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Evidence for Incomplete Neutralization in Chilean Spanish

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Abstract

Background/Aims: In Chilean Spanish, syllable- and word-final /s/ are frequently weakened to an [h]-like segment or completely deleted. In word-final position, /s/ serves as the plural morpheme, so its deletion renders a site for potential neutralization with singular items. Chilean scholars have previously described differences in the vowel preceding weakened or deleted /s/ distinguishing it from non-/s/-final words, but this putative incomplete neutralization has not yet been acoustically verified, nor have its conditioning factors been explored. The primary purpose of this study was to assess via phonetic analysis of spontaneous speech whether neutralization of final vowels in singular words and plural words in Chilean Spanish is indeed incomplete, as hypothesized by scholars during the 20th century. Additionally, these vowels were also compared to the vowels of monomorphemic /s/-final words in order to ensure that the attested singular-versus-plural differences were not simply indicative of closed syllable laxing processes. ***Methods:*** Vowels were extracted from the spontaneous speech of 20 Chilean Spanish speakers and acoustically analyzed via VoiceSauce. ***Results:*** The results revealed that final /a/ vowels of plural words were found to be breathier than singular vowels but less breathy than the final vowels of monomorphemic words, and that plural /o/ was significantly fronted. They also demonstrated increased breathiness on /e/ vowels closed by /s/, regardless of morphological status. ***Conclusion:*** These results provide the first account of incomplete neutralization of plural vowel correlates in spontaneous speech in Chilean Spanish, and they offer evidence for closed syllable processes in this particular dialect, in alignment with an exemplar-theoretic approach.

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Introduction

Consonant lenition is typical in many varieties of Spanish, particularly those resulting from sustained contact with Southern Peninsular Spanish colonization (Hualde, 2005, pp. 19–31). As is common cross-linguistically, much of the consonant weakening in Spanish takes place in intervocalic or in domain-final positions (Gordon, 2016, pp. 154–5). For instance, while the voiced stops /b, d, g/ nearly categorically weaken to approximants in intervocalic position, even in careful speech (Carrasco et al., 2012, p. 150), each of these stops frequently weakens even further and is variably deleted throughout areas of Southern Spain and the Americas, with intervocalic /d/ deletion being the most well known (Alba, 1999; Bedinghaus & Sedó, 2014; Blas Arroyo, 2006; Díaz Campos & Gradoville, 2011; D'Introno & Sosa, 1986; Samper Padilla, 1996). Additionally, several recent studies have demonstrated voicing as weakening of voiceless segments such as /p, t, k, s/ in intervocalic position (Chappell, 2016; Chappell & García, 2017; Garcia, 2015; Lewis, 2001; Machuca Ayuso, 1997; Martínez Celdrán, 2009, Rogers & Mirisis, 2016; Torreira & Ernestus, 2012). One of the most widespread lenition processes, however, is syllable- and word-final /s/ weakening.

In approximately half of the Spanish dialects, coda /s/ is often produced as a glottal frication, known in the literature as /s/ aspiration, and may also variably be deleted (Hammond, 2001; Hualde, 2005; Lipski, 1994). This process has been simplified in many texts as /s/>[s], [h], or [∅], but more detailed acoustic variation has also been described (Torreira, 2007a; Widdison, 1995a; Widdison, 1995b; Widdison, 1997). Scholars have shown that in Chilean Spanish, word-medial /s/ before a consonant is generally produced with an [h]-like frication as in *escuela* [ehkwela] "school," and /s/ in word-final position is frequently produced with this [h]-like aspiration or deleted (Cepeda, 1990a; Cepeda, 1990b; Valdivieso & Magaña, 1991). However, in a recent study (Bolyanatz, 2017), I demonstrated that deletion in word-final position has increased in frequency since these earlier studies, such that /s/ is most frequently deleted before a pause as in *chicos* [tʃiko##] "boys," often deleted before an onset consonant in the next word as in *personas como* [persona komo] "people like," and sometimes deleted or produced as an [h]-like segment when resyllabified as an onset preceding a word-initial vowel as in *libros a* [liβroha] "books to."

In word-final position, /s/ serves as both a plural and a verbal marker[1]. Therefore, when /s/ at the end of plural noun phrase (NP) constituents is completely deleted, as is often the case in Chilean Spanish, the final vowel becomes a site of potential neutralization as in (1).

(1) a.	/las	kasas	bonitas/		b.	/la	kasa	bonita/
	the-*fem pl.*	house-*fem pl.*	pretty-*fem pl.*			the-*fem sg.*	house-*fem sg.*	pretty-*fem sg.*
	"the pretty houses"					"the pretty house"		
	[la 'kasa βo'nita]					[la 'kasa βo'nita]		

[1] Due to the unique behavior of the mixed *voseo* verbal paradigm in this dialect of Spanish, verbal behavior is beyond the scope of this paper. See Torrejón (1986; 1991), Bishop and Michnowicz (2010), Rouse (2010), and Rivadeneira Valenzuela (2016) for a description of this phenomenon.

As Spanish is an inflectional language, NP plurality in many cases is recovered via verbal inflection. However, scholars have also claimed that /s/ deletion occasions a compensatory alternation mechanism on the vowel preceding deleted /s/. Previous research on incomplete neutralization of Chilean Spanish vowels has been descriptive in nature (Cepeda, 1990b; Lenz, 1940; Oroz, 1966; Wagner, 1967), with scholars providing auditory impressions of the process. However, the findings of these accounts have been inconsistent, and questions about both the existence of the phenomenon of incomplete neutralization and the degree to which it occurs cannot be answered without experimental data.

In this paper, I examine the final vowels of singular and plural words extracted from sociolinguistic interviews with 20 speakers of Chilean Spanish for vocalic correlates signaling incomplete neutralization. My aim was to assess whether speakers completely neutralize these items in spontaneous speech, or whether speakers maintain a vocalic distinction between the morphologically distinct words as previously described. In the remainder of this section, I describe incomplete neutralization as attested in other languages, outline the different theoretical frameworks within which incomplete neutralization has been explained, and detail the particular hypotheses that have been made about incomplete neutralization in this dialect of Spanish.

Incomplete Neutralization

According to Warner, Jongman, Sereno, and Kemps (2004), incomplete neutralization is a phenomenon in which speakers produce small differences in the articulation of words which, based on phonological processes of positional neutralization, would be expected to be homophones. Scholars have demonstrated that in several languages, even when an underlying phonemic difference appears to be neutralized in a particular environment, speakers may still produce very small acoustic differences as would be expected if the distinction were maintained (Warner et al., 2006, p. 286). Incomplete neutralization has been demonstrated most frequently in final devoicing in German (Roettger et al., 2014), Polish (Jassem & Richter, 1989), Dutch (Warner et al., 2004), Levantine Arabic (Hall, 2017), Catalan (Charles-Luce & Dinnsen, 1987), and Russian (Kharlamov, 2014). In German, for instance, studies have demonstrated that the plural words *Räder* "wheels/bicycles" and *Räte* "councils," whose singular forms are /ʁa:d/ and /ʁa:t/, show consistent production differences when the final /d/ of "wheels" is devoiced to [t]. Specifically, studies have shown that speakers consistently produce longer vowels before these devoiced stops than before regular voiceless stops (Roettger et al., 2014). Other recent studies have expanded the study of incomplete neutralization beyond final devoicing to other phenomena such as incomplete morphological tone neutralization in Cantonese (Yu, 2007) and flapping in American English (Braver, 2014; Herd et al., 2010). In Spanish, incomplete neutralization has been attested between the liquids /ɾ/ and /l/ in Puerto Rican Spanish (Beaton, 2016; Simonet et al., 2008), and coda /s/ aspiration in Eastern Andalusian Spanish production (Gerfen, 2002) and perception (Bishop, 2007). However, studies of neutralization associated with coda /s/ aspiration in Spanish have focused nearly exclusively on word-medial /s/ in contact with voiceless stops, rather than on the more productive word-final singular-versus-plural contrast examined in this paper.

Studies of final /s/ weakening in Spanish have demonstrated a task effect, in which speakers are less likely to weaken /s/ in more formal tasks or styles (Alba, 2004; File-Muriel, 2009); thus the present study relies on sociolinguistic interview speech rather than on a word list or other more formal task. I acknowledge that there is a potential trade-off here: sociolinguistic interview speech is more natural and more likely to approximate the style typically used by the speakers in a nonexperimental context, but the words of interest to the present study will also therefore carry a more reduced functional load, since semantic and pragmatic factors may limit this load (Iverson & Salmons, 2011). Nonetheless, in Spanish, without prior knowledge, and with no expression of a plural /s/ on either the determiner or the noun, it can be difficult to recover whether a direct object is supposed to be singular or plural, as in the sentence in (2).

(2) Vieron a la(s) chica(s).
saw-*pl.* DOM the-*fem sg.* or *pl.* girl-*fem sg.* or *pl.*
"they saw the girl/s"
['bjeɾon a la 'tʃika]

This is a different case from final German devoicing, for instance, as described by Winter and Röttger (2011), in which the German minimal pair *Rad* "wheel" and *Rat* "council" would almost never occur in the same context for semantic reasons (2011, p. 58). Therefore, this word-final singular-versus-plural contrast allows for acoustic verification of incomplete neutralization of a novel morphophonological contrast.

Winter and Röttger (2011, p. 58) pointed out that studies of incomplete neutralization in German typically involve very small differences, and that the magnitude of the effect appears to be dialect and speaker dependent, as well as sensitive to phonological context. They also state that even in the face of little functional relevance – as is the case for the German contrast, in which these words would hardly ever be confused due to context – small differences that might actually play no role in everyday speech communication can be of importance for theoretical reasons. According to these authors, even small effects can give us hints about the "cognitive architecture" that is at work when people use language (Winter & Röttger, 2011, p. 58).

Scholars posit that incomplete neutralization may result from several competing models of cognitive architecture. In a traditional, feed-forward phonological model (Bermúdez-Otero, 2007; Chomsky & Halle, 1968), incomplete neutralization can be thought of as a phonetic trace of a neutralizing phonological process. However, this would likely mean that any deleted /s/ would leave a phonetic trace, regardless of its morphological function. If this model were to hold true, we would not expect to find any differences between final vowels in monomorphemic words (henceforth monomorphemic vowels) and final vowels in plural words (hereafter plural vowels). Rather, we would only expect differences between words that end in /s/ and words that do not (such as final vowels on singular words, or singular vowels).

Ernestus and Baayen (2006), however, eschew abstract phonological representations altogether, instead claiming that whole words, including inflected

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forms, are stored as complete auditory and visual form representations rather than deriving from abstract underlying forms. In other words, these scholars take phonology out of the process, moving straight from morphological encoding to phonetics, so that when Dutch speakers activate one member of a paradigm such as a voiceless form as in a final devoiced *verwijd* [vɛrʊɛit] "widen," they also partially activate inflectionally related forms such as voiced *verwijden* [vɛrʊɛidən] "to widen," and this activation of multiple forms (both the voiced and the voiceless) is what causes the incomplete neutralization. These authors posited that the probability that a final obstruent is realized as slightly voiced is a function of the spreading activation of connected nodes in the network. Therefore, if words within a paradigm such as the singular and plural vowels analyzed here are predicted to partially activate one another, this would not necessarily make a prediction on how monomorphemic vowels would be produced.

In exemplar-theoretic models such as that of Pierrehumbert (2003), abstract concepts in phonology (such as syllables and underlying representations) are not totally eliminated, as they have been shown to be productive in new word formation. However, probability distributions are paramount, particularly for variable data and gradient outcomes. In exemplar theory, labels (or phonemes) are associated with a cognitive representation of the parametric phonetic space. The mental representation of the distribution of each label is gradually built up with experience, and can likewise shift based on experience. Therefore, in this study, it would be possible for singular vowels and plural vowels to have different phonetic realizations, due to exemplar clouds with different statistical distributions. A monomorphemic vowel could also have a different phonetic realization from these two, based on its production over a speaker's experience, without providing a challenge to the model.

These three hypotheses can be tested using the present data by comparing the two putative positionally neutralized word types: a singular, vowel-final word, and a plural word with its plural /s/ deleted. Monomorphemic vowels with their final /s/ deleted are used as a control, while [h]-final words are excluded, given their overt (though weakened version of) plural /s/.

In Chilean Spanish, singular and plural words form a paradigm only differentiated by /s/, whereas monomorphemic words also end in /s/ but have little to no paradigmatic relationship to the NP constituents. Therefore, these data offer an opportunity to evaluate the theoretical models and the predictions they would make for the three types of words examined here.

Vowel Allophony Associated with /s/ Weakening

While not described overtly as incomplete neutralization, descriptive accounts of vocalic alternation associated with /s/ weakening and deletion are described along three lines: vowel quality, vowel duration, and voice quality. Vowel quality alternations have been attested both in Peninsular Spanish and American Spanish. In Eastern Andalusian Spanish, vowels before weakened /s/ are produced as lowered compared to vowels not before weakened /s/ (Alonso et al., 1950; Alvar, 1955; though see Hualde & Sanders [1995] for the claim that the open/close contrast in plural vs. singular vowels existed prior to /s/ weakening in this region). Navarro Tomás (1948) asserted that in the Spanish of Puerto Rico, /aeo/ vowels before aspirated or deleted /s/ may lower or become

more open, which acts to distinguish apparent homophones, also described by Honsa (1965) in Argentine Spanish and by Oroz (1966) and Wagner (1967) in Chilean Spanish. Cepeda (1990b, p. 7), however, claims that complete deletion of /s/ may be associated with closing or opening of the previous vowel in Chilean Spanish.

Several authors have claimed that /s/ weakening also occasions alternations in a preceding vowel's length. Oroz (1966, p. 102) states that a vowel before a weakened or deleted plural /s/ is likely to be lengthened in a compensatory manner. This is also attested in rural Buenos Aires speech (Vidal de Battini, 1949, p. 42). Cepeda (1990b, p. 7) claims that in Valdivia, Chile, /s/ deletion is associated with both lengthening and shortening.

Finally, in reference to voice quality, Lenz (1940) claims that in unstressed syllables, /s/ may be aspirated or deleted entirely, and may be accompanied by an aspirated vowel, which I take here to mean a breathy vowel, also attested by Cepeda (1990b, p. 7). Voice quality in Spanish is not phonemic as it is in languages such as Jalapa Mazatec (Garellek & Keating, 2011). However, vowels before [s] in English have been shown to be produced breathier as the glottis spreads in anticipation of the production of sibilant [s], which requires great amounts of airflow (Ladefoged, 1993, p. 139), which Widdison (1993; 1995a; 1995b) also demonstrated in Spanish.

While researchers have aimed to provide instrumental verification of these hypotheses, the word-final contrast has been shown to be completely neutralized in certain dialects of Spanish including Miami Cuban Spanish (Resnick & Hammond, 1975), Puerto Rican Spanish (Figueroa, 2000), Andalusian Spanish (Carlson, 2012), and Venezuelan Spanish (Scrivner, 2014). Rincón Pérez (2015), however, found some evidence for incomplete neutralization in Andalusian Spanish and Cartagena-Colombian Spanish, demonstrating /e/ vowel opening and centralization before a deleted plural /s/ in Andalusian Spanish and /e/ and /o/ centralization before deleted plural /s/ in Cartagenan Spanish. However, it is not clear whether Rincón Pérez included a monomorphemic comparison to ensure that any differences found were not simply due to closed syllable processes. Contrastingly, Henriksen (2017) did not find any evidence of incomplete neutralization in Eastern Andalusian Spanish between singular and plural words, but rather found only evidence for closed syllable processes.

Romero (1995), Gerfen (2002), and Torreira (2007a; 2007b; 2012) have each examined other correlates of /s/ weakening in Andalusian Spanish, though in word-internal rather than word-final position. These scholars have demonstrated that in addition to vowel alternations, other articulatory and gestural factors come into play when word-medial, syllable-final /s/ is aspirated. For instance, Gerfen (2002) used a gestural model to demonstrate that when word-medial /s/ aspiration occurs, it is accompanied by shortening of the preceding vowel and lengthening of the following consonant in Eastern Andalusian Spanish. Torreira (2007a) analyzed both word-medial and word-final, utterance-medial /s/ aspiration in several dialects of Peninsular Spanish in both experimental and spontaneous speech to provide the first instrumental verification of post-aspiration of the voiceless stops /p, t̪, k/ following aspirated /s/. Torreira hypothesized, also using a gestural approach, that the openness of the glottis for the /s/ production as an [h]-like segment is maintained through and even past

the following voiceless stop closure, resulting in consistent postaspiration such as in the word *pasta* [paht^{h}a] "pasta." Torreira (2007b) then demonstrated that this postaspiration is exclusive to Western Andalusian Spanish, and not simply a correlate of /s/ aspiration, by comparing Andalusian Spanish /s/-voiceless stop clusters with those of Puerto Rican and Porteño Spanish, both /s/-aspirating dialects. Finally, Torreira (2012) examined whether this postaspiration results from extensive coarticulation and articulatory overlap as his previous work suggested, or whether this voiceless stop aspiration was intended by speakers as an integral part of a series of aspirated stops, distinct from the plain voiceless stop in Spanish. This study confirmed, through experimental manipulation of speech rate and stress location, that aspirated /s/ plus voiceless stop clusters in Western Andalusian Spanish resulted from a dialect-specific gestural mechanism, not as actual aspirated stop segments.

In sum, previous accounts of vowel alternation in Spanish have associated vowel lowering, lengthening and shortening, and breathiness with plurality, though only Rincón Pérez (2015) and Henriksen (2017) have been able to provide acoustic verification of a vowel quality alternation associated with word-final /s/ deletion. No differences in length or breathiness have been verified in the production of singular and plural words in dialects other than Chilean Spanish, and no previous studies have instrumentally verified the putative incomplete neutralization in word-final position in Chilean Spanish. The present study asks whether the final vowels of singular words are produced differently from the final vowels of plural words with their final /s/ deleted, in order to verify whether previous impressionistic hypotheses regarding allophonic vowel variation hold true for this dialect. To ensure that any differences found represent a morphological status and not simply the presence of an underlying /s/, monomorphemic items such as *jueves* [xweβe] "Thursday" were also included as a control.

Methods

Speakers

Twenty native speakers of Spanish were recorded in Santiago, the capital city of Chile. All participants had been born and raised in Santiago and used Spanish as their primary language, and none had lived outside Santiago for more than 1 year. The participants were 10 males and 10 females, aged 18–40 years (average age 26.8, median age 25), and all belonged to the upper-middle class and were university educated (or currently attending university). The participants were paid CLP 5,000, the approximate equivalent of USD 7.50, for completing the experiment, which took between 45 min and 1 h.

Data Collection and Coding

The participants took part in a sociolinguistic interview task (Labov, 1963; Tagliamonte, 2006) in order to elicit singular and plural NP constituents from a variety of environments in a naturalistic setting. Topics of conversation included local politics and some recent current events such as the earthquake of 2010, and the conversation lasted approximately 45 min. Coding of the data began precisely 10 min into each interview. Singular and plural determiners, adjectives, and nouns were included in the coding. This also excluded /i/- and /u/-final words, infrequent in Spanish overall, since many of these words do not have an overt singular-versus-plural contrast on the noun itself (cf. *la tesis* "the thesis" and

el virus "the virus," singular, vs. *las tesis* "the theses" and *los virus* "the viruses," plural). Henriksen (2017) also verified that /i/ and /u/ show minimal phonetic variation across several types of conditions. Therefore, only /a/, /e/, and /o/ vowels were examined in this data set.

The tokens used in this experiment were all pragmatically unambiguously either singular or plural due to their origin in continuous, naturalistic sociolinguistic interview speech. That is, the pragmatic context of the items was the cue for codification as either singular or plural for the analysis, whether via numeric adjectives such as in (3), previously mentioned items such as in (4), in which the participant had mentioned that she took only one other class, or items like (5), in which the singular masculine determiner *el* was pluralized to *los*.

(3) las cuatro chicas
the-*fem pl.* four girl-*fem pl.*
"the four girls"
[la kwatɾo tʃika]

(4) la otra clase
the-*fem sg.* other-*fem sg.* class-*fem sg.*
"the other class"
[la otɾa klase]

(5) los cursos
the-*masc pl.* courses-*masc sg.*
"the courses"
[lo kuɾso]

The recordings were conducted indoors at various sites throughout the city of Santiago, including participants' homes (n = 12) and a soundproof booth at a local university (n = 8). Efforts were made to ensure that the participants' homes were as quiet as possible in order to facilitate comparison with the data from the soundproof booth, such as asking participants to close doors and windows, and speech that was recorded with background noise was not included in this analysis. All speakers were recorded to .wav files on a digital Olympus LS-14 Linear PCM recorder via an Audiotechnica ATR 3350 lapel microphone, digitized at 44.1 kHz and a 16-bit rate.

Measurements

The target vowels were segmented in Praat (Boersma & Weenink, 2018), beginning precisely 10 min into the recording. Following this 10-min mark, the final vowels of the first 50 singular and 50 plural NP words and the final vowels of the first 25 monomorphemic /s/-final words were segmented. When flanked by obstruents, vowel onsets were segmented at the onset of voicing visible in the spectrogram, accompanied by the onset of periodicity in the waveform (following Peterson & Lehiste, 1960), and markers delineating the right edge of the vowels were placed at the offset of the vowel's F2 and regular periodicity in the waveform, following Torreira (2007b). When followed by the nasals and liquids [ɾ] and [l], the waveform was again relied upon, segmenting the offset of the vowel at the abrupt changes in spectral amplitude (Turk et al., 2006, p. 12).

The vowels were coded for several features, including word type (singular, plural, or monomorphemic) and syllable stress (as either tonic, as in *mamá* [ma.'ma] "mother," or atonic, as in *problema* [pɾo.'βle.ma] "problem"). The following phonological segment was coded to account for coarticulatory processes not otherwise related to the deletion of /s/ (Farnetani & Recasens, 1993; Farnetani & Recasens, 2010), and later binned into a 5-level predictor variable. The 5 levels included (1) sonorants, (2) voiced obstruents (/b, d, g/), (3)

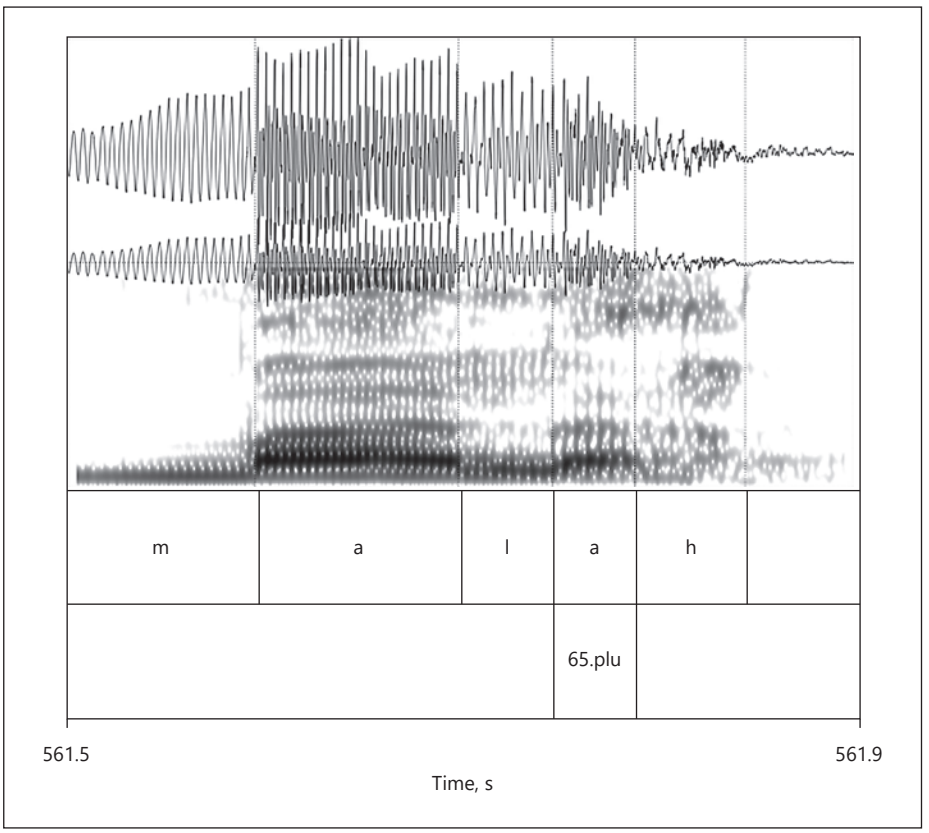

Fig. 1. [malah] with an utterance-final [h]-like segment from *malas* "bad" (female speaker; note that the spectrogram's frequency ranges from 0 to 7,000 Hz).

voiceless obstruents (/p, t̪, k/), (4) vowels, and (5) pause. Pause represents segments in utterance-final prosodic position, and the interviews were also coded for major breaks (a level 4 break in the Spanish ToBI system [Beckman et al., 2002; Face & Prieto, 2007; Estebas Vilaplana & Prieto, 2009]). For the pause or break predictor, 4 levels were coded: (1) short pause with no boundary tone (Yang, 2007); (2) pause accompanying a boundary tone (often in utterance-final position); (3) a boundary tone unaccompanied by a pause, often signaled by domain-final lengthening and perhaps creaking, but no measurable pause; and (4) phrase-medial vowels. Due to the impossibility of segmenting the same vowels appearing next to each other, only heterorganic vowel combinations were segmented to be included in this analysis, and only the steady-state portion of the vowel was included. Target vowels for whom the following word began with fricative segments such as /f/ and /x/ were not included in the original segmentation, since the frication following the vowel could belong to these or to an [h]-like segment. Finally, the /s/ following the plural or monomorphemic vowel was identified as produced overtly or deleted. Overt /s/ included sibilant [s], characterized by high energy above 5,000 Hz, and [h]-like segments, characterized by a high energy frequency around 4,000 Hz and high formant-like energy following a brief weakening in intensity between the formants of the vowel and the [h]-like segment. Figures 1–3 below are taken from the same female speaker, representing a plural [a] vowel followed by

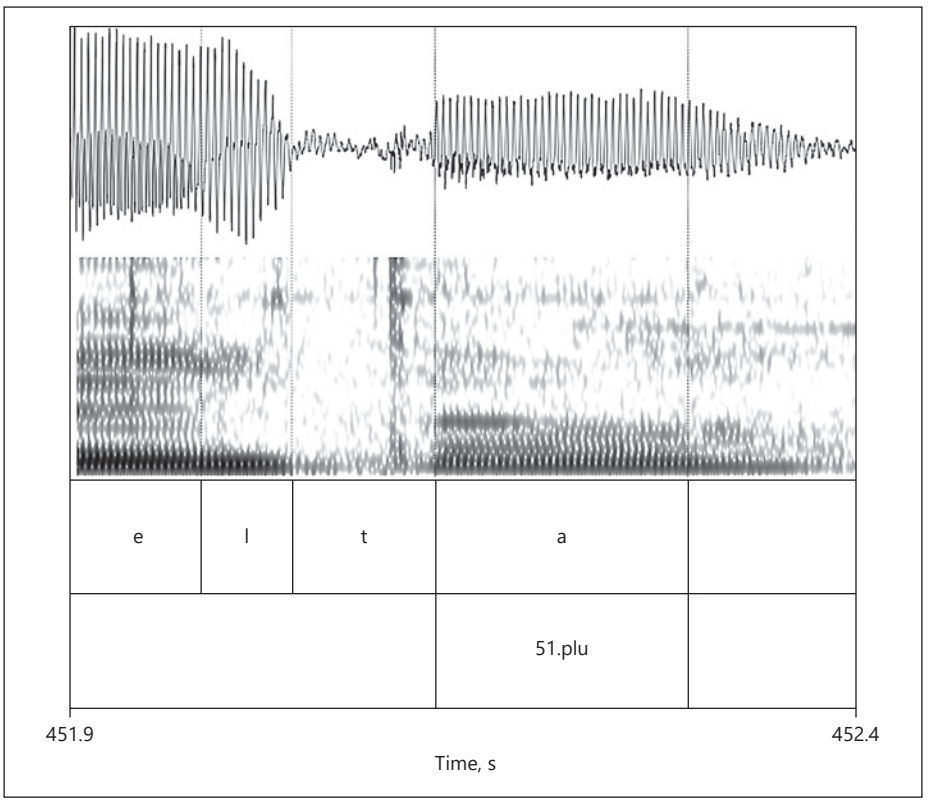

Fig. 2. Plural [a] in [elt̪a] with the final /s/ deleted from *vueltas* "rounds/turns" (female speaker).

an overt /s/, a plural [a] vowel followed by a deleted /s/, and a singular [a] vowel. All are shown at the same dynamic range (40 dB) to facilitate their comparison.

In Figure 1, the word /malas/ <malas> "bad-*fem pl.*" is produced with a fricative [ah], and the rightmost boundary of the [a] vowel is coded at the offset of a clear and continuous F2. Figure 2 shows the second half of the plural word /bwelt̪as/ <vueltas> "rounds-*fem pl.*," in which there is no clear frication noise representing an [h] segment, but rather a final [a] followed by a brief portion of breathy voicing. The rightmost boundary of the vowel was segmented at the offset of the continuous F2. In Figure 3, singular /pjesa/ <pieza> "room-*fem sg.*" was produced, and again, the [a] vowel was segmented at the offset of a continuous F2, though some breathy voicing occurred following this offset.

Following segmentation and coding, .wav files of vowels and their accompanying labeled TextGrids were extracted from the longer files and submitted to analysis via VoiceSauce (Shue, 2010; Shue et al., 2011), a MATLAB application. VoiceSauce can output many measures, but of interest to the present investigation are those of vowel duration, vowel quality (F1 and F2), and H1–H2. The H1–H2 measure, the amplitude of the first harmonic minus the amplitude of the second harmonic, is a correlate of the open quotient of the glottis, or the percentage of a glottal vibration cycle in which the glottis is open (Blankenship, 2002). A higher H1–H2 measure corresponds to a more open glottis or higher open quotient (Kreiman et al., 2012) and a breathier phonation type, and this is generally considered to be

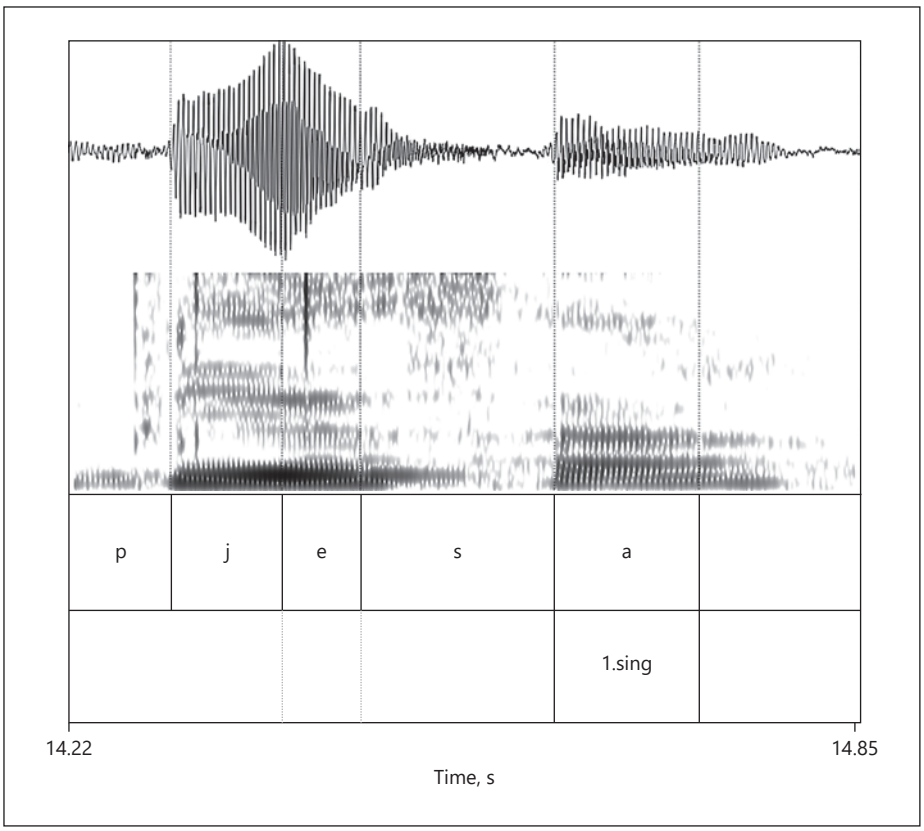

Fig. 3. Singular [a] in [pjesa] from *pieza* "bedroom" (female speaker).

the best measure of breathy versus modal phonation (Esposito, 2010; Keating et al., 2010). Figure 4 shows a schematic of these measures and where they can be found in the spectra.

VoiceSauce uses a function called STRAIGHT (Kawahara et al., 1999) to obtain fundamental frequency measures and Snack (Sjölander, 2004) to estimate the frequencies and bandwidths of the first through the fourth formants, and these estimates are used to correct the harmonic amplitudes using the correction algorithm by Iseli, Shue, and Alwan (2007). The corrected measures are denoted by an asterisk: H1*–H2*. The output of the VoiceSauce measures may be "chunked" into as many as 9 subsegments; using this option will average the data in each of 9 chunks using a certain number of glottal periods. The data presented below represent the third of 3 chunks in order to examine the duration, breathiness, and vowel quality strategies used by speakers across approximately the last third of the vowel. The original number of tokens submitted to VoiceSauce was 2,326, including vowels followed by overt /s/. Of these, 605 tokens were verified by hand.

In order to account for possible differences in vocal tract size, male and female measures of H1*–H2*, F1, and F2 were scaled and centered using the scale function in the base R package (R Core Team, 2017). Standardized duration measures also enabled effect size comparisons. Plural vowel tokens followed by an overt /s/ as either [s] or fricative [h] were excluded (n = 398) in order to more directly compare the final vowels of singular words with their plural counterparts.

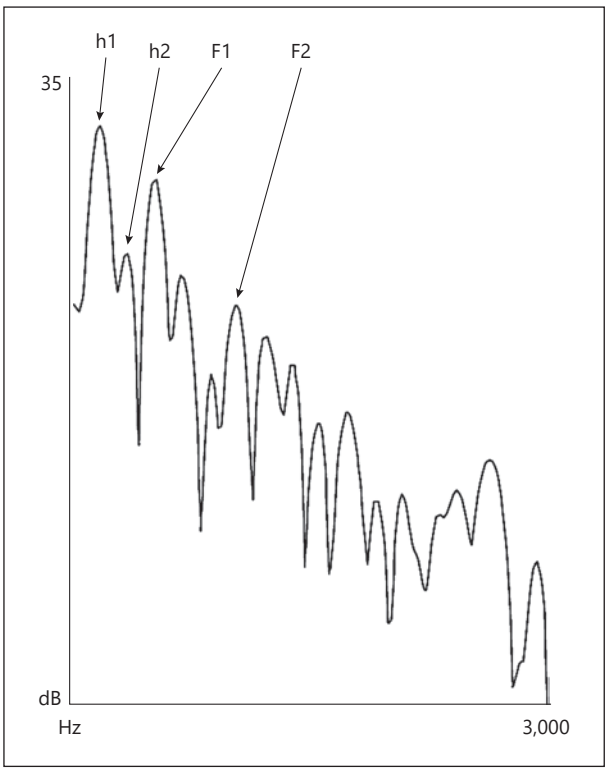

Fig. 4. FFT spectrum of the breathy phase of the /o/ vowel in the Spanish word *extranjeros* /ekxt̪ranxeros/, produced with deleted final /s/ (female speaker).

A total of 926 final vowels of singular words, 646 final vowels of plural words before deleted /s/, and 356 final vowels of /s/-final monomorphemic words before deleted /s/ (total N = 1,928) were submitted to statistical analysis.

Analyses

The statistical models reported below were all linear mixed models using the lmer function within the lme4 package (Bates et al., 2015) of the statistical software package R (R Core Team, 2017), with each model taking one of the four continuous acoustic measures (F1, F2, duration, and H1*–H2*) as its outcome variable. Following Gallagher (2016, p. 107), each vowel was analyzed separately, for a total of 12 models. Each model included a random effect of participant in which each participant contributed their own random intercept in order to account for production idiosyncrasies at the participant level, and all models included an interaction between the following segment predictor and the variable of interest: whether each vowel originated from a singular word (termed a singular vowel), a plural word with the final /s/ deleted (termed a plural vowel), or a monomorphemic /s/-final word with the /s/ deleted (termed a monomorphemic vowel). This predictor is denoted "word type" in the following sections. An interaction of syllable stress with word type was also included, but only for analyses of the /a/ vowel, since there was not enough variation in the /o/ and /e/ data sets to include this predictor. Finally, an interaction between word type and pause or break type was also included in each model. Model comparison was conducted via the *anova* function in R, and main effects are only reported when the model testing revealed that interactions were not significant, and the interactions were subsequently removed to obtain the best fit model. Finally, effects of different levels of the predictors

were tested using simple effects tests as described in Bretz et al. (2011, pp. 108–11) via the *glht* function in the *multcomp* package (Hothorn et al., 2008). Effect sizes were computed by hand using Cohen's (1977) *d* formula and interpreted using the scale described by Sullivan and Feinn (2012, p. 281).

Results

/a/ Vowel

According to the impressionistic descriptions, differences are expected along the F1 dimension, with plural /a/ vowels produced with a higher F1 as compared to final singular vowels. A significant interaction obtained between word type and following segment ($\chi^2(1, n = 826) = 1.79, p < 0.05$), but not between word type and syllable stress ($\chi^2(1, n = 826) = 0.21, p = 0.90$), and syllable stress alone was not selected as a significant main effect ($\chi^2(1, n = 826) = 1.79, p = 0.18$). Similarly, the model did not select pause or break type as significant either in interaction with word type ($\chi^2(6, n = 826) = 1.70, p = 0.95$) or as a main effect ($\chi^2(3, n = 826) = 7.63, p = 0.06$). Simple effects analyses conducted at each level of the word type and following segment predictor variables demonstrated that there are no significant differences in F1 production of /a/ vowels on singular, plural, and monomorphemic words. That is, the singular and plural contrast has been neutralized along the F1 dimension for the /a/ vowel.

Differences were not predicted along the F2 dimension for the low central /a/ vowel. The interactions between word type and following segment ($\chi^2(1, n = 826) = 4.75, p = 0.78$), word type and syllable stress ($\chi^2(1, n = 826) = 0, p = 1$), and word type and pause or break type ($\chi^2(5, n = 826) = 10.13, p = 0.07$) were not significant, and no main effects obtained for word type ($\chi^2(2, n = 826) = 2.43, p = 0.30$), following segment ($\chi^2(4, n = 826) = 7.17, p = 0.13$), syllable stress ($\chi^2(1, n = 826) = 0.17, p = 0.68$), or break or pause type ($\chi^2(3, n = 826) = 1.55, p = 0.67$). Rather, the analysis shows that /a/ vowels are neutralized along the F2 dimension.

For the H1*–H2* measure, the model revealed significant main effects for both word type ($\chi^2(2, n = 826) = 26.01, p < 0.001$) and following segment ($\chi^2(4, n = 826) = 25.23, p < 0.001$), but not for stress ($\chi^2(1, n = 826) = 1.22, p = 0.27$) or pause or break type ($\chi^2(3, n = 826) = 7.08, p = 0.07$). The model showed that plural /a/ vowels are significantly breathier than singular vowels ($\beta = 0.24$, SE = 0.06, $t = -3.71, p < 0.001$), and that monomorphemic /a/ vowels are significantly breathier than plural /a/ vowels ($\beta = 0.20$, SE = 0.10, $t = 1.98, p < 0.05$). That is, there is a continuum of breathiness from singular to plural to monomorphemic /a/ vowels. This effect can be visualized in Figure 5, and it demonstrates that final vowels of singular and plural words show incomplete neutralization along this dimension.

In terms of effect sizes, the difference between breathiness of the plural and singular /a/ vowels defined by Cohen's *d* is 0.23, or a small difference (Sullivan & Fein, 2012, p. 281) of approximately 1.56 dB. Similarly, the difference between breathiness of the monomorphemic and plural /a/ vowels defined by Cohen's *d* is 0.16, also a small difference of approximately 1.03 dB.

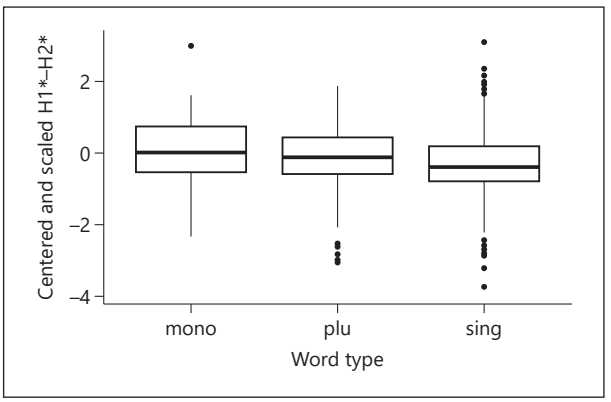

Fig. 5. Boxplot of the H1*–H2* difference for an /a/ vowel. mono, monomorphemic; plu, plural; sing, singular.

Finally, in the duration model, a significant main effect obtained between word type and pause or break type ($\chi^2(6, n = 826) = 24.02$, $p < 0.001$), while no main effect obtained for syllable stress ($\chi^2(1, n = 826) = 2.59$, $p = 0.11$). A main effect obtained for the following segment ($\chi^2(4, n = 826) = 44.54$, $p < 0.001$), and simple effects tests revealed that an /a/ vowel before a pause is significantly lengthened as compared to an /a/ vowel before any other type of segment (with a mean duration of 136 ms), including vowels ($\beta = -0.51$, SE = 0.16, $t = -3.20$, $p < 0.01$, 113 ms [76.6]), voiced obstruents ($\beta = -0.95$, SE = 0.13, $t = -7.38$, $p < 0.001$, 84.6 ms [41.4]), sonorants ($\beta = -1.10$, SE = 0.11, $t = -9.89$, $p < 0.001$, 75.6 ms [45]), and voiceless obstruents ($\beta = -1.25$, SE = 0.09, $t = -14.20$, $p < 0.001$, 68 ms [31.9]). Effect sizes for these comparisons include a small-to-medium 23-ms difference between a following pause and a following vowel (Cohen's $d = 0.36$), and large differences between a following pause and a following sonorant (Cohen's $d = 0.95$, 60.4 ms), a following pause and a following voiced obstruent (Cohen's $d = 0.81$, 51.4 ms), and a following pause and a following voiceless obstruent (Cohen's $d = 1.07$, 68 ms). This provides evidence for utterance-final lengthening of /a/ vowels. Upon further examination of the significant interaction, it was revealed that there were fewer than 5 observations of the "pause no break" and "break no pause" conditions in some of the three word type conditions; so only results for the "break pause" and "phrase medial" conditions are shown here. There were no significant differences between a monomorphemic /a/ and a plural /a/ before a break accompanied by a pause, demonstrating increased vocalic duration as a correlate of closed syllables. No differences were found in word types in the "phrase medial" condition. Both the results from the following segment predictor and the pause or break type predictor demonstrate increased vocalic duration before a pause or major prosodic boundary, while the results suggest that the /a/ vowel is neutralized along the duration dimension.

/e/ Vowels

According to the best fit model for the F1 of /e/ vowels, no significant interaction effects obtained between word type and following segment ($\chi^2(8, n = 323) = 5.53$, $p = 0.70$) or between word type and pause or break type ($\chi^2(5, n =$

323) = 9.83, p = 0.08). No main effect obtained for pause or break type alone (χ^2(3, n = 323) = 1.65, p = 0.65). However, significant main effects obtained for both following segment (χ^2(1, n = 323) = 15.81, p < 0.01) and word type (χ^2(2, n = 323) = 10.92, p < 0.01). Some contextual differences in /e/ F1 were found via the simple effects tests, including lowering of /e/ in prepausal position as compared to before a following voiced obstruent (β = –0.40, SE = 0.12, t = –3.44, p < 0.001), voiceless obstruent (β = –0.27, SE = 0.09, t = –2.99, p < 0.01), or vowel (β = –0.26, SE = 0.13, t = –2.02, p < 0.05), but not when preceding a sonorant (β = –0.19, SE = 0.10, t = –1.87, p = 0.06). Effect size comparisons show that the significant effects reflect small-to-medium differences in F1. A following pause correlates with an increased F1 (a lowered /e/ vowel) as compared to a following vowel by 31 Hz (Cohen's d = 0.28, a small difference), and a following voiceless obstruent correlates with a 38-Hz decrease in F1 (Cohen's d = 0.38, a small-to-medium difference), while a following voiced obstruent correlates with a 58-Hz difference (Cohen's d = 0.51, a medium-sized difference). Despite the significance of the main effect of word type, the simple effects tests revealed that there are no relevant differences between singular and plural vowels (β = –0.16, SE = 0.10, t = –1.68, p = 0.09). Therefore, along this measure, the singular-versus-plural contrast has been neutralized.

For the F2 of the /e/ vowel, no significant interaction obtained between word type and following segment (χ^2(8, n = 323) = 4.66, p = 0.79). Additionally, no main effects obtained for the word type predictor (χ^2(2, n = 323) = 1.39, p = 0.50) or the following segment predictor (χ^2(4, n = 323) = 6.12, p = 0.19). A main effect did obtain, however, for the break or pause predictor. Simple effects tests revealed that F2 followed by a break (whether accompanied by a pause or not) was significantly higher than F2 in phrase-medial position (i.e., followed by another segment) by approximately 150 Hz (β = –0.41, SE = 0.16, t = –2.48, p < 0.05, Cohen's d = 0.43). However, given that this factor did not interact with the word type predictor, the analysis shows that /e/ vowels are neutralized along the F2 dimension.

The interaction between word type and following segment regarding vowel breathiness was not significant (χ^2(8, n = 323) = 9.44, p = 0.31). There was no main effect for the following segment predictor (χ^2(4, n = 323) = 7.43, p = 0.12), break or pause type (χ^2(3, n = 323) = 0.29, p = 0.96), or stress (χ^2(1, n = 323) = 0.1, p = 0.91), but a main effect obtained for the word type's effect on the breathiness of /e/ vowels (χ^2(2, n = 323) = 9.81, p < 0.01). A simple effects analysis revealed that plural vowels are significantly breathier than singular vowels (β = –0.35, SE = 0.18, t = –2.01, p < 0.05, Cohen's d = 0.30), but are not significantly different in breathiness from monomorphemic vowels (β = –0.02, SE = 0.10, t = –0.09, p = 0.93, Cohen's d = 0.01). This finding reveals that breathiness on an /e/ vowel is a correlate of syllables closed with /s/, rather than plurality, so breathiness on a plural /e/ vowel cannot be considered evidence of incomplete neutralization of the singular-versus-plural contrast.

Finally, significant main effects for duration obtained for the following segment predictor (χ^2(4, n = 323) = 66.40, p < 0.001), stress (χ^2(1, n = 323) = 4.90, p < 0.05), and pause or break type (χ^2(3, n = 323) = 104.17, p < 0.001). No main effect obtained for word type (χ^2(2, n = 323) = 1.40, p = 0.50). According to the simple effects tests, /e/ vowels demonstrate significant lengthening in prepaus-

al and prevocalic position as compared to preconsonantal position (approx. 49 ms, Cohen's $d = 0.8$, a large difference). Additionally, an /e/ vowel before a break but no pause is longest in duration (173 ms [92.6]), followed by a break accompanied by a pause (120 ms [60.8]) and a pause unaccompanied by a break (120 ms [82.1]), and each of these is significantly longer than a phrase-medial /e/ (58.9 ms [29], Cohen's d of the average of the phrase-final segments in comparison to the phrase-medial segments = 1.28, a large difference). This analysis reveals evidence for domain-final lengthening on /e/ vowels. However, no significant differences obtained for the variable of interest, instead providing evidence for neutralization of the singular-versus-plural contrast along this measure.

/o/ Vowels

No significant interaction effects obtained for the model taking normalized F1 of /o/ vowels as the dependent variable. No interaction effect obtained between word type and following segment ($\chi^2(8, n = 776) = 7.96$, $p = 0.44$), nor between word type and pause or break type ($\chi^2(5, n = 776) = 10.55$, $p = 0.06$). Significant main effects for the F1 of /o/ vowels obtained for both word type ($\chi^2(2, n = 776) = 19.08$, $p < 0.001$) and following segment ($\chi^2(4, n = 776) = 13.59$, $p < 0.01$), but not for pause or break type ($\chi^2(3, n = 776) = 0.72$, $p = 0.87$). According to the simple effects tests, /o/ vowels are produced significantly lowered in prepausal position as compared to before following sonorants ($\beta = -0.24$, SE = 0.09, $t = -2.81$, $p < 0.01$, Cohen's $d = 0.23$), voiced obstruents ($\beta = -0.29$, SE = 0.10, $t = -2.92$, $p < 0.01$, Cohen's $d = 0.33$), and voiceless obstruents ($\beta = -0.16$, SE = 0.07, $t = -2.29$, $p < 0.05$, Cohen's $d = 0.22$). However, the simple effects tests revealed that while the differences in F1 between singular and plural /o/ vowels approached significance ($\beta = 0.12$, SE = 0.06, $t = -1.95$, $p = 0.05$), the null hypothesis cannot be rejected. Rather, neutralization is demonstrated along this measure.

In the model taking the /o/ vowel's F2 as the dependent variable, significant main effects obtained for word type ($\chi^2(2, n = 776) = 15.76$, $p < 0.001$) and pause or break type ($\chi^2(3, n = 776) = 16.79$, $p < 0.001$). In the opposite direction of /a/ and /e/ vowels, F2 is significantly lower before breaks than before other segments ($\beta = 0.16$, SE = 0.06, $t = 2.84$, $p < 0.01$, Cohen's $d = 0.21$), while the presence of a pause but no break does not change F2's realization in comparison to utterance-medial vowels. That is, there is a prosodic boundary effect for F2: before breaks, /o/ vowels are produced backer, while /a/ and /e/ vowels are produced fronter. Additionally, an effect related to word type was found. Specifically, plural /o/ vowels have a significantly higher F2 than singular /o/ vowels ($\beta = -0.12$, SE = 0.06, $t = -2.13$, $p < 0.05$, Cohen's $d = 0.15$, a small difference of approx. 47 Hz) and monomorphemic /o/ vowels ($\beta = -0.31$, SE = 0.08, $t = -4.01$, $p < 0.001$, Cohen's $d = 0.30$, a small difference of approx. 94 Hz). That is, these speakers produced their /o/ vowels on plural words significantly fronted in comparison with /o/ vowels on singular and monomorphemic words, as shown in Figure 6.

This demonstrates evidence for incomplete neutralization: speakers differentiate their plural vowels from singular vowels via fronting of /o/, and this difference was not simply based on the presence of an /s/, as the same effect did not obtain for final /o/ vowels preceding monomorphemic /s/.

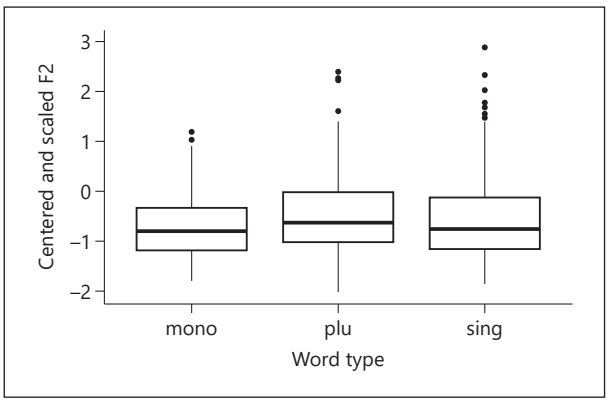

Fig. 6. Boxplot of the F2 difference for an /o/ vowel. mono, monomorphemic; plu, plural; sing, singular.

Along the breathiness measure, no significant main effects obtained for pause or break type ($\chi^2(3, n = 776) = 5.86$, $p = 0.12$) or stress ($\chi^2(1, n = 776) = 0.63$, $p = 0.43$). A significant interaction between word type and following segment obtained for /o/ vowels ($\chi^2(8, n = 776) = 16.07$, $p < 0.05$). However, no significant simple effects were found between singular and plural word types by any of the following segment levels: pause (β = –0.14, SE = 0.13, $t = -1.06$, $p = 0.29$), sonorant (β = 0.00, SE = 0.21, $t = 0.02$, $p = 0.99$), voiced obstruent (β = –0.47, SE = 0.25, $t = -1.87$, $p = 0.06$), voiceless obstruent (β = –0.14, SE = 0.15, $t = -0.93$, $p = 0.35$), or vowel (β = 0.20, SE = 0.25, $t = 0.81$, $p = 0.42$). Instead, these results demonstrate that /o/ vowels have been neutralized along the H1*–H2* measure.

Finally, main effects were found for word type ($\chi^2(2, n = 776) = 9.95$, $p < 0.01$), pause or break type ($\chi^2(3, N = 776) = 83.31$, $p < 0.001$), and following segment ($\chi^2(4, n = 776) = 16.45$, $p < 0.01$) on duration of /o/ vowels. Evidence for utterance-final lengthening is attested, as /o/ in prepausal position is significantly longer than before any of the segments: sonorants (β = –1.00, SE = 0.11, $t = -9.16$, $p < 0.001$, Cohen's $d = 0.94$), voiced obstruents (β = –0.91, SE = 0.13, $t = -7.22$, $p < 0.001$, Cohen's $d = 0.83$), voiceless obstruents (β = –1.13, SE = 0.09, $t = -12.48$, $p < 0.001$, Cohen's $d = 1.02$), or vowels (β = –0.64, SE = 0.12, $t = -5.48$, $p < 0.001$, Cohen's $d = 0.63$). Similarly, all /o/ vowels preceding breaks or pauses were significantly longer than all phrase-medial /o/ vowels (by 69 ms, Cohen's $d = 1.15$), with /o/s preceding a break but no pause being the longest /o/ vowels (at 155 ms [70.8]). However, no significant differences were found in duration between singular and plural vowels (β = 0.04, SE = 0.08, $t = 0.45$, $p = 0.65$), providing evidence for neutralization along this measure.

Discussion

According to the descriptive accounts of previous scholars, differences between plural vowels and singular vowels in Chilean Spanish were impressionistically described along the measures of vowel quality, breathiness, and duration

during the mid-to-late 20th century. Specifically, the low and mid vowels of plural words were expected to be produced with a higher F1 (or lower) than singular vowels, with a lower F2 on front vowels and higher F2 on back vowels, lengthened, and breathier. However, in this paper, not all of these putative differences were attested. Rather, the results demonstrated some evidence for incomplete neutralization of the final vowels of singular and plural words, as well as some findings related to prosodic position. An anonymous reviewer asked whether the few acoustic differences found in the present study as compared to the numerous descriptive historical differences might be an issue of spontaneous versus laboratory speech. Several of the previous scholars cited did not provide an explanation of the origins of their data, but others' descriptions of vowel allophony were formed based on impressionistic accounts of sociolinguistic interview data, so it is difficult to say whether this could be the case. Alternatively, perhaps these multiple differentiating characteristics have been neutralized over time, so that there might also be a diachronic element at work here.

First, this analysis revealed that speakers differentiated their /a/ vowels on different word types according to H1*–H2*, the measure that indicates breathiness. Specifically, plural /a/ vowels are produced breathier than singular /a/ vowels, but monomorphemic /a/ vowels are breathier still. Though these differences are small, in some cases tens of milliseconds or a few decibels of intensity, they may contribute to small, incremental shifts in production that over time may gradually shift the production of the variant (cf. Pierrehumbert, 2002), as described by Winter and Röttger (2011, p. 58) mentioned above.

A perception experiment would need to be carried out to determine whether this difference is perceptible to or functional for listeners, but for present purposes, this finding indicates that /a/ vowels are incompletely neutralized along the breathiness measure.

Additionally, in confirmation of the accounts of previous scholars, /o/ vowels in plural words were produced significantly fronted. Rincón Pérez (2015) reported a similar finding for speakers of Cartagenan Spanish, but not for Granada Spanish speakers. Fronting of /o/ was likewise not attested in Henriksen's (2017) study of Granada and Madrid vowels followed by /s/. This suggests that incomplete neutralization is demonstrated in Latin American varieties but not in Peninsular varieties, suggesting differing processes across the Atlantic. In studies comparing Peruvian and Peninsular Spanish vowels, Morrison and Escudero (2007) likewise found differences in vowel duration and quality, while Chládková, Escudero, and Boersma (2011) also attested differences in quality as well as differences in speaking rate between these two dialects. The differences attested here, including the experimental verification of the existence of incomplete neutralization in this dialect of Spanish, provide further evidence that while Latin American Spanish may have historically derived from Southern Peninsular Spanish, different processes have evolved diachronically.

Though the /a/ and /o/ vowels in this experiment demonstrated incomplete neutralization according to one measure each, the /e/ vowel appears to be completely neutralized, at least along these four measures. This could be due to greater variability in the /e/ vowel in this dialect as compared to the /a/ and /o/ vowels, or perhaps due to this particular study design. This analysis included final /e/ vowels of monomorphemic words like *viernes* [bjerne] "Friday" and

/e/-final roots like *estudiante* [es̪udjan̪t̪e] "student" whose plural allomorph is /s/. However, /es/ allomorphs of the plural, which appear on consonant-final words such as *árboles* [aɾβole] "trees," were not included. The reason for this was to ensure that any acoustic differences found for the /e/ vowel of a root could be solely attributed to plurality with a plural /s/ morpheme, not to this confounding factor. Additionally, /a/ and /o/ in NP constituents encode grammatical gender in Spanish, whereas /e/ does not, such as in *estudiante* or *inteligente* [in̪t̪elixen̪t̪e] "intelligent." Perhaps the functional load on the /a/ and /o/ vowels is therefore higher than on the /e/ vowel, and thus speakers are more likely to disambiguate these /a/ and /o/ vowels via phonetic means.

Conversely, /e/ vowels of plural and monomorphemic words were found to be significantly breathier than singular /e/ vowels. That is, this breathiness only obtains on /s/-final syllables closed by /s/, and therefore appears to be a correlate of closed syllables rather than an indicator of morphological status.

This takes us back to the discussion of incomplete neutralization. Given the phonetic differences found between singular and plural /a/ and /o/ vowels that did not also obtain on the monomorphemic vowels, it appears that some feature of the system retains the [+plural] specification that is not simply a phonological /s/ specification. If /a/ breathiness and /o/ fronting were due only to the presence of /s/, we would not expect differences between plural and monomorphemic vowels, but these obtained, offering counterevidence for both a traditional feed-forward model and Ernestus and Baayen's (2006) morphologically centered model. However, closed syllable breathiness also obtained on /e/ vowels. Therefore, it appears that a phonological /s/ still has relevance for the production of the /e/ vowels of these speakers.

An exemplar approach seems to best account for the variation observed in these data. In Pierrehumbert's (2003) model, it would be possible for singular vowels, plural vowels, and monomorphemic vowels to have different phonetic realizations due to exemplar clouds with different statistical distributions for each type of word. For instance, the exemplar cloud of plural vowels might include vowels followed by overt [s] spoken in more formal or read styles, which might shift the exemplar clouds toward a more extreme production. This might be a different shift from the final vowels of monomorphemic words, since these vowels would be encoded differently as to their morphological status. An exemplar model permits these distinctions based on multiple factors in a more satisfactory way than the other two models discussed, since these would not predict differences in both final vowels of singular and plural words and /s/-final versus non-/s/-final words.

Conclusions

This study provided an examination of a novel process of incomplete neutralization, in that the context for potential neutralization between singular and plural words derives from deletion of a morphologically meaningful /s/. Via an analysis of the spontaneous speech of 20 Chilean Spanish speakers, I have provided evidence for incomplete neutralization of /a/ and /o/ vowels of plural words, as well as evidence for closed syllable breathiness of /e/ vowels. I argue

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that because differences obtained according to both morphological and phonological motivations, the best model to account for these data is an exemplar model that permits words to have differing exemplar clouds according to elements such as morphological paradigm, phonological context, or speech style. Additionally, I argue that the reason that /a/ and /o/ are incompletely neutralized whereas /e/ is not stems from the grammatical gender agreement of Spanish. That is, /a/ and /o/ carry a heavier functional load, so it may be that speakers are more likely to disambiguate /a/ and /o/ according to breathiness and fronting (respectively) than /e/. Incomplete neutralization in word-final position has been attested in Cartagenan Spanish but not Eastern Andalusian Spanish, also suggesting a unique development of cross-continental phonological processes, or exemplar clouds. Future perception studies could speak to the functionality of these vowel alternations, but for now, I have provided instrumental evidence of a previously solely impressionistic incomplete neutralization process.

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Statement of Ethics

The participants in this project provided their written informed consent, as required by UCLA IRB #15-001231.

Disclosure Statement

The author has no conflict of interest to declare.

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