it will compare two products resulting from different historical processes, one taking place in Argentina, detached from the linguistic development in Denmark and under possible increasing influence of Spanish, the other taking place in Denmark under the influence of other sociocultural factors. An ideal baseline would be a corpus consisting of the Danish varieties spoken by the ancestors of this study's speakers, the people who emigrated. Such data do not exist, to the best of this author's knowledge.

Another obvious baseline would be to draw data from a corpus representing the speech varieties in Denmark at the time of emigration to Argentina. But the available Danish dialect corpora, CorDiale (Henrichsen 2004) and CoREST (Asmussen 2017), do not allow user access to the sound files for annotation of the affrication. Besides, there are certain methodological problems in using these corpora as a baseline for Argentine Danish, since it is debatable to what extent these dialect corpora represent Danish (dialects) at the time of the emigration of the Argentine Danish speakers' ancestors, 1850–1930. First, we do not know, for all Argentine Danish speakers, the exact home region of their ancestors and their linguistic backgrounds; an often-used broad denomination such as 'Jutland' can mean the presence and absence of a large number of linguistic features defining different Jutish dialects. Second, during the period of emigration, 1850–1930, there was a considerable de-dialectalization process in Denmark, due to industrialization, urbanization, and increase in educational level (Pedersen 2003), factors which

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promoted dialect levelling or standardization so that the speakers of that period could have spoken anything from strong, traditional dialect to standard-like Danish. This has the implication for this study that the emigrants' /t/-affrication could have been weak, rather strong, or totally absent (Brink & Lund 1975:354).

5. Method

5.1 Acoustic measurement of /tˢ/

The acoustic measure used in this study is 'Centre of Gravity' (CoG). CoG is used in a number of studies as a measure of the nature of frication involved in fricatives such as /s/, /ʃ/, /ʐ/ etc. and the frication phase of /tˢ/ (e.g. Tabain 2001, Miller-Ockhuizen & Zec 2003, Haley et al. 2010, Schmid 2011). During the articulation of a sibilant fricative, the air is forced through a narrow constriction of the tongue, at the place of articulation, and as the air hits the teeth and continues out through the lips, a particular turbulent airstream is produced. This turbulence, the frication noise, has a specific spectral property which makes sibilant fricatives characteristic speech sounds acoustically and auditorily. CoG is a measure of the spectral property, and as the spectral properties of a fricative are dependent on the size and shape of the cavity in front of the constriction, different fricatives will generate different CoG values. A fricative articulated with a large cavity, such as palatal /ʃ/ or /ɕ/, will have a small CoG value, reflecting a lower frication noise. A fricative articulated with a small cavity, such as alveolar /s/, will have a large CoG value, reflecting a higher frication noise (Levon et al. 2017:981).

Since the CoG value is dependent on the size of the vocal tract, it is to be expected that there will be a gender effect, as men have larger vocal tracts than women, resulting in lower CoG values for male speakers and higher CoG for female speakers (Fant 1973, Stevens 1998, Stuart-Smith 2007, Levon et al. 2017). In relation to the present study, I expect a labialized consonant to have a lower CoG value than a non-labialized consonant, as the protrusion of the lips increases the length of the speech channel and thereby the cavity, and I expect that /tˢ/ produced by men will have a lower CoG value than when produced by women.

5.2 Segmentation and extraction

The segmentation of /tˢ/ took place by means of Praat (Boersma & Weenink 2017). For each sound file, the annotator searched for words with /tˢ/ in onset position in stressed syllables in text grids with orthographic transcription.

For each occurrence of /tˢ/, the frication phase was identified through visual and auditory inspection. In order to reduce possible influence from neighbouring segments, including possible (high-intensity) influence from the following vowel, the left boundary of the segmentation was placed one-fourth into the frication phase and the right boundary at the lowest possible intensity (Jongman et al. 2000:1255) (see Figure 1).[6]

After segmentation and annotation, a Praat script was run that generated a text file with the extracted acoustic information for the CoG for each annotation. The frication phase was high-pass filtered with 1,000 Hz as the lower limit and 22,000 Hz

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Table 2. Distribution of /tˢ/ tokens broken down by gender and settlement

	Buenos Aires	Eldorado	Pampas	Total
Women	259	241	827	1,327
Men	282	142	531	955
Total	541	383	1,358	2,282

Table 3. Distribution of /tˢ/ according to phonological context ($N = 2{,}282$)

Front vowel, unrounded		Front vowel, rounded		Back vowel		Mid, low vowel		Consonant	
/i/	356	/y/	189	/u/	108	/ɑ/	96	/ʁ/	336
/e/	226	/ø/	29	/o/	237				
/ɛ/	245	/œ/	28	/ɔ/	13				
/a/	315			/ʌ/	104				

as the higher limit in order to exclude possible influence from voicing. CoG values were calculated as an average for the segmented frication phase, and they were computed over a 10 ms Hamming window. The text file was transformed into a spreadsheet that was supplemented by annotation of speakers' metadata and the linguistic context of /tˢ/. This served as the basis for the statistical analyses.

5.3 Number of tokens

Only up to 10 tokens per phonological context per speaker were segmented. The phonological context was defined as the position of /tˢ/ before each of the 14 vowels /i e ɛ a y ø œ ɶ ɑ ɒ ʌ ɔ o u/[7] and the consonant /ʁ/. This provides a maximum of 150 tokens per speaker, and with 42 speakers, a total maximum of 6,300 tokens. In order to include as many different word forms as possible while at the same time allowing the dataset to be representative of lexemic occurrence in actual speech, only four tokens of any one lexeme were included per speaker, calculated from the beginning of the interview. The lexemic limitation and the fact that not all contexts are equally frequent yielded a total of 2,373 tokens. Of these, 91 tokens were removed: 12 tokens with the context /ɒ/ because it was not represented among the Eldorado speakers, and 79 outliers with a *z*-score of +2.0 ('not very conservative', Levshina 2015:59). This resulted in a dataset of 2,282 tokens, as shown in Table 2.

The distribution of /tˢ/ according to phonological context is not homogeneous in the dataset, as shown in Table 3: /tˢ/ is frequent before front, unrounded vowels, and infrequent before the rounded front vowels /ø/ and /œ/ and before the back vowel /ɔ/.

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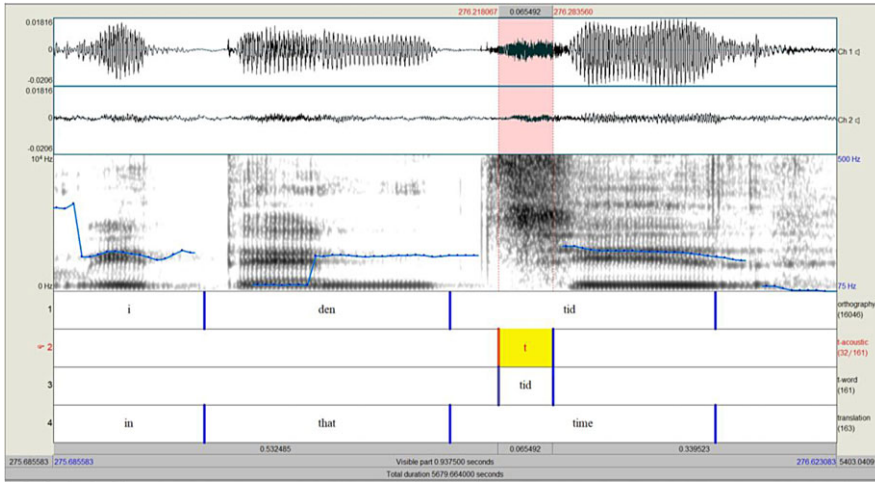

Figure 1. Adapted screenshot of a Praat TextGrid with tiers for orthography, segmentation of friction phase, annotation of word form, and English translation of the word form; target word *tid* /tˢiðˀ/ 'time'. The intervals in the three latter tiers have been inserted manually. The intervals in the orthography tiers are inserted automatically and not always aligned precisely with the sound file.

6. Analysis

This section first presents the acoustic analysis of the Argentine Danish /tˢ/ (Sections 6.1–6.2). This is followed by a summary of the analysis of /tˢ/ in a Modern Danish dataset (Section 6.3) before concluding with a comparison of Argentine Danish and Modern Danish in Section 6.4. See the tables and figures in the supplementary material for further statistical information.[8]

6.1 Argentine Danish: descriptive statistics

The boxplots in Figures 2–4 show how the CoG values vary according to the factors Context, Gender, and Location (see Tables A1–A3 in the supplementary material).

Figure 2 shows that the context of /tˢ/ before rounded front and back vowels triggers lower CoG values (below the average value 5,005 Hz) than before unrounded front vowels and the consonant [ʁ]. The mean CoG value for rounded vowels is 4,380 Hz ($N = 666$), and the mean for unrounded vowels is 5,261 Hz ($N = 1{,}238$). This indicates, as expected, labialization of /tˢ/ as a cavity-expanding coarticulation. Figure 3 shows, also as expected, that /tˢ/ produced by men has on average lower CoG than /tˢ/ produced by women. Figure 4 shows that /tˢ/ produced by speakers in Eldorado has lower CoG than /tˢ/ produced by speakers on the Pampas and in Buenos Aires, indicating a stronger tendency for coarticulatory allophony in Eldorado.

The correlation of Age with CoG was tested with Pearson's product-moment correlation efficient, but no correlation was found: cor $= -0.02$, $t = -0.944$, df $= 2280$, $p = 0.345$; $N = 2{,}282$. There is a considerable inter-speaker variation in the dataset, for both genders and in all three settlements. The mean CoG for men is

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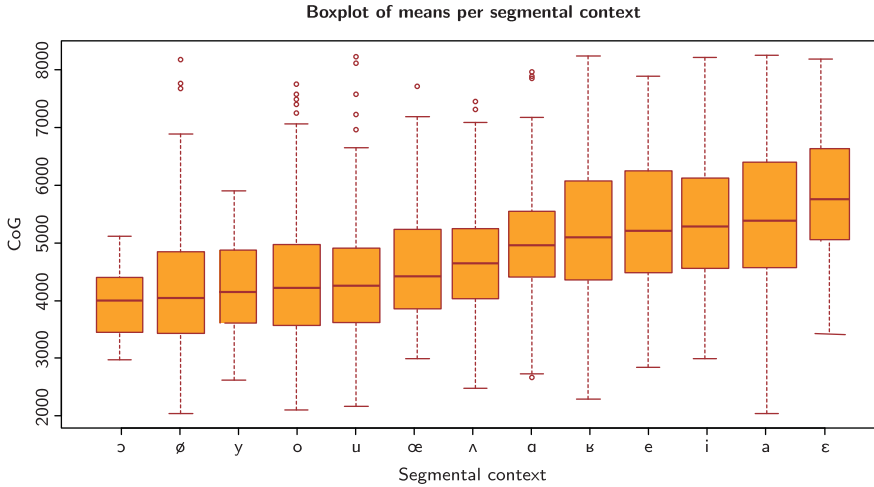

Figure 2. Boxplot of means of CoG (Hz) by segmental context. Total mean CoG value = 5,005 Hz; total no. of tokens 2,282.

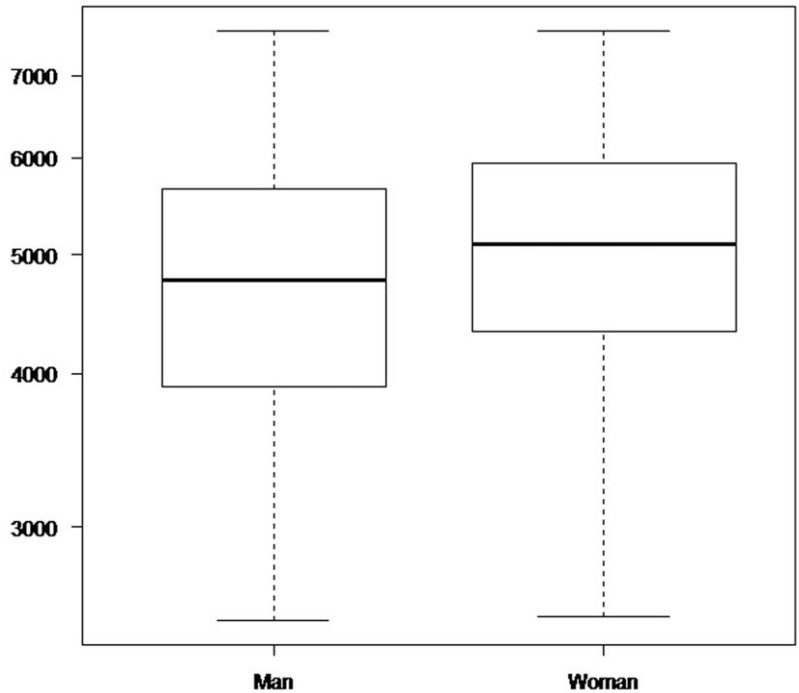

Figure 3. Boxplot of means of CoG (Hz) by Gender.

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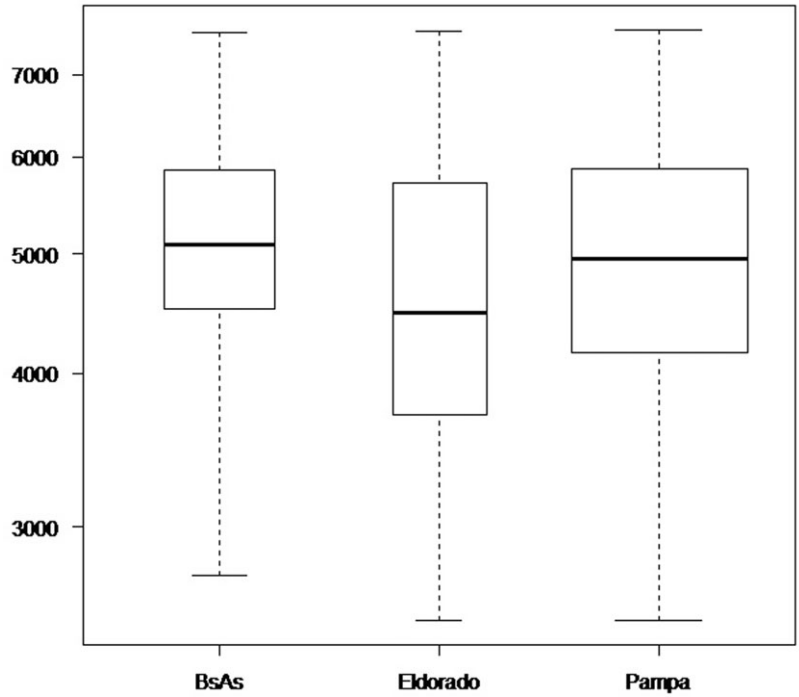

Figure 4. Boxplot of means of CoG (Hz) by Location.

4,830 Hz, the range of means is 3,824–6,552 Hz (955 tokens); the mean CoG for women is 5,131 Hz, the range of means is 3,808–6,825 Hz (1,327 tokens).[9]

6.2 Linear multi-factorial mixed-effect regression analysis of Argentine Danish /tˢ/

The linear multi-factorial mixed effect regression analysis tested a number of models with the factors Context, Gender, Location, and Age with Wordform and Speaker as random factors.[10] The factor Context was defined with two levels, rounded and unrounded. Adding the parameters of tongue height or tongue position (front vs. back) did not result in a better model, that is, the parameters of tongue height and tongue position are not better predictors of the CoG value than the parameters of manner of articulation, labialization of /tˢ/ caused by a following rounded vowel. Since roundedness as a distinctive feature is only relevant for the vowels, the consonantal context /ʁ/ (336 tokens) was excluded from further analysis, reducing the number of tokens to 1,946.[11] The factor Location was defined as binary, Eldorado vs. not_Eldorado (Buenos Aires and the Pampas), as there was no significant difference between Buenos Aires and the Pampas, and as supplementary model testing showed that models with Location as a two-level factor were better than models with Location as a three-level factor.

The final model reported in Table 4 was reached by testing first the significance of one factor and then adding another factor either as a single factor or in a two-way

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Table 4. Final model (N = 1,946). Random factors: Wordform (N = 397) and Speaker (N = 42)

Fixed effects	Estimate	Standard error	*t*-value
(Intercept)	5,794	2289.7	2.531
Roundedness: unrounded	4,432.4	731.8	−6.057
Location: not_Eldorado	−1,435.3	2687.2	−0.534
Age	−24.2	29.7	−0.842
Roundedness: unrounded * Location: not_Eldorado	−4,896.8	857.1	5.713
Roundedness: unrounded * Age	−41.2	9.3	4.421
Location: not_Eldorado * Age	27.1	35.0	0.775
Roundedness: unrounded * Location: not_Eldorado * Age	58.8	11.0	−5.332

or three-way interaction. If a factor as a single factor or as part of an interaction did not contribute significantly to the improvement of the model, it was discarded for further analysis. Models were tested against each other with the function Anova in the languageR package (Baayen 2008).

Unexpectedly, the final model did not include Gender as a significant contribution to the variation of the CoG values, either as a single factor or in two-way or three-way combinations with any of the other factors. This goes against the general tendency for fricatives produced by men to have lower CoG values than those for women (Section 5.1). The model that was found to fit the data best included a three-way interaction Roundedness*Location*Age and three two-way interactions. Table 4, Figures 5–7, and the following text report the results of the analysis.[12]

For all plots in Figures 5–7 we see that a rounded context gives a lower CoG, as shown on the *y*-axis, with the predicted means of CoG given the reference level of the included factors. However, the difference between the effects of a rounded and an unrounded context varies according to other factors. The interaction Roundedness*Location (Figure 5) shows that in an unrounded context there is hardly any difference between the two locations; in a rounded context, i.e. before a rounded vowel, /tˢ/ is more labialized in the group of Eldorado speakers.

The effect that Age has in interaction with Roundedness and Location is intriguing, as illustrated by Figures 6, 7a, and 7b. In Figure 6, for both locations not_Eldorado and Eldorado, we can see that the oldest speakers have a larger contrast between the effects of a rounded and an unrounded context than the youngest speakers. Figures 7a and 7b break up the three-way interaction Roundedness*Location*Age into the two subsets not_Eldorado and Eldorado. Figure 7a, subset not_Eldorado, reflects the general pattern shown in Figure 6. Figure 7b, subset Eldorado, shows the reverse pattern as the oldest speakers have a smaller contrast between the two contexts and a remarkably low CoG for /tˢ/ in an unrounded context.

This result indicates age-related change internally in the Danish speaking communities in Argentina, but I shall refrain from speculating further on this result, as the data from Eldorado are too sparse to enable firm conclusions to be drawn. There are only 8 Eldorado speakers and only 6 years' difference between the

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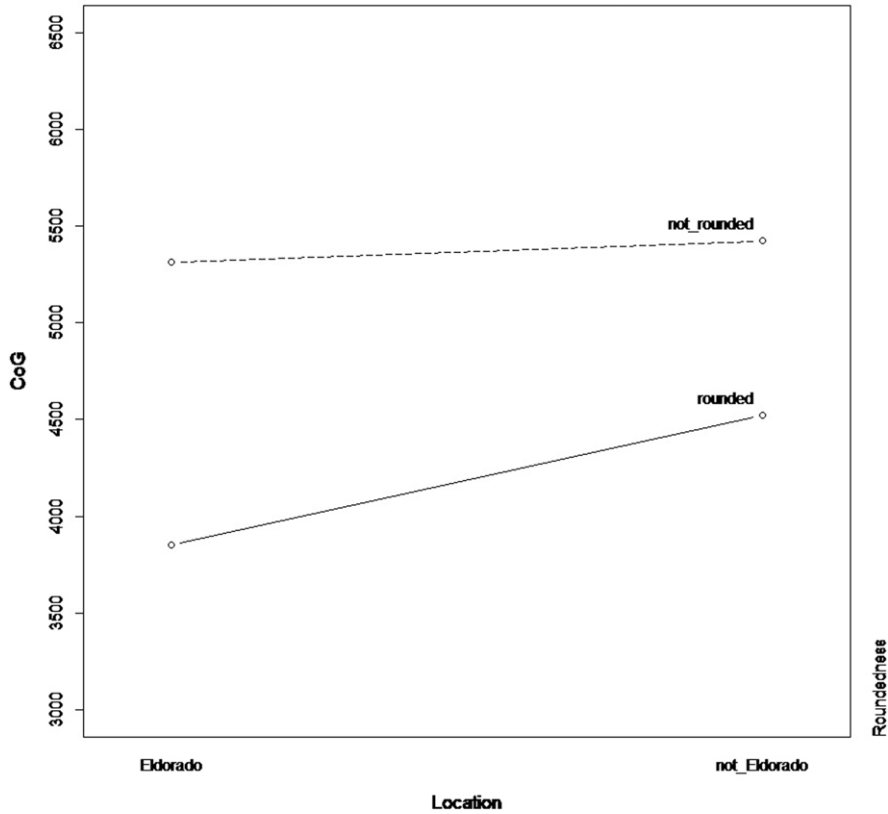

Figure 5. Estimated effect of Roundedness and Location on CoG.

youngest in a 'group' of the oldest (79, 86, and 94 years) and the oldest in a 'group' of the youngest speakers (65, 71, 72, 73, and 73 years). Furthermore, the effect is low (Table 4).

To sum up, the articulation of /tˢ/ in Argentine Danish is affected by linguistic context, the roundedness of the following vowel, and at the same time has sociolinguistic significance. A following rounded vowel results in a lower CoG value, i.e. reflecting a larger cavity before the contact zone of the tongue and the alveolar ridge. The effect that this has on the CoG is present in all three settlements, but it is significantly stronger among the Eldorado speakers. Unexpectedly from the descriptive statistics, Gender did not appear as a significant factor in the final model, and Age emerged as a significant but weak factor in the multi-factorial regression analysis.

6.3 Modern Danish /tˢ/: summary

Modern Danish pronunciation of /tˢ/ is represented by the speech of 34 speakers from the LANCHART corpus of Modern Danish (Gregersen et al. 2014).[13] The procedure for extraction and annotation was the same for this dataset as described

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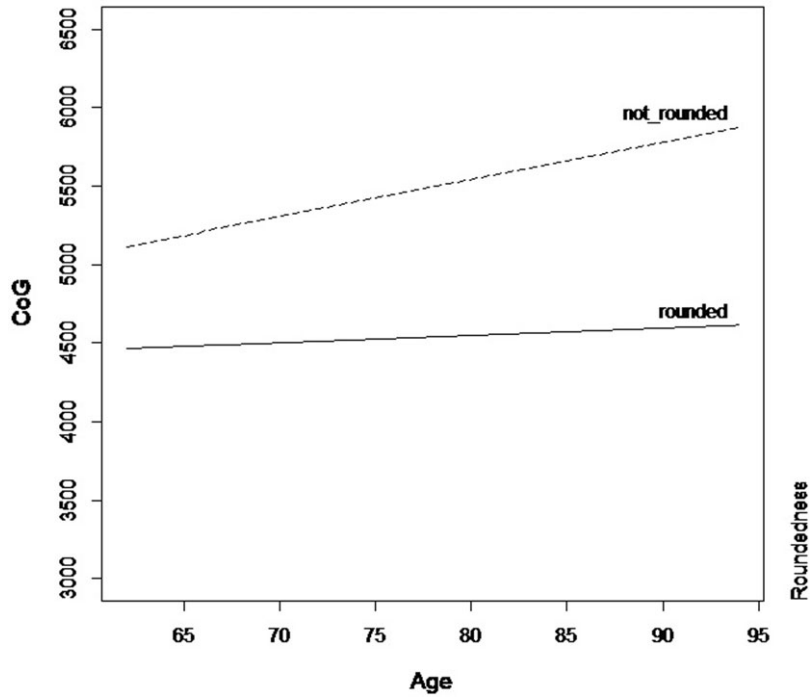

Figure 6. Estimated effect of Roundedness and Age on CoG.

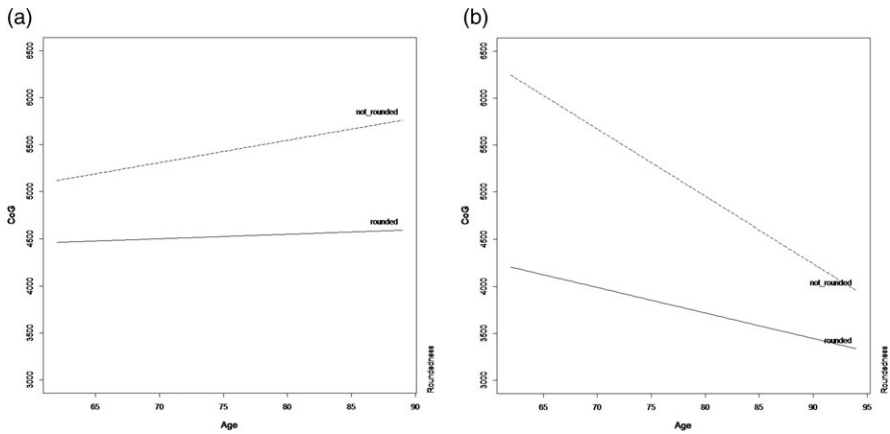

Figure 7. Estimated effect of Age and Roundedness: (a) subset = not_Eldorado, (b) subset = Eldorado.

for the Argentine Danish dataset. With the exclusion of outliers above and below 2.0 and −2.0 standard deviations away from the mean of the CoG value (Levshina 2015:59), and with exclusion of tokens of /tˢ/ before /ʁ/, the dataset includes a total of 1,931 tokens produced by 16 men and 18 women, with a mean age of 57 years and

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an age span of 39–70 years. (Table A7 in the supplementary material breaks down the distribution of the tokens into Gender, Location, and Age.)

Anova testing for the CoG variation according to following phonological segment showed that this is statistically significant ($F = 23.16$, $p < 0.001$, df = 12; see Table A8 and Figure A3 in the supplementary material). As for Argentine Danish, rounded vowels trigger a lower CoG value: /u ʌ o ɔ y œ/ all have CoG values below the mean 4,981 Hz, with /ø/ a little above the mean, 4,995 Hz. This confirms that labialization also in Modern Danish is a cavity-extending coarticulatory feature for /tˢ/. A series of Anova testing indicated a significant gender difference ($F = 140.2$, $p < 0.001$, df = 1; Table A9 and Figure A3), but the factor Location is not statistically significant in the Modern Danish dataset ($F = 1.737$, $p = 0.157$, df = 3; Table A10). As in Argentine Danish, the Modern Danish dataset contains significant inter-speaker variation (Tables A11–A12 and Figures A4–A5).

6.4 Comparison of Argentine Danish and Modern Danish

In the following, the CoG values for /tˢ/ produced by speakers of Argentine Danish are compared with /tˢ/ produced by speakers of Modern Danish. In both varieties, the articulation of /tˢ/ is affected by the roundedness of the following vowel, but the question is whether this is the case to a larger extent in Argentine Danish than in Modern Danish, i.e. whether Argentine Danish has enhanced the coarticulation feature. In this analysis, Country (Argentina, Denmark), Gender (man, woman), Roundedness (rounded, unrounded), and Age (39–89 years) are independent factors. All tokens produced by speakers from Eldorado were excluded from the Argentine Danish dataset because the analysis above showed that these speakers had a stronger effect of labialization on /tˢ/ than the other Argentine Danish speakers. In effect, then, the analysis shows the difference between Modern Danish and Argentine Danish as spoken in Buenos Aires and on the Pampas. Table 5 presents the dataset and Table 6 the model that best explained the variation in the dataset.

Figure 8 shows that there is a larger difference between the effects of rounded and unrounded vowels on /tˢ/ in Argentine Danish than in Modern Danish; in other words that the effect of coarticulation is larger among the Argentine Danish speakers. Figure 9 shows, as expected, that tokens of /tˢ/ produced by men have a lower CoG than those produced by women, irrespective of phonological context.

The plots in Figure 10a and 10b break up the three-way interaction Gender*Roundedness*Country into Argentine Danish and Modern Danish. The plots show that the factor Gender has different effects in the two datasets: there is a smaller difference between the effects of Roundedness on /tˢ/ for the men in the Modern Danish dataset than for the men in the Argentine Danish dataset.

Figure 11 illustrates the interaction Age*Roundedness. It shows that the older the speakers, the larger the difference between the effects of a following rounded vs. unrounded vowel. Behind this result lies a significant effect of Age on the difference between the effects of rounded and unrounded vowels among the Argentine Danish speakers but not among the Modern Danish speakers, confirming the weak effect of Age illustrated in Figures 6 and 7a.

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Table 5. The dataset for the comparison of Argentine Danish with Modern Danish

	Argentina	Denmark	Total
Men	13	17	39
Women	21	20	39
Total	34	37	78

Table 6. Final model; observations (N = 3,553). Random factors: Speaker (N = 68) and Wordform (N = 904). (Not included: Eldorado speakers and occurrences before /ɒ/ and /r/.)

Fixed effects	Estimate	Standard error	*t*-value
(Intercept)	3942.5	817.5	4.822
Roundedness: rounded	247.2	273.5	0.904
Country: Denmark	−84.4	315.6	−0.268
Gender: woman	208.9	227.9	0.916
Age	17.2	10.5	1.639
Country: Denmark * Gender: woman	454.3	319.1	1.424
Roundedness: rounded * Country: Denmark	219.5	97.3	2.255
Roundedness: rounded * Gender: woman	187.3	76.0	2.465
Roundedness: rounded * Age	−15.9	3.5	−4.541
Roundedness: rounded * Country: Denmark * Gender: woman	−598.0	102.5	−5.834

7. Discussion

The analysis has shown for both Argentine Danish and Modern Danish that the CoG measured in the frication phase of /tˢ/ correlates with segmental context: it is lower before rounded vowels and higher before unrounded vowels. This is a clear indication of a general labialization as a coarticulation feature of /tˢ/. This reflects a 'universal' tendency (Hyman 2015) for coarticulation. The analysis also showed that this coarticulation is stronger in Argentine Danish than in Modern Danish, suggesting that an enhancement of the coarticulation feature, or 'phonologization', following Hyman (2015:6), has taken place. In the following, I discuss the implications that these findings may have and present further observations.

7.1 Gender

The male speakers in the study have lower CoG values than the female speakers (see Table A2, Tables A5–A6, Figures A1–A2, and Figure A3 in the supplementary material). This is in accordance with previous studies and it seems reasonable to conclude that this is an effect of men's larger oral anatomy (Fant 1973, Stevens 1998, Stuart-Smith 2007). Why, then, does Gender not appear as a significant factor in the Argentine dataset (Table 4) when the individual speaker is included as a random factor? One possible explanation could be that it is a reflection of the notable

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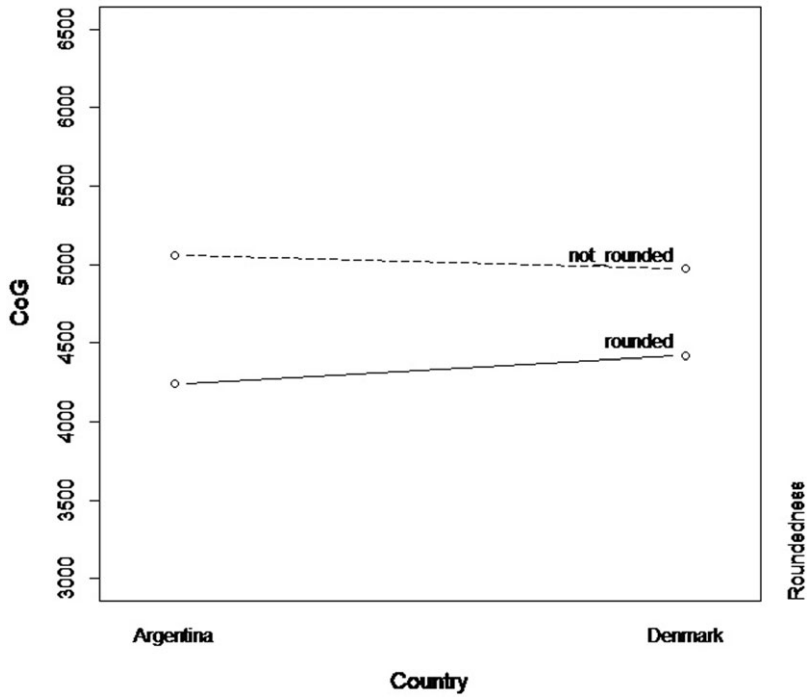

Figure 8. Estimated effect of Country and Roundedness on CoG.

inter-speaker variation, where some women increase their cavity, for example through coarticulatory palatalization (or less likely that some men decrease their cavity), or, to put it differently, that some women are forerunners in the phonologization of [tˢʷ]. An obvious next step on this path would be to explore this inter-speaker variation further, for example from a network perspective (Milroy 1987). Supplementing this, it would be of interest to see whether the same women are also forerunners of other innovations in Argentine Danish (see Section 2).

7.2 Eldorado

It was a clear finding that the effect of coarticulatory labialization is greater in the Eldorado community than in the communities of Buenos Aires and the Pampas, indicating that the enhancement of the coarticulation allophony has gone a step further in Eldorado. This is not the only aspect of Argentine Danish where the Eldorado speakers differ from the speakers in Buenos Aires and on the Pampas in a direction away from Standard Danish; Heegård Petersen (2018) provides evidence for a lexical feature and Kühl & Heegård Petersen (2021) for a grammatical feature. Taken together, these three studies point in the direction of a development of a particular Argentine Danish variety in the Danish colony in the far north. It is for future studies to analyse other variables and include the sociolinguistic perspectives of the different Danish settlements in Argentina.

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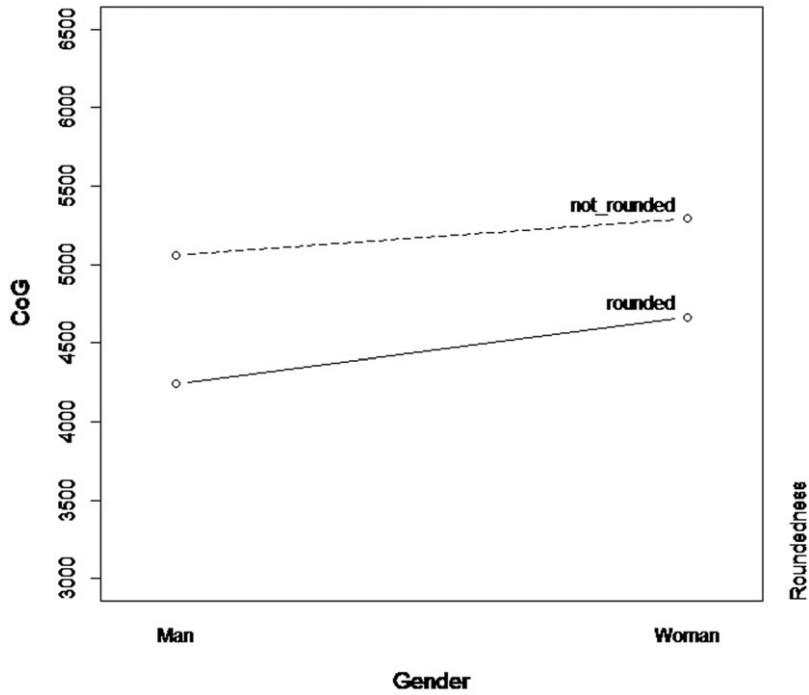

Figure 9. Estimated effect of Gender and Roundedness on CoG.

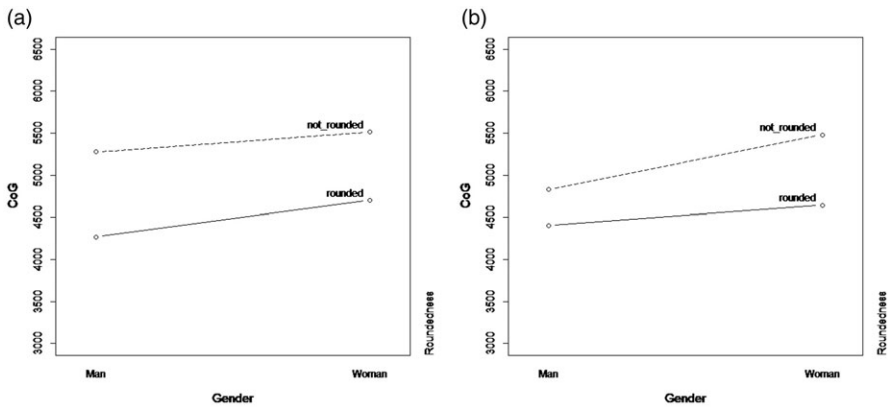

Figure 10. Estimated effect of Gender on Roundedness: (a) Argentine Danish, (b) Modern Danish.

7.3 Is /t^{s}/ also palatalized?

Without a supplementing articulatory study, we cannot exclude that /t^{s}/ is also articulated as palatalized, as palatalization would also cause an extended cavity and therefore lower CoG compared to /t^{s}/ without palatalization. The phoneme

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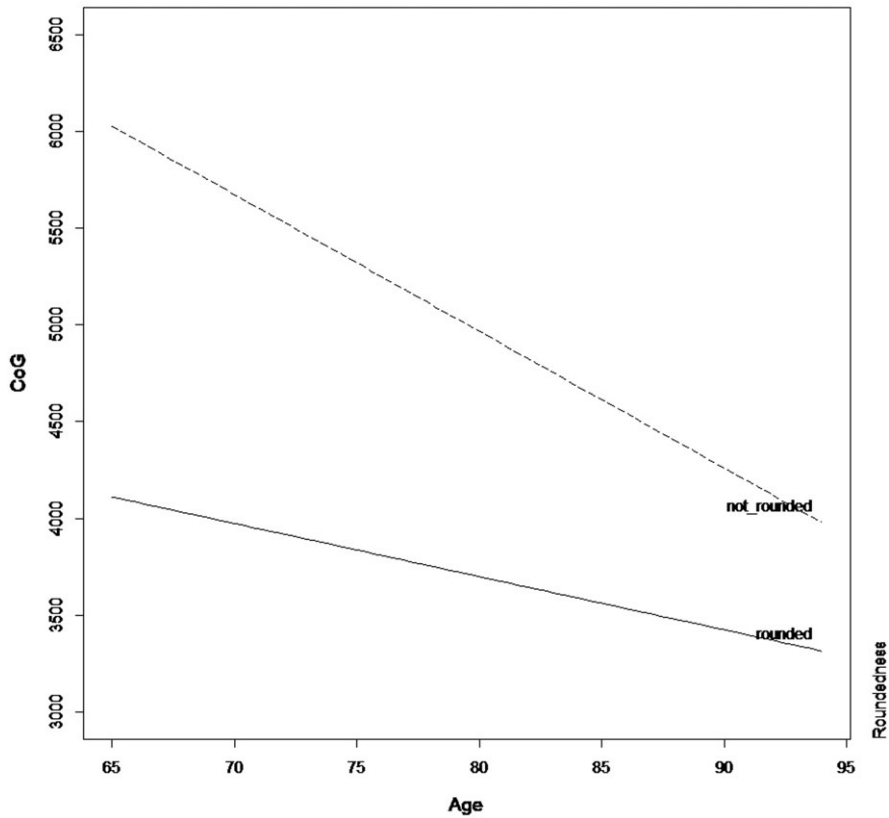

Figure 11. Estimated effect of Age and Roundedness on CoG.

sequence /tˢ+j/, as in *tjener* 'waiter', *tjo* 'well' (interjection), and *tjat* 'dab', is pronounced as a palatal affricate, [tᶜ], in both Modern Danish and Argentine Danish (Brink & Lund 1975, Basbøll 2005, Grønnum 2005, 2007), and we would therefore expect higher CoG for /tˢ+j/ compared to /tˢ/ (in an unrounded context). But as Table 7 shows, this is not obviously so.

Table 7 shows the effect of Location on /tˢ/: Eldorado speakers have lower CoG values than the speakers elsewhere, except for women before unrounded vowels. Also, as expected, we can see that the men's average CoG value is consistently smaller than the women's, and that the CoG values are higher for Argentine Danish /tˢ/ than for Argentine Danish /tˢ+j/ for both genders and before unrounded vowels. For all speakers from Buenos Aires and the Pampas, there is a significant difference between the CoG values for /tˢ/ and /tˢ+j/ ($t = 3.1167$, df $= 93.967$, $p = 0.002427$). This also holds true for the men in this group ($t = 2.8608$, df $= 32.957$, $p = 0.007282$) though not for the women ($t = 1.9226$, df $= 60.465$, $p = 0.05925$). In overall terms this indicates that /tˢ/, unlike /tˢ+j/, is not palatalized across the board, but some women either labialize /tˢ/ in unrounded contexts or they (also) palatalize /tˢ/. There is, however, only a weak empirical basis for firm conclusions,

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Table 7. Average CoG values (Hz) in the phonological context rounded vs. unrounded vowel for /tˢ/ and /tˢ+j/ in Argentine Danish

		Buenos Aires and Pampas		Eldorado	
	Context	/tˢ/	/tˢ+j/	/tˢ/	/tˢ+j/
Men	Rounded	4,074 (207)	4,679 (1)	3,694 (53)	—
	Unrounded	5,278 (353)	4,769 (28)	4,649 (75)	—
Women	Rounded	4,596 (303)	—	3,983 (77)	—
	Unrounded	5,440 (568)	5,190 (48)	5,535 (134)	5,197 (4)
All speakers	Rounded	4,384 (510)	4,679 (1)	3,865 (130)	—
	Unrounded	5,378 (921)	5,035 (76)	5,220 (209)	5,197 (4)
All speakers	Both contexts	5,024 (1,431)	5,030 (77)	4,699 (339)	5,197 (4)

with only 81 occurrences of /tˢ+j/ (26 speakers), and only one occurrence before a rounded vowel, in the interjection *tjo* [tᵉoː] 'well'.[14]

7.4 Enhanced coarticulatory labialization of /tˢ/ is (probably) not an influence from Argentine Spanish

Argentine Danish shows several innovations due to influence from the majority language Argentine Spanish (see references in Section 2.3), and it could be questioned whether the enhanced coarticulatory labialization of /tˢ/ is also a borrowed feature from Argentine Spanish phonology. To the best of this author's knowledge, there is little indication in the literature that Argentine Spanish fricative /ʃ/ – or /s/ or /ʃ/ – are labialized in general or particularly so before rounded vowels. The only clue comes from Zabala et al. (2016:160), who state that the noise frequency of palato-alveolar /ʃ/ can change depending on the formants of the neighbouring vowels, referring to García Jurado (2005), according to whom /ʃi/ has an initial transition frequency of 2.146 Hz, while that of /ʃo/ is 1.735 Hz. Apart from this documentation of an expected coarticulation process, there are no indications in the phonetic descriptions of Argentine Spanish that coarticulatory labialization should be a prominent or inherent feature of /ʃ/ (or other fricatives) (Lipski 1994:168–172, Harris & Kaisse 1999, Baker & Wiltshire 2003, Hualde 2005, Chang 2008, Kochetov & Colantoni 2011, Colomá 2018). Further research is required to establish whether this is because /ʃ/ is not generally labialized, or whether labialization before rounded vowels is considered a natural process of coarticulation and therefore does not attract attention.[15]

7.5 Why enhanced coarticulation?

Since neither historical nor contact-linguistic explanations are obvious or clearly identifiable as relevant for the phonologization of coarticulatory labialization of Argentine Danish /tˢ/, we are directed towards considering a language-internal explanation. Why should a listener 'fail' to 'hypo-correct' for the noise, the

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perturbations, and take the actual pronunciation at 'face value' as the intended pronunciation (Ohala 1993b)?

One answer could be that the coarticulatory feature has become a signal for the rounded vowel, in Keyser and Stevens' (2001:287) words, 'Enhancement . . . can be considered as a form of "fine-tuning" of a basic phonological contrast,' the basic phonological contrast in this case being the roundedness distinction for (front) vowels in Danish. This hypothesis does not find obvious support in the Argentine Danish data at hand. From Figure 2 (and Table A8 in the supplementary material), we learn that the (rounded) back vowels have a larger effect on /tˢ/ than the rounded front vowels.

The enhanced coarticulation as a signal for a following rounded vowel may also be interpreted as a compensation for less rounded vowels and thereby maintaining or emphasizing the phonological contrast between /C+V[−round]/ and /C+V[+round]/. This would be a case of 'trans-phonologization' (Hagège & Haudricourt 1978:75, Hyman 2015:9; see also Harrington et al. 2019:413) and it could eventually lead to a new phonemic contrast, /C/ vs. /Cʷ/, if the source that triggers the roundedness, the rounded vowels, disappears or weakens drastically as a phonological feature. Future comparative studies of F3 differences in Modern Danish, Argentine Danish, and Argentine Spanish rounded (back) vowels will show if this hypothesis holds. If the enhanced coarticulation compensates for loss or weakening of distinctive roundedness in vowels, one expects enhanced coarticulation in the realization of other consonants, or at least in the fricatives /s/ and /ɕ/. There are no reports of this so far, but the present analysis emphasizes the need for a closer auditory and acoustic examination. In addition, comparative perception studies between speakers of Argentine Danish and Modern Danish would shed light on the hypothesis regarding labialization as phonologized in one variant but not in the other.

A second answer could be sociolinguistic and is in fact suggested by Ohala himself; hypo-correction may occur if the listener does not have the experience to do a correction; this is what we see in children's and L2-learners' misconceptions resulting in erroneous pronunciation (Ohala 1993a:246; see also Ohala 1989:186 and Ohala 1993b:162–163). Its relevance is stressed by the fact that Argentine Danish in contrast to Modern Danish does not have a *Dachsprache* (Kloss 1978:60–63, Ammon 2004:330), i.e. a standard, non-local language which serves as a reference and normative language that would hold regiolectal and other variation at bay. This is not to say, of course, that a *Dachsprache* will prevent any synchronic variation from hypo-correction, to use Ohala's term, but the absence of a standardizing *Dachsprache* may provide an additional reason for hypo-correction.

7.6 Enhanced labialization as a language-internal process in a heritage language

What seems to be at play for the enhanced labialization of /tˢ/ in Argentine Danish is a case of a minority language enhancing a characteristic (phonetic) feature without it being an influence from the dominating language. The literature on so-called heritage languages, i.e. languages spoken by descendants of immigrants to other countries where another language is the dominant, majority language,[16] is abundant with examples of language change attributed to language contact. Reported cases of

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language-internal development, i.e. a development that is neither an effect of borrowing from the majority language, nor an effect of a compromise strategy, nor of a mere 'over-use' replication of a feature in the homeland language, are fewer. One example is reported for Italian–German emigrant speakers' tendency to exaggerate Italian consonant gemination, a feature not found in the majority language German (Kupisch et al. 2014). Another example is given by Polinsky (2018:134–135), referring to Lyskawa et al. (2016), who argues that a language-internal development has taken place in Polish spoken by Polish second-generation immigrants in Canada. The Polish heritage speakers 'exaggerate' the devoicing of final voiced obstruents as they devoice these obstruents to a larger degree than the first-generation immigrants and monolingual Polish speakers. Polinsky suggests that this 'may point to a bilingual speaker's overall strategy of amplifying the differences between their two languages' (Polinsky 2018:135).

One implication of a language-internal development to come about (for a significant number of speakers) is that there is or must have been a certain prestige or usage status (among certain groups of speakers) related to the variety. This would give the sociolinguistic basis for certain characteristics of speech to spread and lead them to becoming characteristic of the variety. Such standardization processes have been established for several heritage languages, a well-known example being the development of German Pennsylvanian Dutch in the USA; for other examples, see Putnam (2011), Johannessen & Salmons (2015), and Polinsky 2018). From a Danish perspective, and in contrast to what is known about the development of Danish spoken by descendants of immigrants to the USA (Heegård Petersen et al. 2021), this phenomenon provides linguistic evidence of the Danish speech community in Argentina being internally stable enough to have developed a special linguistic characteristic.

8. Conclusion

This study has investigated a significant feature in the pronunciation of /tˢ/ in Argentine Danish. By measuring the CoG values of 2,361 tokens and correlating these with speakers' gender, age, residence, and with the following vocalic context, the study showed that the frication phase of Argentine Danish /tˢ/ is to a significant extent influenced by a rounded vowel, indicating a coarticulation effect. The study also showed that this coarticulation effect is more prominent in the Eldorado speech community than in the two other communities investigated. By comparing the CoG values of Argentine Danish /tˢ/, excluding speakers from Eldorado, with CoG values of /tˢ/ produced by speakers of Modern Danish, the study further showed that the coarticulation effect is stronger or more generalized in Argentine Danish. An examination of the literature does not seem to suggest any obvious reasons for this allophonic change to have occurred due to contact with Spanish, and the paper therefore concludes that a process of 'phonologization' (Hyman 2015:6) has taken place internally in Argentine Danish. In addition to these results, the study also revealed that there is significant inter-speaker variation. This would be fruitful to investigate in future studies, focusing on the dynamics of individual speaker behaviour, speakers' attitudes towards Standard Danish, participation in networks,

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and with the inclusion of other instances of variation in Argentine Danish as presented in other studies of this variety of Danish.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S0332586524000040.

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Notes

1 See Heegård Petersen & Kühl (2017), Heegård Petersen, Hansen & Thøgersen (2020), and Heegård Petersen, Kühl & Hansen (2020) for examples of lexical influence, and Hartling (2019, 2020) and Kühl & Heegård Petersen (2021) for examples of morphological and syntactic changes attributable to a bilingual Danish–Spanish setting.

2 For the sake of simplicity, I follow the standard representation of this affricate, /tˢ/ rather than the symbol for the lenis articulation (Grønnum 2005:303–305).

3 The affrication varies in strength, and the variation [tʰ] – [tˢ] – [ts] and the variation regarding place of articulation have become a strong sociolinguistic index, with variants having a fronted or 'ad-dental' articulation, [tˢ⁺] or [tˢ̪], vs. not fronted [tˢ] (e.g. Maegaard 2007, Lillelund & Pharao 2014, Pharao & Maegaard 2017).

4 An exception to this is the historically new variant of /tˢ/, palatalized [tᶜ], reported for so-called multi-ethnolect, or 'Danish street language' or 'urban contact variety', before front as well as back vowels and /ʁ/ (Maegaard 2007:87, 187–193, Lillelund & Pharao 2014).

5 The interviews were conducted in 2014–2015 and they last between 60 and 90 minutes. They took place in the speakers' homes and included questions regarding language acquisition and language use as well as questions about the speakers' involvement in Danish-speaking networks; they were open to any topic that the speakers wanted to talk about. The interviews have all been transcribed and are searchable following standardized criteria. See Kühl et al. (2019) for detailed information about the research project, the structure of the database, and the fieldwork.

6 With this procedure, rise time cannot be used as an indicator of whether [tˢ] is a realization of an affricate /ts/, with slow rise time, or as a cluster /t+s/, with long rise time (Johnson 2012:179–180).

7 The phonological context as defined here ignores differences in vowel length, collapsing /i/ and /iː/ into /i/, the allophones [æ], [æː], and [a] into /a/, etc. There are no occurrences of /t/ before /œ/ in the dataset. Interviews or occurrences of tokens with disturbing background noise such as traffic noise, noise from refrigerators, birdsong, etc. were not annotated.

8 The statistical analyses were conducted in the R environment (R Core Team 2013), the descriptive statistics with the use of the package Rcmdr (Fox 2017) and the inferential statistics with use of the packages lme4 (Bates et al. 2015) and languageR (Baayen & Shafaei-Bajestan 2019). Plots were modified by Adobe Illustrator.

9 See Tables A5–A6 and Figures A1–A2 in the supplementary material for numerical information and plot presentations of inter-speaker variation.

10 A series of supplementary tests was run to check whether the CoG values are also influenced by the position of the microphone as a headset microphone (1657 tokens, 35 speakers, mean CoG = 4,916 Hz), lapel microphone (65 tokens, one speaker, mean CoG = 5,106 Hz), or table microphone (225 tokens, six speakers, mean CoG = 5,389 Hz). The statistical tool used was a linear multi-factorial mixed effect regression analysis with Speaker and Wordform as random factors.

11 A supplementary test showed no effects on /tˢ/ of rounded and unrounded vowel after /ʁ/.

12 Following Baayen (2008:248), a *t*-value of +/− 2.0 (rightmost column) is considered the threshold of significance.

13 The data come from recordings of sociolinguistic interviews conducted between 2005 and 2007, all recorded with a headset microphone. The speech in the interviews represents Modern Danish as spoken with varying degrees of regiolectal features in the capital Copenhagen and in the provincial towns of Næstved (Zealand), Odder (East Jutland), and Vinderup (West Jutland).

14 91% of all instances of /tˢ+j/ in Argentine Danish are before the mid front vowel /ɛ/ in the stressed root *tjen* 'serve; service': *betjent* 'police officer' 1, *fortjeneste* 'profit' 2, *gudstjeneste* 'mass (in church)' 27, *tjene* 'serve' 25, *tjener* 'waiter' 8, *tjeneste* 'service; favour' 12, *Chile* 3 (/i/), *chilensk* 'Chilean' 2 (/i/), *Tjæreborg* (proper noun) 3 (/a/), *tja* 'well' 1 (/a/), *tjat* 'dab' 1 (/a/), *tjo* 'well' 1 (/o/). /tˢ+j/ before a rounded vowel is a rare combination in Danish. The Danish Dictionary lists only five words, besides *tjo*, also *tjur* [tᵉuɐ̯ˀ] 'capercaillie', *tju* [tᵉu] 'crash' (onomatopoeia), *tju-bang-film* [tᵉu-] 'movie with a lot of fighting', and *tjørn* [tᵉœɐ̯ˀn] 'hawthorn' (and compounds with *tjørn-*).

15 In Castilian Spanish, Navarro Tomas (1977:125) notes for the lip gesture of /ʧ/ that it is 'conditioned by the following sounds'.

16 For definitions of 'heritage language', see Aalberse (2018), Rothman (2009), and Benmamoun et al. (2013).

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