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# On competing indexicalities in southern Peninsular Spanish. A sociophonetic and perceptual analysis of affricate [ts] through time

Matilde Vida-Castro

Malaga University, Spain
Corresponding author. Email: mvida@uma.es

**Abstract**
This paper examines linguistic, cognitive, and social factors in the development of an ongoing sound change in Andalusian Spanish related to the crosslinguistically well-known process of syllable coda lenition. The resyllabification of word internal /-s/ when followed by dental plosive /t/, in words such as *lingüística* [liŋ·ˈgujs·ti·ka] 'linguistics' realized as [liŋ·ˈguj·tsi·ka], results in an affricate sound [ts] that may be indexed in different ways within the speech community. Findings are reported from a trend study of two sample surveys separated by a twenty-year time gap, acoustic analysis, and two perception experiments. Acoustic phonetics, historical linguistics, theoretical phonology, and sociolinguistic studies provide the theoretical background to help explain the development of this sound change and its connection with other phonological features of Andalusian Spanish. Development of the affricate allophone is a natural outcome consistent with universal constraints boosted by the recent emergence of a regional koine, where its indexicality is undetermined.

**Keywords:** Andalusian Spanish; coda lenition process; word-internal resyllabification; sound change; indexation

Southern varieties of European Spanish are characterized by innovative features sharply contrasting with those of northern Spanish, the basis of the Castilian Spanish standard and, therefore, the most prestigious variety in Spain. Apart from a different phonemic system in onset position, which is a consequence of a set of mergers during the late Middle Ages (e.g., Penny, 2002:98–103), southern European Spanish is known for the lenition process that affects consonants in coda position. For example, words such as *reloj* 'clock' [reˈlox] and *Madrid* 'Madrid' [maˈðrið] are usually realized as [reˈlo] or [maˈðri]. The most salient phoneme undergoing this process is the voiceless alveolar fricative /-s/, which presents aspirated and deleted variants, not only in Spain but also in most Latin American speech communities (Penny, 2002:106-108). In Malaga, the lenition process of postnuclear /-s/ (either word-internal or word-final) is almost completed, as the most frequent variant is the total deletion of this segment (words like *adios* /aˈðjos/ 'good bye' or *isla* /ˈisla/ 'island' are categorically pronounced as [aˈðjo] or [ˈila]), with no statistically significant influence of any external factors (Vida-Castro, 2004:155-78).

The single exception to this rule is when word-internal /-s/ is followed by a voiceless plosive phoneme /p, t, k/. In this particular context and position, the most frequent variants are a set of postaspirated realizations (Torreira, 2006, 2007, 2012), so words like *chispa* /ˈt͡ʃispa/ 'spark,' *agosto* /aˈɣosto/ 'August,' or *casco* /ˈkasko/ 'helmet' are usually pronounced as [ˈt͡ʃipʰa], [aˈɣotʰo] or [ˈkakʰo], especially among the youngest and most educated groups of speakers, while the oldest and less educated ones seem to favor the deletion rule (Vida-Castro, 2004:159, 192). More specifically, when word-internal /-s/ is followed by the dental voiceless plosive /t/, it is nowadays common to hear an allegedly new affricate variant, such that words like *estudiar* /estuˈðjar/ 'to study' or *fiesta* /ˈfjesta/ 'party' are pronounced as [etˢuˈðjaʳ] or [ˈfjetˢa], especially by young female speakers (Vida-Castro, 2018:106-107).

In this paper, historical linguistics, theoretical phonology, and sociolinguistic studies provide the theoretical background to help us explore the development of this sound change. Data are extracted from (1) a trend study where two sample surveys separated by a twenty-year time gap, between 1995 and 2015, are compared; (2) an acoustic analysis based on the 2015 corpus of data; and (3) two perception experiments. The results show that (i) the acoustic characteristics of the affricate sound can be interpreted as the result of a re-syllabification process where postnuclear /-s/ changes its position to the onset of the following syllable; (ii) the acoustic cues that define the acoustic distance between the new sound and the voiceless palatal affricate /t͡ʃ/ seem to be operative in the perceptual discrimination tasks, especially among the youngest listeners; (iii) the frequency of the resyllabified variant has significantly increased over the last twenty years; and (iv) its social distribution has also changed during the same period of time, so that different and competing indexicalities may be associated to the affricate (new) allophone in the context of the emergence of an intermediate variety between the southern vernacular varieties and the national standard (Villena-Ponsoda & Vida-Castro, 2017, 2020).

## Theoretical background

### *Universal linguistic constraints on the coda lenition process*

The lenition process of codas is a crosslinguistically well-known language-internal tendency that affects consonants in a weak syllabic position. Examples can be found in different languages such as English (Guy, 1980; Labov, 1972:216-23; Neu, 1980; Raymond, Dautricourt, & Hume, 2006; Wolfram, 1969); Dutch (Hinskens, 2009; Hinskens & van Hout, 1994:297-310), German (Gilles & Hinskens, 2019), Brazilian Portuguese (Naro, 1981; Scherre & Naro, 1991) or Spanish (Penny, 2002:106-108), among many others. Although some coda lenition examples can be considered specific cases of simplification of consonant clusters ending in /-t, -d/, the deletion process usually applies to every sort of consonant (and not only plosives or fricatives, but also nasal, laterals, and rhotics) in postvocalic positions–and even with grammatical functions.

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In the particular context of postnuclear /-s/ variable realization in European Spanish, it can be assumed in the framework of Optimality Theory that a set of conflicting constraints are either triggering or blocking the deletion process (Boersma, Dekkers, & van de Weijer, 2000:2-4; Prince & Smolensky, 2004:1-10). Thus, among the more conservative varieties of Spanish (those upon which the Castilian standard variety has been formed and that preserve syllable-final /-s/), the *Faithfulness* family of linguistic constraints (those that make it possible that every segment of the *input* has a physical representation in the *output*) dominates over *Well-formedness* constraints (which promote open-syllable structures); on the contrary, among innovative varieties (those which frequently delete syllable-final /-s/), syllabic *well-formedness* is the most dominant constraint even when the morphological affixation takes place[1] (Vida-Castro, 2004:33-49).

The aspiration rule, which is usually considered the initial stage of the deletion process (López-Morales, 1983:48-51; Samper-Padilla, 1990:127-29; Sankoff, 1986:109-15; Terrell, 1979:154-65), can also be understood in the same framework. Aspirated codas guarantee the phonetic representation of the underlying form, and, at the same time, they can be regarded as more harmonic than fricative or plosive realizations in the postnuclear position according to the sonority scale of sounds (Clements, 1990; Goldsmith, 1990:111; Jiménez & Lloret, 2011). Furthermore, the postaspirated allophones that usually appear in sequences of /-s/ plus voiceless stop (henceforth /-s·C/ sequences (words such as *casco* /ˈkasko/ 'helmet' pronounced as [ˈkak$^{\text{h}}$o] or *estudiar* /estuˈdiar/ 'to study' realized as [et$^{\text{h}}$uˈðja$^{\text{ɾ}}$]) completely satisfy both the *faithfullness* and *well-formedness* families of constraints.

In the framework of Articulatory Phonology, Parrell (2012:38) provided evidence that, in Western Andalusian Spanish, postaspirated allophones of /-s·C/ sequences are the outcome of a shift in the phasing relationship of the articulatory gestures between the glottal spreading gesture for coda /-s/ and the oral closure gesture for the voiceless stop, so the two gestures begin simultaneously (in-phase relationship). This finding not only provides an articulatory basis to explain the resyllabification process in preconsonantal contexts but also reveals that its outcome produces an open-syllable structure which follows the *Well-formedness* restrictions.

Therefore, it can be considered that the postaspirated and affricate allophones that result from the resyllabification process of /-s·C/ sequences constitute an optimal output in maintaining the phonological representation of the underlying forms while also favoring open-syllable structure through a group of sounds that show a natural realization from the articulatory perspective. It should not be forgotten that postaspirated plosives and affricate sounds can be found as phonological categories in several languages, such as Thai, Korean, Lithuanian, Italian, or Catalan (Jiménez, 1995; Ladefoged & Maddieson, 1996:55-56; Maddieson, 1984:12, 28, 38; Rogers & d'Arcangeli, 2004).

## *Long-term sound shifts: diachronic evidence of lenition*

Linguistic evolution of different language families provides clear evidence of the vitality of the aforementioned linguistic constraints. It is well known that word-final /-s/ had a weak articulation among many ancient Indo-European languages, which led to

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its aspiration and even deletion in, among others, Sanskrit, Armenian, ancient Slavic, or Celtic (Alvar, 1955; Meringer, 1923; Politzer, 1947; Väänänem, 1950). It is also known that deletion of the final /-s/ plural marker divided Romance languages into the two main traditional—eastern and western—linguistic groups (von Wartburg, 1952) and that the same process has continued in the western group in French, where the historical deletion of final /p, t, k, s/ took place during the Middle Ages (Meyer-Lübke, 1934).

Another well-documented linguistic change is the development of affricates and fricatives out of voiceless plosives registered among Indo-European languages. A first example can be found in the First Germanic Sound Shift (Grimm's and Verner's Law), where Proto-Indo-European voiceless stops changed into voiceless fricatives, and in the Second (or "High German") Sound Shift (Gloning & Young, 2003:13-15, 32-36), which involved a series of consonant changes that made the three Germanic voiceless stops become affricates or fricatives depending on the phonetic environments (i.e., Modern Standard German /p/ > /p͡f/ in *Apfel* (*apple*) [ˈap͡fəl] and /t/ > /t͡s/ in *Zwei* (*two*) [t͡svai]). Currently, fricative and even affricate variants of /t/ are very frequent in several varieties of modern English (Kallen, 2005; West, 2013).

A second example can be found in Romance languages. In the evolution from Latin to Old Spanish, dental and velar voiceless plosives also evolved, under a process of palatalization in different phonetic environments, into a series of affricate and fricative (new) consonants (Penny, 2002:62-65, 101). Closer to resyllabification of /-s·t/ is the process of palatalization of syllable-final plosive velars, which produced both fricative /ʃ/, /x/, and affricate /t͡ʃ/ outcomes (e.g., Penny, 2002:69-71). This last case, the Latin group K·T > /t͡ʃ/ (NOCTE [ˈnokte] (*night*) > *noche* [ˈnot͡ʃe]), is very similar to the current Andalusian metathesis in words such as *coste* /ˈkoste/ (*cost*, *price*) to [ˈkotˢe]. Additionally, although we cannot find a direct shift from the Latin group /S·T/ to an affricate outcome in Spanish, there are many examples of that transformation in words that come from Arabic (e.g., Ar. *osṭawán* (*hall*) > old Sp. *açaguán* [atˢa ˈwan]) (Alonso, 1967:106-24).

Finally, a postaspirated realization of /-s·t/ can be documented, at least by the late 1950s, in the *Linguistic Atlas of Andalusia* (ALEA) (Alvar, Llorente, & Salvador, 1973, VI: map 1602; Moya-Corral & Tejada-Giráldez, 2020:205; Villena-Ponsoda, 2018:25-31).

### *Sociolinguistic studies on final /-s/ variation in Spanish*

The lenition process of postnuclear /-s/ in Latin American and European innovative varieties of Spanish has been widely studied from a variationist perspective. Studies on Latin American varieties over the last fifty years include those of Donni de Mirande (1968, 1989) in Rosario (Argentina), Cedergren (1972) in Panama, Terrell (1978) in Buenos Aires (Argentina), Poplack (1979) on Spanish speakers in Philadelphia (USA), López-Morales (1983) in Puerto Rico, Alba (1990) in Santiago de los Caballeros (Dominican Republic), or Brown and Torres Cacoullos (2003) in Chihuahua (Mexico), where the authors explored the interrelation between processes of syllable-final and syllable-initial /s/. As to the European Spanish varieties, the most relevant studies were those by Moya-Corral (1979) in Jaen, Samper-Padilla (1990) in Las Palmas de Gran Canaria, Martín-Butragueño (1991) in Getafe, Gómez-Serrano

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(1993) in Linares, Molina-Martos (1998, 2015) in Toledo and Vallecas, Blanco-Canales (2004) in Alcalá de Henares, Kapović (2014) in Ciudad Real, or Fernández de Molina-Ortés in Mérida (2016).

As traditionally described, the lenition process of post-nuclear /-s/ consists of two basic successive steps, that is, the aspiration and the total deletion of the segment: [s]>[h]>[∅]. Thus, most of the aforementioned studies rely on the perceptual categorization of the traditional allophonic realizations, mainly sibilant [s], aspiration [h], and deletion [∅]. However, acoustic approximations to this topic have also been accomplished in different speech communities, for example, by Erker (2010) in Santo Domingo (Dominican Republic) or File-Muriel and Brown (2011) in Cali (Colombia).

In southern Spain, studies conducted by Vida-Castro (2004, 2016) in Malaga, Ruch (2008, 2013, 2018) in Seville, and Tejada-Giráldez (2015) in Granada that address the acoustic characterization of the different variants of /-s/ revealed the presence of post-aspirated allophones whenever postnuclear /-s/ is followed by a voiceless plosive consonant. The acoustic characterization of such aspirated plosive sounds in Western Andalusian Spanish has specifically been explored by Gylfadottir (2019), O'Neill (2010), Parrel (2012), and Torreira (2007, 2012), who established a solid basis for the experimental approach to this set of aspirated variants of /-s/ in coda position. Furthermore, Ruch and Harrington (2014) provided phonetic evidence that postaspiration is a result of a sound change in progress in Western Andalusian Spanish. In a perception experiment, they furthermore found out that postaspiration was a relevant cue for distinguishing the minimal pair /ˈpata/-/ˈpasta/ ('leg' and 'dough' respectively), not only among Andalusian speakers (Ruch & Peters, 2016) but also by listeners of Argentinian Spanish, a nonpostaspirating variety.

As to the special case of the affricate allophone of /-s·t/ in Andalusian Spanish, Moya-Corral (2007) compared the realizations of /-s·t/ in two samples of speakers from Seville (the historical and administrative head city of Andalusia) and Antequera (a town in the province of Malaga, in fact, in central Andalusia), and found that the affricate realizations were favored by educated young informants. Ruch (2008) thoroughly analyzed the acoustic characteristics and the social distribution of this specific sound and the linguistic constraints that favor its realization among a stratified group of fifty-four speakers in Seville. Not only did she study the case of word-internal /-s·t/, but she also analyzed word-final /-s# t/ in sequences such as *los tomates* 'the tomatoes,' which can be realized as [lotsoˈmate]. Her results indicate that the affricate sound is favored in word-internal position, especially in frequent words (Bybee & Hopper, 2001:3), and it is promoted by young speakers. Similarly, in Malaga city (Vida-Castro, 2018), where only word-internal /-s·t/ occurrences have been analyzed, the affricate sound is favored by young speakers. Regarding the Eastern Andalusian Spanish variety, Tejada-Giráldez (2015:82, 164) found that, in Granada, this variant is not frequent at all (1.2%), but the emergence of this allophone is interpreted as an incipient change.

### *The indexicality of a new feature in a blended new variety*

It should be considered that the appearance of the allegedly new affricate allophone of /-s·t/ in Malaga takes place in the context of the emergence of a koinesed variety, which would have developed (since approximately 1950) in southern Spain, between, on the one hand, the Andalusian vernacular varieties and, on the other, the national standard in Spain (Villena-Ponsoda, 1996; Villena-Ponsoda & Vida-Castro, 2017, 2020). The linguistic features that shape this intermediate variety are a combination of northern conservative standard-like realizations of consonants in syllable-onset position (of which most salient is the acquisition of the phonemic contrast between dentoalveolar fricatives /s/ and /θ/) with southern innovative vernacular deletion of syllable-final consonants, especially syllable-final /-s/, which is an unmarked phonetic trait in southern varieties. However, as has been observed elsewhere (Cerruti & Tsiplakou, 2020), not only is the presence of vernacular unmarked features frequent in the formation of regional varieties, but such varieties may also accept and develop linguistic innovations with no basis in either the standard or in local dialects (Auer, 2005:25). This could probably be the case of the affricate allophone [ts] of /-s·t/, that is, the result of a natural shift that finds, in an emerging variety, a fertile environment in which to spread across the speech community.

Recent research on the intermediate southern Spanish variety shows evidence for a perceptually coherent sociolect that indexes a blended identity as it is used by urban, modern, and standard-orientated speakers who are, at the same time, loyal to both the local community norms and the southern traditional values (Villena-Ponsoda & Vida-Castro, 2017, 2020).[2] Bearing in mind that the affricate realization of /-s·t/ is frequent among young educated speakers, it could be hypothesized that it is one of the features forming the intermediate southern variety. However, as it has not traditionally been associated either with the vernacular or with the standard, its social meaning is yet to be assigned, and its indexical values can easily be transformed and enregistered among the speech community members (on these general notions, see Eckert, 2012:94-97; Silverstein, 2003:216-20; Sneller, 2020).

## *Hypotheses*

Based on the background discussed above, the analysis presented in this paper examines the following hypotheses:

- H1: The affricate allophone of /-s·t/ is relatively new in the speech community, and its indexicality is still quite undetermined (Eckert, 2012:94-97).
- H2: The affricate allophone is the result of a resyllabification process (Ruch, 2008:67-73, 2013; Vida-Castro, 2004:61-86) with four basic stages: sibilant, preaspiration, postaspiration, and affricate, in which plosive [t] gradually becomes longer (Parrell, 2012:38) and more fronted (Martínez-Celdrán & Fernández-Planas, 2013:113).
- H3: Listeners are able to associate affricate fronted sounds with /-s·t/ sequences (Ruch & Harrington, 2014).

Related to the hypotheses, three research questions (RQs) can be posed:

- RQ1. Has the frequency of the affricate allophone of /-s·t/ increased over the last twenty years in Malaga city? If so, has the social distribution of the affricate allophone changed? In order to test this question, a trend study compares data from two samples separated by a twenty-year gap.

- RQ2. Which acoustic characteristics contrast the different perceptive categories of /-s·t/? The acoustic analysis of data from the most recent sample responds to this question.
- RQ3. To what extent are the 'resyllabified' (postaspirated [th] and affricate [ts]) allophones of /-s·t/ reliably perceived as an /-s·t/ sequence (and not as a singleton stop or palatal affricate)? Two perception experiments address this point.

## Trend Study

### *Method*

Data were obtained through the recording of partially guided interviews with two representative samples of speakers designed to obtain social and stylistic variation. Both samples were stratified according to three social variables: age, gender, and education (Table 1). It should be noted that this particular study follows the theoretical and methodological framework of the international sociolinguistic research project on Latin American and Castilian Spanish (PRESEEA project) (Moreno-Fernández, 1996).

The first sample was recorded in 1995 using a tape recorder (Sanyo®, TRC 1250), and it is composed of a total of seventy-two interviews (four speakers per cell in Table 1) which were digitized afterward using Audacity® (Vida-Castro, Ávila-Muñoz, Lasarte-Cervantes, Villena-Ponsoda, & Sánchez-Sáez, 2008). The second sample was recorded in 2015, and it consists of a set of fifty-four interviews (three speakers per cell in Table 1) taken with a digital recorder (Roland® R-05). The internal microphone of each recorder was used for the two samples. All the participants come from Malaga city, and the interviews last, approximately, forty-five minutes each. Apart from the partially guided interview, the informants were also asked to fill out a sociological and attitudinal questionnaire to complete the speaker's background and sociological information. In order to test the idea that the affricate allophone of /-s·t/ is an allegedly new variant in the speech community with an undetermined indexicality (H1), the social distribution of the variants of /-s·t/ in each sample was compared. With that purpose, a set of 4,894 tokens of /-s·t/ (2,750 taken from the 1995 sample and 2,144 tokens from the 2015 one[3]), were auditorily codified by the author of this paper into five perceptive allophonic categories:[4] sibilant [s·t], preaspiration [h·t], elision [ø], postaspiration [th], and affricate [ts]. The tokens were listened to in context and in order of appearance. Pearson's chi-squared and Cramer's V tests were used to measure associations between categorical variables, such as the distribution of allophonic categories across the two corpora (Levshina, 2015:199-222). Additionally, a mixed effects logistic regression model (Bates, Maechler, Bolker, & Walker, 2015) was fitted in order to measure the effect size of the social variables. All the statistical analyses presented in the paper were conducted in *R* (*R* Core Team, 2019).

### *Results*

As displayed in Figure 1, the affricate variant of /-s·t/ was not frequent in the 1995 sample (12.80%), where the postaspirated realization [th] (54.87%) and complete

**Table 1.** Tableau of parameters for the two Malaga sample surveys (1995 = 72: 4 speakers per cell; 2015 = 54: 3 speakers per cell)

| | 20-34 year old[1] | | 35-54 year old | | More than 55 | |
|---|---|---|---|---|---|---|
| Education | Men | Women | Men | Women | Men | Women |
| Primary school | | | | | | |
| Secondary school | | | | | | |
| University | | | | | | |

[1]Age is based on year of recording

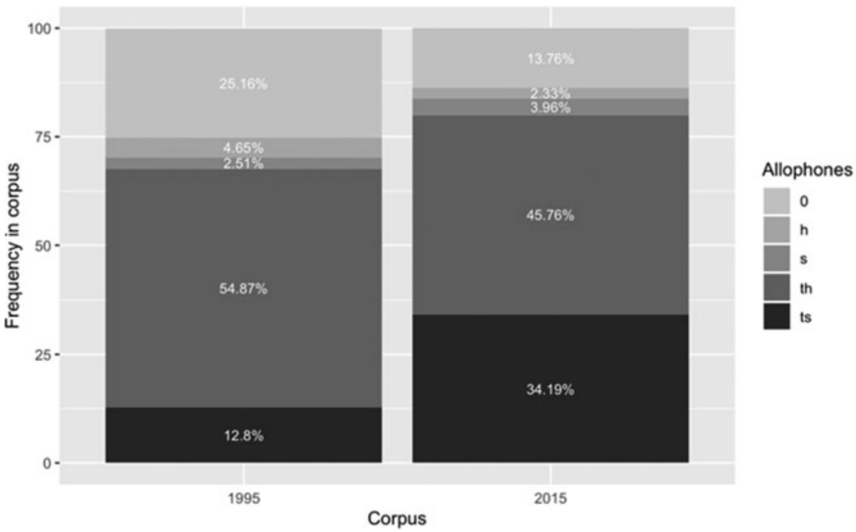


**Figure 1.** Effect of time in the allophonic variation of /-s·t/. Pearson's Chi-squared: 371.94 (4). Sig.: <.001. Cramer's V: .276. (1995 Corpus $n = 2750$; 2015 Corpus $n = 2144$).

deletion (25.16%) were the two main allophones. However, during the last twenty years, the frequency of the affricate realization has sharply soared (34.19%) at the expense of both the deleted and the postaspirated allophone.

Zooming in on the affricate variant, Figure 2 displays the individual probabilities of occurrence of this allophone. As it is apparent, older speakers were hardly using this allophone twenty years ago, and they seldom use it now, while the frequency of using this variant gradually rises among the youngest speakers of both samples.

However, the most striking shift can be found among the youngest female speakers. As readily observable in Table 2, in 1995 only young secondary- and university-level educated women tended to produce this allophone (0.31 and 0.40), while young primary-level educated women hardly used it (0.11). On the contrary, in 2015 a completely different pattern appears: although the use of the affricate variant has increased among all young women, those with the lowest levels of formal education are the ones who are currently leading the change (0.79). The use of the affricate

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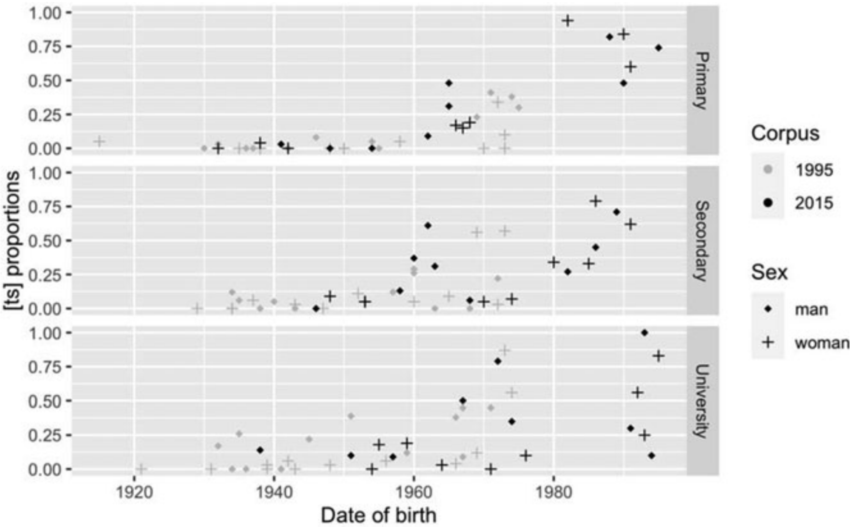


**Figure 2.** By-speaker probability of affrication [ts] in apparent time.

**Table 2.** Mean probability of affrication [ts] in every group of speakers in 1995 and in 2015

| | | > 55 years old | | | 35-54 years old | | | 20-34 years old | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Prim. | Sec. | Univ. | Prim. | Sec. | Univ. | Prim. | Sec. | Univ. |
| Men | 1995 sample | 0.01 | 0.06 | 0.11 | 0.03 | 0.17 | 0.18 | 0.33 | 0.07 | 0.34 |
| | 2015 sample | 0.01 | 0.17 | 0.11 | 0.29 | 0.33 | 0.55 | 0.68 | 0.48 | 0.47 |
| Women | 1995 sample | 0.01 | 0.01 | 0.01 | 0.01 | 0.05 | 0.04 | 0.11 | 0.31 | 0.40 |
| | 2015 sample | 0.01 | 0.06 | 0.12 | 0.17 | 0.15 | 0.04 | 0.79 | 0.58 | 0.55 |

allophone has also increased sharply among the primary-level educated youngest group of men (0.68), but not so much among the university-educated young men in 2015.

Table 3 presents the results of the mixed effect logistic regression analysis. The independent variables selected as fixed factors were age[5] (continuous) and, as data come from two different samples, the interactions of corpus (1995 and 2015) with (1) gender (men and women) and (2) education (primary, secondary, and university).

The results suggest that age and corpus are the most significant factors that predict the realization of the affricate allophone, which is more likely to appear in the 2015 sample and always among the younger speakers (the odds of producing the affricate variant decrease as the age of the speaker rises). Although the tested interaction between gender and corpus is not statistically significant, the coefficients are consistent with the results displayed in Figure 2 and Table 2: the affricate realizations are more likely among women in the 2015 sample than they were in 1995. The main effect of education is superseded by the interaction with corpus: in 1995, speakers were more likely to produce the affricate allophone as their level of education

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**Table 3.** Summary of mixed effects logistic regression for [ts] realizations (versus [0+h+th+s]), speaker as random factor. Signif. codes: '***' < .001 '**' < .01 '*'< .05 '·' < 0.1

| [ts] vs. [0+h+th+s] | | | | | | |
|---|---|---|---|---|---|---|
| Deviance: 3458.2 $R^2$ total 0.605 $R^2$ fixed 0.390 $R^2$ random (speaker) 0.215<br>Frequencies of dependent variable: [ts] = 1085 (22.17%); [0+h+th+s] = 3809 (77.8%); Total *n*: 4894 | | | | | | |
| Predictors | Estimate | Std. error | z value | Total *n* | *n* of [ts] | *p*-value |
| **Intercept** | 0.334 | 0.525 | 0.636 | 4894 | 1085 | 0.524 |
| **Age** | | | | | | |
| +1 | −0.085 | 0.009 | −9.534 | | | <.001*** |
| **Corpus** (Ref = 1995) | | | | 2750 | 352 | |
| 2015 | 2.701 | 0.577 | 4.680 | 2144 | 733 | < .001*** |
| **Gender** (Ref = Men) | | | | 2401 | 574 | |
| Women | −0.883 | 0.392 | −2.249 | 2493 | 511 | 0.024* |
| **Education** (Ref = Primary) | | | | 1711 | 379 | |
| Secondary | 0.708 | 0.493 | 1.437 | 1633 | 319 | 0.150 |
| University | 1.446 | 0.488 | 2.961 | 1544 | 387 | 0.003** |
| **Interactions** | | | | | | |
| **Corpus*gender** (Ref = 1995*Men) | | | | 1362 | 201 | |
| 2015*Women | 0.274 | 0.561 | 0.488 | 1105 | 360 | 0.625 |
| **Corpus*Education** (Ref = 1995*Primary) | | | | 921 | 79 | |
| 2015*Secondary | −0.893 | 0.697 | −1.282 | 703 | 214 | 0.199 |
| 2015*University | −1.662 | 0.698 | −2.381 | 645 | 219 | 0.017* |
| **Comparison of models** | | | | | | |
| Null model: Allophone ~ (1 \| Speaker) | | | | | | |
| Model 1: Allophone ~ Age + (1 \| Speaker) | | | | | | |
| Model 2: Allophone ~ Age + Corpus* Education + (1 \| Speaker) | | | | | | |
| Model 3: Allophone ~ Age + Corpus* Sex + Corpus* Education + (1 \| Speaker) | | | | | | |

| | npar | AIC | BIC | logLik | deviance | Chisq | Df | Pr(>Chisq) |
|---|---|---|---|---|---|---|---|---|
| Null Model | 2 | 3565.4 | 3578.4 | −1780.7 | 3561.4 | | | |
| Model 1 | 3 | 3516.9 | 3536.3 | −1755.4 | 3510.9 | 50.5962 | 1 | < .001*** |
| Model 2 | 8 | 3481.4 | 3533.4 | −1732.7 | 3465.4 | 45.4405 | 5 | < .001*** |
| Model 3 | 10 | 3478.2 | `3543.2 | −1729.1 | 3458.2 | 7.1869 | 2 | 0.027* |

increased while the opposite tendency is found in 2015: the odds of realizing the affricate variant decrease as the level of education rises. The R-squared values reveal that the 39% of the variation explained by the whole model (60%) is due to the fixed predictors, while the remaining 21% is due to individual variation (speaker).

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## Acoustic Analysis

### *Method*

Materials and procedure. In order to answer RQ2, an acoustic analysis based on the 2015 sample was conducted. The 2015 sample was specifically designed to carry out this acoustic analysis of the /-s·t/ allophones, thus, along with the semistructured interview, every participant was asked to read aloud a reading passage, a list of sentences, and a wordlist. The main purpose of this reading task was to obtain a relevant number of the sibilant realization of /-s·t/, the standard variant, which is infrequent in casual styles (Vida-Castro, 2004:117).

A set of 3,430 tokens from the 2015 sample (2,144 from the interviews—see previous section—and 1,286 from the reading tasks) were auditorily classified into the five perceptive allophonic categories described in the previous section (sibilant [s·t], preaspiration [h], elision [ø], postaspiration [th] and affricate [ts]) and segmented using Praat (Boersma & Weenink, 2012). Every word under study was isolated in a separate sound file, and the boundaries for acoustic measure were placed by hand. The labeled segments were: (1) the sibilant [s] or aspiration [h] fricative noise (if any); and (2) the voice onset time (VOT) of the dental stop /t/. A Praat script (Elvira-García, 2019) was used to measure different acoustic parameters that are described in the following paragraphs and represented in Figure 3: (1) duration values; (2) spectral properties (center of gravity and spectral peak location); and (3) zero crossing rates.

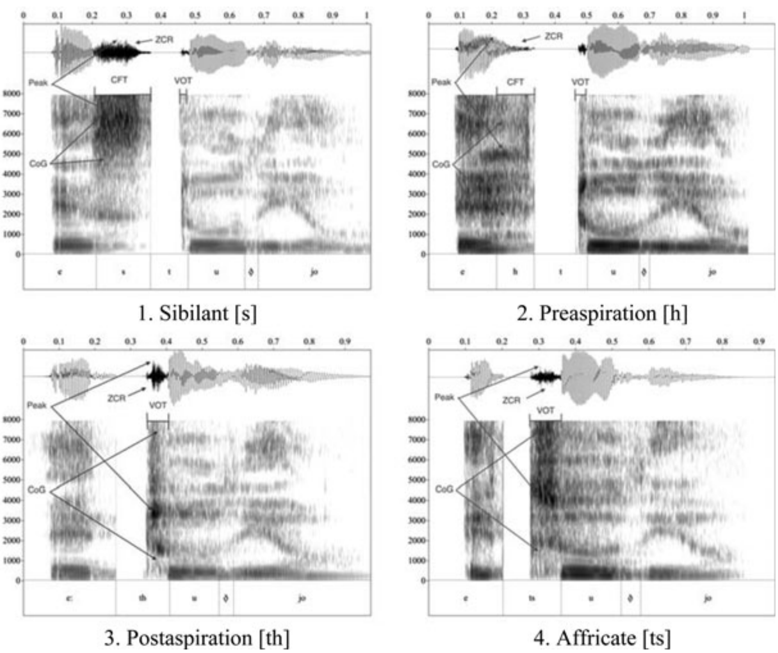


**Figure 3.** Relevant acoustic features related to basic stages in the word-medial /-s + t/ resyllabification process.

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Duration values are related to the duration (milliseconds, ms.) of the fricative noise. Coda Frication Time (CFT) refers to the fricative noise that appears before the stop closure (see spectrograms 1 and 2 in Figure 3). CFT is expected to be shorter in preaspiration [h] than in the sibilant allophone [s] (File-Muriel & Brown, 2011:230). Voice Onset Time (VOT) refers to the length of time between the release of the stop and the onset of the voicing. Plosive [t] is expected to present a shorter VOT than the postaspirated realization [th] (Ladefoged & Maddieson, 1996:66-73; Torreira, 2007:72-77) and the affricate allophone is expected to display the longest values of VOT (Martínez-Celdrán & Fernández-Planas, 2013:46-50).

Spectral properties are values that refer to the spectrum of frequencies (hertz, Hz.) in which fricative noise is produced. Center of Gravity (CoG)[6] is a measure of how high the frequencies in a spectrum are on average and the spectral peak location (Peak) is the period of the maximum (*peak*) energy density (intensity) in the spectrum. Fronted variants ([s] and [ts]) are expected to present a higher CoG and Peak than aspirated allophones [h] and [th] (Gordon, Barthmaier, & Sands, 2002:166-70; Jongman, Wayland, & Wong, 2000:1253-5).

A zero crossing is a point where the waveform crosses the horizontal axis. The zero crossing rate (ZCR) measurement considers the number of zero crossings along the whole interval of the fricative noise multiplied by ten and divided by the whole duration of the interval. ZCR is useful for quantifying the noise level that is present in consonants (Martínez-Celdrán, 2015:121-4). Thus, aspirated [h] and postaspirated variants [th] are expected to present lower rates of zero crossings than the sibilant [s] and affricate [ts] allophones.

It should be noted that spectral properties and zero crossing rates are subject to biological sex effects. As the sample is balanced for gender, the overall results are given in section 3.2, but values separated by gender can be found online in Appendices 1 and 2.

The main purposes of the acoustical scrutiny are related to H2: (1) to check to what extent the idea of the emergence of an allegedly new affricate allophone of /-s·t/ has a physical basis; and (2) to confirm the acoustical contrast among the different perceptive categories, especially the preaspirated versus the postaspirated ones.

Statistical analysis. In order to compare the acoustic features across the perceptual categories it was necessary to check the normality of the samples and their homoscedasticity first, so the Shapiro-Wilk test of normality and the Levene's test for the homogeneity of the variances were used to compare the mean values of every parameter across the five categories. As the results suggested that the assumptions of normality and homogeneity across the groups were not met, nonparametric tests were chosen to contrast the different measures: the Wilcoxon test was used to compare the acoustic features across two groups while the Asymptotic K-Sample Fisher-Pitman Permutation Test, a nonparametric ANOVA based on permutation, was used to contrast all the groups. Additionally, the *post hoc* Nonparametric Multiple Comparison Test for relative contrast effects (Tukey) was performed to find out which groups differ significantly. Additionally, Pearson's chi-squared and Cramer's V tests were also used to examine the relationship between categorical variables (Levshina, 2015:87-113, 171-222).

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### *Results*

According to the data shown in Table 4, where the distribution of the five allophonic categories of word-internal /-s·t/ is observed across two different styles (interview style and reading tasks), reading styles favor the sibilant allophone, while the interview style increases the occurrence of innovative postaspirated [$t^h$] (45.76%) and affricate [$t^s$] (34.19%) variants. Deletion is not very frequent (10.82% of the total cases) and preaspiration is almost absent in this particular context.[7]

As shown above (Figure 3), the location of fricative noise, either before the closure of the plosive (CFT) or immediately after its release (VOT), is the first and evident considerable difference among two main groups of allophones, that is, the postnuclear realizations, [s] and [h], and the postaspirated ones, [$t^h$] and [$t^s$].

Sibilant [s] and preaspirated [h] are the only allophones that show fricative noise in postnuclear position. In Table 5, the values of the main acoustic features of coda fricative noise are shown: sibilant noise is longer, its center of gravity and spectral peak are located at higher frequencies, and it reveals a higher rate of zero crossings than the preaspirated variant. The Wilcoxon test shows significant statistical differences across the two contrasting categories.

When the acoustic features of the plosive [t] are compared across the categories (Table 6), statistically significant differences are also found for most of them. The results of the Fisher-Pitman and the *post hoc* Tukey tests revealed a set of findings that support H2.

First, the affricate allophone [ts] specifically differs from each one of the /-s·t/ variants ([ts] ≠ [s·t]; [ts] ≠ [h·t]; [ts] ≠ [th]; [ts] ≠ ∅) for every acoustic feature (*posthoc* Tukey p-values < 0.001, including the contrast with the adjacent postaspirated category [th]). In fact, [ts] consistently shows longer VOT, higher frequency of both CoG and spectral peak of the fricative noise, as well as a bigger rate of zero crossing.

**Table 4.** Effect of style on the allophonic variation of /-s·t/. Absolute and relative frequencies and statistical significance. Source: 2015 sample

| | Reading | Interview | Total |
|---|---|---|---|
| Sibilant [s·t] | 734<br>57.08% | 85<br>3.96% | 819<br>23.88% |
| Preaspiration [h·t] | 25<br>1.94% | 50<br>2.33% | 75<br>2.19% |
| Deletion ∅ | 76<br>5.91% | 295<br>13.76% | 371<br>10.82% |
| Postaspiration [$t^h$] | 286<br>22.24% | 981<br>45.76% | 1267<br>36.94% |
| Affricate [ts] | 165<br>12.83% | 733<br>34.19% | 898<br>26.18% |
| Total | 1286<br>100% | 2144<br>100% | 3430<br>100% |
| | Pearson's Chi-Squared: 1256.4 (4) Sig.: < .001<br>Cramer's V: .605 | | |

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**Table 5.** Acoustic correlates of coda fricative noise. Means, standard deviation and statistical significance (see Online Appendix 1 for values separated by gender)

| Coda fricative noise [s·t, h·t] | | | |
|---|---|---|---|
| | [s·t] | [h·t] | |
| *n* | 819 | 75 | Wilcoxon |
| CFT | 70 ± 30 | 50 ± 20 | 15326 Sig. < 0.001 |
| CoG | 5650 ± 1746 | 1200 ± 731 | 1089 Sig. < 0.001 |
| Peak | 6133 ± 2643 | 4934 ± 2810 | 20470 Sig. < 0.001 |
| ZCR | 61 ± 36 | 26 ± 17 | 11570 Sig. < 0.001 |

**Table 6.** Acoustic correlates of onset fricative noise in /-s·t/ variants. Means, standard deviation and statistical significance (Online Appendix 2 for values separated by gender)

| Onset fricative noise [s·t, h·t, $t^h$, ts, ∅·t ] | | | | | | |
|---|---|---|---|---|---|---|
| | [s·t] | [h·t] | [$t^h$] | [ts] | ∅ | |
| *n* | 819 | 75 | 1267 | 898 | 371 | Fisher-Pitman |
| VOT | 20 ± 10 | 30 ± 10 | 40 ± 10 | 50 ± 10 | 20 ± 10 | 1500.4 (4) Sig. < 0.001 |
| CoG | 4130 ± 1576 | 3766 ± 1344 | 3998 ± 1277 | 5029 ± 1491 | 3461 ± 1162 | 396.75 (4) Sig. < 0.001 |
| Peak | 4887 ± 2428 | 4582 ± 2316 | 4561 ± 2247 | 5478 ± 2527 | 3962 ± 1800 | 133.26 (4) Sig. < 0.001 |
| ZCR | 45 ± 29 | 47 ± 23 | 46 ± 24 | 64 ± 27 | 34 ± 20 | 403.87 (4) Sig. < 0.001 |

This suggests that the existence of an affricate category, distinct from the traditional postaspirated variant, has a physical basis (H2).

Second, when the variants involved in the postaspiration process are observed, it is apparent that as the resyllabification process advances, the VOT of the following plosive /t/ becomes longer as well. *Post hoc* tests reveal that VOT length consistently contrasts "adjacent" categories: [s·t] < [h·t] < [th] < [ts] ($p$-values < 0.003 in every contrast).

Third, spectral measures and zero crossing rates do not contrast "adjacent" categories such as the sibilant and the preaspirated realizations: [s] = [h] ($p$-values > 0.23), nor the "pre" and "post" aspirated allophones [h] = [th] ($p$-values > 0.37). The only significant difference appears in the contrast of any of these groups with the affricate allophone [ts] (see first point above). The fricative noise found after the release of the plosive is produced at the highest average frequencies (CoG = 5029; Peak = 5478), which, in articulatory terms, means that it is produced in a relatively more fronted position than the rest of the groups (Jongman et al., 2000:1253; Martínez-Celdrán & Fernández-Planas, 2013:107).

## Perception Experiments

The idea that the postaspirated [th] and affricate [ts] sounds are the result of a natural and optimal resyllabification process can also be explored from the listener's

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**Table 7.** List of stimuli for perception experiment 1: target stimuli, distractors and order of presentation to listeners

| Minimal pairs/triplets | Distractors |
|---|---|
| castillo/cachillo ('castle' / 'little piece') | asma/ama ('asthma'/ 'he loves') |
| testar/techar ('to make a will' / 'to roof') | mimo/mismo ('mime'/ 'same') |
| cato/casto/cacho ('I taste'/ 'chaste' / 'piece') | asno/ano ('donkey' / 'anus') |
| moto/mosto/mocho ('motorbike', 'grape juice', 'mop') | isla/hila ('island'/ 'to spin') |
| | muslo/mulo ('thigh'/ 'mule') |
| **Order of presentation** (always in the frame sentence *Digo la palabra* ___ 'I say the word') | |
| castillo, testar, cato, moto, asma, mimo, asno, isla, mulo, cacho, cachillo, techar, casto, mosto, ama, mismo, ano, hila, muslo, mocho | |

perspective. Two different perception experiments were conducted in order to show to what extent listeners from the speech community can recognize the postaspirated sounds as allophones of /-s·t/ segments, such that the articulation of a sequence such as [ˈmo·t$^h$o] or [ˈmo·t$^s$o] is associated to the word *mosto* /ˈmos·to/ 'grape juice,' and not to the word *moto* /ˈmo·to/ 'motorbike' or *mocho* /ˈmo·t͡ʃo/, 'mop' (H3).

### *Perception experiment 1*

Method. The first test was a pilot experiment. A digital recorder (Roland® 05) was used to record the stimuli, a set of ten words pertaining to four minimal pairs or triplets (Table 7) produced by a female speaker from Malaga who realized the segment /-s·t/ with a postaspirated allophone ([ts]). Together with the ten target stimuli, a group of ten distractors was included. Each word was realized inside the carrier sentence *Digo la palabra…* ('I say the word…') which was recorded for each item and played unaltered to the listeners. The order was randomized once, so that members of the triplets/pairs were never adjacent to each other in the trial list and all the informants listened to the words in the same order.

The listeners were the same fifty-four informants who composed the 2015 sample (see Trend Study section). All of them were tested individually just after their interviews. They were asked to write the word they heard on an answer sheet (where no choices were presented) immediately after listening to each sentence only once. An external speaker (Mini Monster Beatbox®) connected to the recorder was used to play the sentences.

### *Results*

The results of the first perception experiment (Table 8) showed a high level of accuracy (90%) in associating the stimuli to their corresponding words. This is not surprising as the stimuli were not manipulated, and the listeners could find phonetic cues in the previous vowel that may facilitate the proper association. But there was an interesting exception related to the minimal pair *castillo* 'castle'/*cachillo* 'little piece.' In this case, the word *cachillo* /ka·ˈʧi· ɟo/ (realized with a dentoalveolar articulation) was interpreted as *castillo* /kas·ˈti· ɟo/ by 29.63% of the listeners (see Ruch [2008:62] for very similar results). This result suggests that a dentoalveolar affricate sound may be associated with the /-s·t/ segment, facilitating the path to the resyllabification process.

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**Table 8.** Answers to perception experiment 1. Total *n* of responses per word = 54. The accurate answers are shadowed

| | Responses | | | |
|---|---|---|---|---|
| | /—s·t/ | /—k·t/ /—p·t/ | /ʧ/ | /t—/ /s—/ |
| *Castillo* 'castle' | 100% | 0% | 0% | 0% |
| *Testar* 'to make a will' | 79.63% | 16.67% | 0% | 3.7% |
| *Casto* 'chaste' | 66.67% | 24.07% | 3.70% | 5.56% |
| *Mosto* 'grape juice' | 98.15% | 1.85% | 0% | 1.85% |
| *Cachillo* 'little piece' | **29.63%** | 0% | 68.52% | 1.85% |
| *Techar* 'to roof' | 0% | 0% | 96.30% | 3.7% |
| *Cacho* 'piece' | 1.85% | 0% | 96.30% | 1.85% |
| *Mocho* 'mop' | 0% | 0% | 96.30% | 3.70% |
| *Cato* 'I taste' | 0% | 1.85% | 0% | 98.15% |
| *Moto* 'motorbike' | 0% | 0% | 0% | 100% |

### *Perception experiment 2*

Stimuli, subjects and procedure. The second perception test was prepared after measuring the acoustic correlates of the different variants of /-s·t/ (see Acoustic Analysis section) and once the data from the pilot experiment had been analyzed. The main goal was to find out which acoustic cues, if any, enable the implicit association of an affricate sound with either the Spanish palatal phoneme /t͡ʃ/—whose occurrence is limited to the syllable-onset position–or the sequence /-s·t/, in which the alveolar fricative phoneme /s/ belongs to the coda of the previous syllable.

It should be noted that statistically significant acoustic differences exist between the most frequent realization of the palatal affricate phoneme /t͡ʃ/ and the affricate variant [ts] of the /-s·t/ sequence (Table 9). Therefore, the main hypothesis here is that listeners are able to recognize those differences and, hence, associate each sound to the corresponding category (H3).

As the main differences between the two affricate sounds in contrast (Table 9) are the spectral measures (CoG and Peak) and VOT duration, a set of nine affricate stimuli was prepared (Table 10). First, a student of Spanish philology, a male speaker from Malaga (who also realized the /-s·t/ segment with an affricate pronunciation [ts]) was trained to read a total of twenty-eight words and nonce-words in the frame sentence *Digo la palabra* ('I say the word') with different phonetic realizations (e.g.: [ˈmata] - [ˈmasta] - [ˈmatsa] - [ˈmaʧa]).[8] The sounds were taken with a digital-recorder (Roland® 05) and then acoustically analyzed with *Praat* using the same procedure explained in the Acoustic Analysis section. After the analysis, three fricative segments were selected based on their respective CoG and Peak values to synthesize the manipulated stimuli. Their duration was altered using the *Manipulation* function to generate three new sound objects out of each one (three natural speech sounds x three manipulations = nine altered

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**Table 9.** Acoustic correlates of affricate sounds. Means, standard deviation, and statistical significance. Source: 2015 sample (see Trend Study section)

| Affricate sounds | | | | |
|---|---|---|---|---|
| | [ts] | [t͡ʃ] | | |
| *n* | 898 | 863 | Wilcoxon | |
| VOT | 50 ± 10 | 70 ± 20 | 572274 | Sig. < 0.001 |
| CoG | 5029 ± 1491 | 4347 ± 1011 | 283650 | Sig. < 0.001 |
| Peak | 5478 ± 2527 | 3945 ± 1385 | 223185 | Sig. < 0.001 |

**Table 10.** Groups of stimuli generated for the perception test

| Group of stimuli | Spectral values (approx.) | VOT duration values (approx.) | | |
|---|---|---|---|---|
| | | 50 ms. | 70 ms. | 90 ms. |
| Apical [ts̺] | CoG. 6500 Hz. Peak 6000 Hz. | [ts̺1] | [ts̺2] | [ts̺3] |
| Dentoalveolar [ts̪] | CoG. 5000 Hz. Peak 5000 Hz. | [ts̪1] | [ts̪2] | [ts̪3] |
| Palatal [ʧ] | CoG. 4500 Hz. Peak 3750 Hz. | [ʧ1] | [ʧ2] | [ʧ3] |

stimuli) with different duration values. The manipulated sounds were analyzed again to test the CoG and Peak mean values.

As a result, the affricate stimuli in the perception experiment can be organized in three groups respectively labeled as apical, dentoalveolar, and palatal. The sounds of the apical group show very high frequencies of the correlates of fricative noise (CoG. 6500 Hz., Peak 6000 Hz.) while the dentoalveolar and the palatal group of sounds feature fricative noise at relatively lower frequencies. As shown in Table 10, nine affricate sounds with different VOT durations were created.

The *Edit* function was used to insert each stimulus after the plosive sound in two different sequences: [ˈmat_a] and [ˈpat_a]. The phonetic context was always the same recorded sequence of sounds that was always included in the same recorded frame sentence, so any other phonetic cues apart from the stimuli were blocked. The resulting sequence *masta* corresponds to the minimal pair *masta*/*macha* (which are nonce-words in southern Spanish), but the second series (*pasta*/*pacha*) contains an available and very frequent unit in Malaga variety (*pasta* 'dough') opposed to *pacha*, which is not a word (Ávila-Muñoz & Villena-Ponsoda, 2010).

Subsequently, an online questionnaire was prepared using LimeSurvey®. The survey included twelve questions about the origin and sociological background of the participant, eighteen queries with the target stimuli and twelve fillers.[8] The thirty sounds were randomized once so all the informants listened to the stimuli in the same order (online Appendix 3).

A total of seventy-one subjects from Malaga participated (forty-seven women and twenty-four men; thirty-nine younger than thirty-five and thirty-two older than thirty-five). All used their own computer to complete the test. In the instructions they were informed about the task: click on a sound icon, listen to the sentence and then click on the sequence they had perceived among three options they were presented with.[9] They were informed that some of the sounds could be "meaningless words."

Statistical Analysis. The association between the listeners' responses and the stimuli was first measured using Pearson's chi-squared and Cramer's V tests. Then, as the participants could choose among three options (a stop, a /-s·t/ sequence or a palatal affricate, that is, *pata*/*pasta*/*pacha*), a multinomial logistic regression model was fitted (Levshina, 2015:277-89). Palatal response /ʧ/ was taken as the reference level, so the model tests how the predictors influence the selection of a /-s·t/ sequence versus the palatal affricate sound and, separately, the choice of a plosive /t/ versus the affricate option. The independent variables selected as predictors were duration (treated here as a continuous variable), stimulus type (apical, dental, or palatal), lexical frame ([pa_a] or [ma_a]) and subject age group. Additionally, interactions were tested between independent variables.

### *Results*

According to Table 11, which shows the distribution of the participant responses across the different stimuli, palatal sounds are mostly related to the Spanish palatal phoneme /ʧ/, whereas those with the highest spectral values (apical group) are usually associated to the /-s·t/ sequence, especially the two longest stimuli of this group. Therefore, fricative noise duration seems to be the factor that determines phoneme discrimination among the dentoalveolar group of stimuli: sounds with longer fricative noise are usually categorized as allophones of the palatal phoneme /ʧ/ while those with the shortest noise are identified as occurrences of the /-s·t/ phonological segment.

The results of the multinomial regression analysis (Table 12) suggest that whether the participants listened to a fronted stimulus (apical or dental) instead of a palatal one, the chances of associating it to an /-s·t/ sequence or even to a single plosive /t/ significantly increased. On the contrary, as the duration of the stimulus increases, it is less likely to get an /-s·t/ or a /t/ response instead of a /ʧ/ one. However, this effect is superseded by the interaction with the stimulus type: the association of longer sounds to an /-s·t/ response increases whenever the participants listen to an apical stimulus instead of a palatal one. Lexical frame does not significantly predict the participant responses, but when the stimulus type changes from palatal to dental, the biased context results in more /-s·t/ sequences associations. Finally, although the participants' age group does not predict the responses, longer stimuli are associated to /-s·t/ sequences when they are presented to the youngest group of participants.

## Discussion

### *H1 A new allophone with an undetermined indexicality*

Although the affricate outcome of the resyllabification process seems to have historical precedents in Indo-European languages, it had not been documented as an independent allophone in the landscape of the innovative varieties of Spanish, where the lenition process of /-s/ takes place. Recent studies indicate that the affricate

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**Table 11.** Effect of noise duration and spectral values on the phoneme discrimination. Absolute and relative frequencies and statistical significance

| Duration | Stimuli | Responses ø | /s·t/ | /ʧ/ | Total |
|---|---|---|---|---|---|
| 50 ms. short | Apical | 67<br>47.18% | 51<br>35.92% | 24<br>16.90% | 142<br>100% |
| | Dental | 40<br>28.17% | 58<br>40.85% | 44<br>30.99% | 142<br>100% |
| | Palatal | 39<br>27.46% | 10<br>7.04% | 93<br>65.49% | 142<br>100% |
| Pearson's Chi-squared: 91.238 (4). Sig.: < .001<br>Cramer's V: .327 | | | | | |
| 70 ms. medium | Apical | 22<br>15.49% | 84<br>59.15% | 36<br>25.35% | 142<br>100% |
| | Dental | 16<br>11.27% | 52<br>36.62% | 74<br>52.11% | 142<br>100% |
| | Palatal | 16<br>11.27% | 6<br>4.23% | 120<br>84.51% | 142<br>100% |
| Pearson's Chi-squared: 112.45 (4). Sig.: < .001<br>Cramer's V: .363 | | | | | |
| 90 ms. long | Apical | 10<br>7.04% | 94<br>66.20% | 38<br>26.76% | 142<br>100% |
| | Dental | 12<br>8.45% | 49<br>34.51% | 81<br>57.04% | 142<br>100% |
| | Palatal | 7<br>4.93% | 1<br>0.70% | 134<br>94.37% | 142<br>100% |
| Pearson's Chi-squared: 146.27 (4). Sig.: < .001<br>Cramer's V: .414 | | | | | |

variant appears in western Andalusian Spanish during the last decades (Moya-Corral, 2007:461; Ruch, 2008:101-102; Ruch & Peters, 2016:13). The results of the trend study in Malaga city provide confirmation: the affricate allophone, which rarely appeared in 1995 (12.8% of the total cases) and only among the youngest, mainly university-educated speakers, has increased sharply during the last twenty years, and it is now the preferred realization of young less-educated speakers. This could support an interpretation of [ts] as a change from below (Labov, 2006:203-209).

The shift leading to the resyllabification process could have originated in the context of the regional koine, the intermediate variety emerging among middle-class young speakers in southern Spanish, which can be–as is the case with similar varieties in different contexts–an enabling environment to spread and develop linguistic innovations (Auer, 2005:25). In 2015, noneducated speakers were the ones leading the change, but as the resyllabification process is also frequent among young educated speakers and middle-aged men, it seems reasonable that competing indexicalities are related to this brand-new allophone (Eckert, 2012:90).

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**Table 12.** Summary of multinomial regression for /-st/ (left) and /t/ (right) responses versus /ʧ/ responses (reference level: /ʧ/ responses)

| | /—s·t/ responses vs. /ʧ/ | | | | /t/ responses vs. /ʧ/ | | | |
|---|---|---|---|---|---|---|---|---|
| Predictors (Total N) | Estimate (SE) | z value | *n* | *p*-value | Estimate (SE) | z value | *n* | *p*-value |
| **Intercept** (1278) | −2.382 (0.436) | −5.464 | 405 | < .001*** | −1.027 (0.268) | −3.825 | 229 | < .001*** |
| **Stimuli** (Ref = Palatal) (426) | | | 17 | | | | 62 | |
| Apical (426) | 3.227 (0.482) | 6.689 | 229 | < .001*** | 1.830 (0.360) | 5.082 | 99 | < .001*** |
| Dental (426) | 1.551 (0.470) | 3.299 | 159 | < .001*** | 0.560 (0.327) | 1.712 | 68 | .086· |
| **Duration** | | | | | | | | |
| +1 | −1.418 (0.391) | −3.625 | | < .001*** | −1.213 (0.256) | −4.728 | | < .001*** |
| **Lexical frame** (Ref = ma_a) (639) | | | 178 | | | | 121 | |
| Pa_a (biased) (639) | 0.089 (0.505) | 0.177 | 227 | .859 | −0.157 (0.288) | −0.543 | 108 | .586 |
| **Age** (Ref = > 35) (576) | | | 155 | | | | 92 | |
| < 35 (702) | 0.321 (0.248) | 1.296 | 250 | .194 | 0.397 (0.231) | 1.716 | 137 | .086· |
| **Interactions** | | | | | | | | |
| **Stimuli*duration** (Ref = Palatal* +1) (426) | | | | | | | | |
| Apical * +1 (426) | 1.285 (0.403) | 3.183 | | .001** | −0.131 (0.295) | −0.446 | | .655 |
| Dental * +1 (426) | 0.755 (0.397) | 1.901 | | .057· | 0.137 (0.281) | 0.490 | | .624 |
| **Stimuli*lexical frame** (Ref = Palatal*ma_a) (213) | | | 8 | | | | 33 | |
| Apical*pa_a (213) | −0.600 (0.562) | −1.066 | 103 | .286 | 0.086 (0.419) | 0.205 | 54 | .837 |
| Dental*pa_a (213) | 1.483 (0.558) | 2.657 | 115 | .007** | 0.229 (0.419) | 0.547 | 25 | .584 |
| **Age*duration** (Ref = >35* +1) (576) | | | | | | | | |
| < 35 * +1 (702) | 0.449 (0.194) | 2.307 | | .021* | 0.200 (0.237) | 0.846 | | .397 |

Frequencies of alternative responses: /ʧ/ = 644 (50%); /—s·t/ = 405 (31%); /t/ = 229 (18%); Total *n*: 1278
Log-Likelihood: -993.28 McFadden $R^2$: 0.23624 Likelihood ratio test : chisq = 614.46 *p*.value = < .001
Signif. codes: '***' < .001 '**' < .01 '*'< .05 '·' < 0.1

When exploring the social meanings of several features of the Malaga variety, Chariatte (2015:133, 137, 144, 155) observes that the affricate variant of /-s·t/ is recognized by the speech community as one of its most salient and widespread characteristics and, at the same time, as a salient feature of the Malaga middle-class variety (see also Ruch, 2018). According to all of this, it may be assumed that, although speakers are nowadays quite aware of the existence of this feature in the Malaga variety, its indexicality is not yet well-defined. Although further perceptual (Chariatte, 2015), stylistic (Eckert, 2012), and ethnographic (Sneller, 2020) investigation about this trait's indexicality is needed, one likely explanation would follow the ensuing line of reasoning:

(1) Resyllabified affricate /ts/ would be intended as a natural, unmarked solution to balance, on the one hand, the southern tendency to delete consonants in coda position and, on the other, the educated urban middle-class trend toward standardization, that is, maintenance of the underlying form of the word, close to the mainstream norm of pronunciation. This urban, modern, standard-like indexicality would likely be sustained originally by [ts] and expanded, especially, by young speakers.
(2) Once [ts] was established, a competing indexicality would have started among lower-class speakers, particularly prone to use unmarked phonetic outcomes. Regardless of its alleged faithfulness to the underlying form of the word, [ts] seems to currently be acquiring a quite different indexicality, probably associated with covert prestige and the local speech community.

### *H2 The resyllabification process*

The acoustic analysis reinforces the idea that the affricate variant is the optimal result of a resyllabification process. As shown in Table 6, the affricate allophone's acoustic correlates significantly differ from the rest of /-s·t/ realizations, even from the very similar postaspirated [$t^h$] variant. Furthermore, its structure and physical characteristics support the idea that postaspirated variants are the outcome of a natural shift in the phasing relationship of the articulatory gestures (Parrell, 2012), from a sequential production in the preaspirated variants (the aspiration precedes the oral closure of the plosive [h·t]) to a simultaneous articulation in the postaspirated allophones (where both gestures begin at the same time). Additionally, it could be assumed that /-s·t/ word-medial articulation is undergoing an assimilatory process (Martínez-Celdrán & Fernández-Planas, 2013:113), where the place of articulation of the first consonant (the sibilant [s] or its lenited variant [h]) blends with the adjacent one during its entire production. The final outcome is a natural and unmarked result from a gradual assimilatory process that maintains on the surface the phonological representation of the underlying form (sibilant fricative /-s/) in an open-syllable structure.

### *H3 Categorizing affricate sounds*

According to the results of the two perception experiments, in Malaga coronal affricate sounds with particular acoustic characteristics (mainly, high rates of spectral values–CoG and Peak) were perceived as an /-s·t/ sequence, which contains a segment that belongs to a postnuclear syllabic position in the underlying representation. These results, in line with those reported by Ruch and Harrington (2014) and Ruch and Peters (2016), reinforce the idea that the resyllabified allophones constitute an optimal output, not only from an articulatory perspective, but also from a perceptual one, as they maintain the phonological representation of the underlying forms.

It seems expected that listeners will be more likely to identify the /-s·t/ sequence (against any other possible candidate with /ʧ/) whenever a dental stimulus occurs in a frequent and recognizable /-s·t/ word, the opposite being also true, that is, the unlikeliness of successful identification of rare and infrequent words (Ganong, 1980). It may be assumed that speakers associate certain affricate sounds with /-s·t/ sequences in the right circumstances. Furthermore, the relationship between age of subject and response is a straightforward reflection of the change in progress.

## Conclusion

This paper explored the internal and external factors that, according to the available data, are triggering the resyllabification process of word-internal /-s/ when followed by the voiceless dental plosive /t/. The results obtained so far allow us to conclude that the development of a resyllabified affricate allophone is based on the convergence of, at least, two complementary conditions: (1) it is a natural articulatory outcome (Parrell, 2012) (2) that finds, in a context of koineization, a favorable environment to spread (Auer, 2005).

In addition, the results obtained in the perception test indicate that the acoustical cues defining the new affricate sound [ts] lead speakers to perceive an /-s·t/ sequence, especially by the youngest listeners. It can thus be argued that the affricate allophone is an optimal output regarding syllabic restrictions, since the sound that stems from the resyllabification process maintains all the phonological information pertaining to the underlying form (*faithfulness* constraints in Optimality Theory terms). The fact that this information is analyzed as part of the onset of the following syllable makes it possible to create an open-syllable structure (*well-formedness* restrictions) without losing any relevant semantic information. The assimilatory shift is not only natural from the production perspective but also when linguistic universal constraints are regarded. Finally, the results of the trend study indicate that the indexicality of this new allophone, which can be related neither to the standard nor to local vernacular use, is undetermined.

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## Notes

**1.** It should be noted that word-final /-s/ can have a grammatical function as a plural marker in a noun (*libro/libros*, 'book/books') or a second person singular marker in a verb (*amas/ama*, 'you love/he loves').
**2.** The development of intermediate coherent varieties in Europe is a well-known and thoroughly studied process (Cerruti & Tsiplakou, 2020). See also Chela-Flores (2017) for a different perspective on these issues.
**3.** A minimum of thirty tokens per participant was established for the codification. 1995 sample: mean = 38.19 tokens per participant, sd = 6.35; 2015 sample: mean = 39.70 tokens per participant, sd = 9.92.
**4.** 5.4% of the sample was codified again by another researcher. The intercoder percent agreement was 94.1%.
**5.** Age of the speaker at the time of recording.
**6.** CoG is one of the so-called spectral moments (Forrest, Weismer, Milenkovic, & Dougall, 1988). The other three, Standard deviation, Skewness, and Kurtosis, were also measured for this analysis, and the statistical differences found among the perceptual variants turned out to be similar when any of the spectral moments is considered. However, since CoG showed the most highly significant differences between the categories, it is the only spectral moment reported in this paper.
**7.** It should be noted that no other linguistic factors (previous phonetic environment, stress, etc.) proved to be related to allophonic variation in this particular context.
**8.** List of words and nonwords (fillers are in bold): **[ˈmata]** [ˈmasta] [ˈmatsa] [ˈmatʃa]; **[ˈmoto]** [ˈmosto] **[ˈmotso]** **[ˈmotʃo]**; **[ˈcato]** [ˈcasto] [ˈcatso] [ˈcatʃo]; **[ˈteto]** [ˈtesto] [ˈtetso] [ˈtecho]; [piˈton] [pisˈton] **[piˈtson]** **[piˈtʃon]**; **[ˈpata]** [ˈpasta] [ˈpatsa] [ˈpatʃa]; **[ˈmuto]** [ˈmusto] **[ˈmutso]** **[ˈmutʃo]**.
**9.** Both pairs are actually minimal triplets (pata / pasta / pacha and mata / masta / macha), mata ('bush') and pata ('paw') are Spanish words.

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