

**WORD-INITIAL H ASPIRATION AND THE
PRESENCE OF THE POST-VELAR FRICATIVE
[χ] IN NEW MEXICO SPANISH**

**LA ASPIRACIÓN DE H INICIAL DE PALABRA
Y LA PRESENCIA DE LA FRICATIVA POST-VELAR
[χ] EN EL ESPAÑOL DE NUEVO MÉXICO**

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ABSTRACT

Researchers first reported the aspiration of word-initial orthographic *h* (i.e. *humo* ['hu.mo]) in the traditional Spanish of New Mexico over a century ago. Subsequent studies confirmed the presence of this aspiration, but, to date, none have gone into phonetic and spectrographic detail. The current study summarizes some of the synchronic reports of *h* aspiration, details diachronic explanations given, as well as provides spectrographic analyses of this phenomenon as produced by six speakers of traditional New Mexico Spanish in a guided elicitation speech task. The results reveal that word-initial *h* aspiration is not only realized as both a glottal fricative [h] and a voiceless velar fricative [x] as previously reported, but also as a voiceless post-velar fricative [χ].

Keywords: *word-initial h aspiration, New Mexico Spanish, U.S. Spanish, post-velar fricative.*

RESUMEN

Los investigadores reportaron por primera vez la aspiración de la *h* ortográfica (i.e. *humo* ['hu.mo]) en el español tradicional de Nuevo México hace más de un siglo. Algunos estudios subsecuentes confirman la presencia de esta aspiración, sin embargo, hasta hoy, ninguno de éstos entra en detalle fonético ni espectrográfico. Este estudio resume algunos de los análisis sincrónicos, algunas de las explicaciones diacrónicas dadas y a la vez presenta análisis espectrográficos de este fenómeno producido por seis hablantes del español tradicional de Nuevo México en una tarea guiada de habla. La aspiración de la *h* inicial de palabra no solo se realiza como una fricativa glotal [h] y una fricativa velar [x], sino también como una fricativa posvelar [χ].

Palabras clave: *aspiración de la h inicial, español de Nuevo México, español de los EE. UU., fricativa pos-velar.*

1. INTRODUCTION

Linguists have described the Spanish spoken by native New Mexicans as a traditional variety (Lope Blanch, 1987; Piñeros, 2005; Bills and Vigil, 1999, 2008), in part, due to the sixteenth-century linguistic features that characterize it. One of these features is the aspiration of word-initial *h*, as first reported by Espinosa (1909) and then observed again by Bills and Vigil (1999, 2008). These

studies, however, did not examine this phenomenon in phonetic detail, and only hint at the nature of the aspiration produced, i.e. that the aspiration appears variably as either [h] or [x]. The present study seeks to use phonetic and spectrographic analyses of speaker pronunciations to further investigate this topic. To this end, the *h* aspiration present in the speech of six native speakers of traditional New Mexico Spanish (TNMS) is analyzed.

2. BACKGROUND

Word-initial *h* aspiration, also sometimes referred to as orthographic *h* aspiration, has been investigated from a predominately diachronic perspective to date. In this section, we will provide a description of this aspiration phenomenon by detailing the historical development of word-initial *h* from Latin to Spanish in order to show how the phenomenon arrived in the new world. Then, we will give a brief summary of some diachronic explanations of word-initial *h* aspiration in TNMS that attempt to explain why the [x], [h] variation is present. Next, a synchronic account of the various reports of word-initial *h* aspiration attested to in TNMS will be given and used to show that a quantitative and phonetically detailed account of the phenomenon does not exist. Finally, the research questions that guide the present study will be listed.

2.1. Development of word-initial *h* from Latin to Spanish

Any discussion of modern word-initial *h* aspiration in Spanish should begin with a diachronic description of the phenomenon. Being a Romance language, Spanish traces its roots to Classical Latin, which had the phonemes /f/ and /h/. The Latin /h/ was lost by the first century B.C.E. and words with initial /f/ have two outcomes in modern normative Spanish, i.e. F- > [ø] (FACĒRE > *hacer*) and F- > [f] (FAMILIA > *familia*). This process was predictable, as Brown and Raymond (2012) point out in their thorough summary of the literature on this phenomenon, when the Latin F- was followed by a glide or a liquid as in *flor* and *fuelle*, however, when followed by a vowel, the outcome of the initial [f] is not determinable solely based on the word's phonology, e.g. FURNUS > *horno* and FĪXUS > *fijo*. Moreover, the Latin etymon does not help predict the outcome of F-, as both *humo* and *fumar* have the same root, but different outcomes, i.e. FŪMUS > *humo* and FUMĀRE > *fumar* (Brown and Raymond, 2012). This unpredictability has led many researchers (Menéndez Pidal, 1968; Blake, 1988; Penny 1972, 1990, 2000; Brown and Raymond, 2012; Brown and Alba, 2017) to hypothesize and research the reasons for the outcomes in words that are outliers. As Brown and Raymond (2012) conclude, researchers have generally focused on the individual histories of these

words and they provide alternative analysis showing that the frequency of a word's use in extralexical phonetic reducing environments and lexical stress patterns significantly predict the outcomes. In addition, Brown and Alba (2017) analyzed the acoustic energy of 996 tokens of word-initial /f/ in the speech of 38 speakers of Mexican Spanish and concluded that the reduction of /f/ is conditioned by the immediate phonological context as well as by the frequency with which words occur in phonological contexts favorable to reduction.

In the present study, we are concerned most with the F- words whose outcome in modern normative Spanish is F- > [ø], represented orthographically as *h*, but which are articulated as F- > [h] in TNMS. The articulation F- > [h] in TNMS may represent an earlier stage in the evolution of this sound change. In (1), the derivations of four words are detailed from Latin through the periods of Old Spanish (409-711) and Medieval Spanish (711-1492) into modern normative Spanish. The sound change can be summarized as [f-] > [h] > [ø].

(1)	Latin	Old Spanish	Medieval Spanish	Modern Normative Spanish
	FĪCU>	figo ['fi.go]	higo ['hi.yo]	higo ['i.yo]
	FŪMUS >	fumo ['fu.mo]	humo ['hu.mo]	humo ['u.mo]
	FERVĒRE>	fervir [fer.'βir]	hervir [her.'βir]	hervir [er.'βir]
	FACĒRE>	fatser [fa.'tser]	hacer [ha.'tser]	hacer [a.'ser]

While *humo* and *hervir* in (1) are pronounced as ['u.mo] and [er.'βir] respectively in modern normative Spanish, researchers (Espinosa 1909; Bills and Vigil, 2008) have reported aspiration ([ʰu.mo] and [her.'βir]) by speakers of TNMS. Aspiration of Latin F- words arose in Spanish during the Medieval period and many researchers have proposed both internal and external linguistic factors to explain this sound change, yet there is no consensus as Brown and Alba (2017) conclude. Internal influences of this phenomenon include changes in the place of articulation of phones that were possibly present, such as the voiceless labiovelar [ɱ] and voiceless bilabial fricative [ɸ] allophones. For example, a bilabial articulation ([ɸ]) of /f-/ eventually dissimilated to [h] (Penny, 1972). External contact influences of this phenomenon include Mozarab, Basque, Gascon and French, among others, as well as regional and social variation. For example, observations show that diatopically speaking, aspiration emerged in the north of the Peninsula and then was carried to the south by resettlement during the Reconquest (Penny, 1972). Then, in the 16th century, orthographic *h* ceased to be aspirated in Old Castile, whereas aspiration continued in Toledo, Cantabria, New Castile, Extremadura and Andalusia. As Penny notes, one well-known sixteenth-

century contrast existed *between the Burgos pronunciation of /ablár/, etc., and the Toledan pronunciation /hablár/* (Penny, 2000:94). Ultimately, variation in /h/ aspiration and elision in the Peninsula became diastatic in distribution since aspiration became confined to speakers in rural and urban settings with little formal education. Regardless of whether aspiration in Medieval Spanish was due to internal or external factors, in modern normative Spanish, orthographic *h* is not aspirated. Nonetheless, researchers have impressionistically observed and reported modern aspiration of orthographic *h* in TNMS, and early colonizers carried this phenomenon to the New World in the 16th century.

2.2. Aspiration of orthographic word-initial *h* in the Spanish of New Mexico and southern Colorado

Espinosa (1909) reported the first phonetic descriptions of the sounds of New Mexico and southern Colorado Spanish. In his analysis, he compared TNMS to Castilian Spanish and, at times weaved in discussion of the historical development of Spanish from Latin. Speaking of TNMS, Espinosa asserted that, *this dialect is for the most part a Castilian dialect [...] and to be exact, the sources of New Mexican Spanish are to be found in the Spanish of the XV and XVI centuries* (Espinosa, 1909:53). He also provided analysis of vowels and consonants observable at that time. In short, he described the phonetics and phonology of TNMS by providing a phonetic inventory of sounds present, and detailed the environments in which each sound occurred, namely in the context of specific words. In his analysis of velar and pharyngeal sounds, Espinosa described word-initial *h* aspiration in TNMS:

The aspiration is preserved as a rule when initial (and also in other positions) and in all cases when the h was from Latin f. Initial Latin F > Old Spanish aspirate f with but few exceptions (probably in all regions except Asturias, where F has persisted to the present day) became, in the XVIth century, an aspirate h as in the American English h of house, and the same as the New Mexican Spanish j [x] (Espinosa, 1909:105).

By way of clarification, it should be noted that, based on Espinosa's descriptions, the voiceless pharyngeal aspirate [x] he describes may be equivalent to the modern day voiceless glottal fricative [h] of the International Phonetic Alphabet. One may conclude this based on his description of phonetic changes in words of English origin where he states that, *There is no essential difference between English aspirate h and New Mexican j (g + e, i). Both have the value of a voiceless pharyngeal aspirate [x]* (Espinosa, 1909:149). In another analysis of what he labels lingual sounds, he describes /s/ reduction by stating that *s may in all*

positions become, in New Mexican Spanish a very weak pharyngeal aspirate [x], which will be represented by [h]. When intervocalic it is practically [x], otherwise [h], or entirely silent, especially final before some consonants (Espinosa, 1909:103). From these descriptions, one may infer, that for Espinosa, the voiceless pharyngeal aspirate [x] he describes as present in TNMS for *ge*, *gi*, *j*, and *s* (in environments susceptible to apparent weakening or aspiration) would be equivalent to the IPA voiceless glottal fricative [h]. However, his statement that, [x], [h] or deletion are observable, alludes to the presence of variation and the possibility of a gradient nature of pronunciation. In a separate analysis, which is relevant in the present study, Espinosa (1909) provides examples where initial *F*- is aspirated and states that, *F*- > *j*- [x] in New Mexican Spanish are *juí*, *jué*, *juersa*, *jogón*, *juego*, *Jelipe*, *juerte*, *Julano*, *Jilomena* (Espinosa, 1909:108). Espinosa does not provide any quantitative results or spectrographic analysis. The present study seeks to provide such information.

Bills and Vigil (1999, 2008) also reported on orthographic *h* aspiration in TNMS. Their research is based on a large corpus of Spanish spoken in New Mexico, which they developed and which is known as the New Mexico-Colorado Spanish Survey (NMCOS). It was conducted in the early 1990s with funding from the National Endowment for the Humanities, and its main goal was to produce a linguistic atlas. The survey comprises 350 audio recorded interviews with Spanish-speaking people who are native to New Mexico or southern Colorado. Southern Colorado was included because it was part of the New Mexico territory until it became a state in 1876; Spanish speakers from New Mexico were the first settlers in southern Colorado; and probably a majority of Spanish-speaking southern Coloradans today can trace their ancestry to New Mexico (Bills and Vigil, 2008:5). Researchers have referred to this variety of Spanish spoken in northern New Mexico and southern Colorado as traditional because it has features that date back to the sixteenth century when the area was first settled and because some of these features distinguish it from other varieties.

The NMCOS survey targeted 63 localities pre-identified on the basis of 1980 Census research and sought six consultants from each area: one male and one female from three age groups (18-39, 40-60, 61 and older). Bills and Vigil state that *On the phonological level, one of the most salient archaic features is the retention of the /x/ fricative corresponding to orthographic h, a phonological unit that has been lost in mainstream Spanish. The following forms, for example, are pronounced with an initial glottal [h] or velar [x]: humo 'smoke', hervir 'to boil', hallar 'to find', hediondo 'smelly, stinky'* (Bills and Vigil, 1999:50). However, they also note that pronouncing the *h* is not a categorical phenomenon, since the

initial *h* in *Hombre* ‘man,’ *hambre* ‘hunger,’ *hija* ‘daughter,’ and *hermana* ‘sister’, is never aspirated. Bills and Vigil reported that the following four tokens have aspiration (labeled as [x]) of /h/: *honda* ‘slingshot’ (52.7%, n=328), *hongo* ‘mushroom’ (45.9%, n=333), *huellas* ‘tracks’ (41.2 n=337) and *humo* ‘smoke’ (28.7% n=335) (2008:73). If Espinosa’s (1909) description alluded to the fact that *h* aspiration was variable, Bills and Vigil (1999) affirm that variation does exist, at least for the speech of TNMS speakers of the late 20th century. However, from their report it is not clear if variation is present as both [h] and [x] for all tokens.

2.3. Diachronic explanations of *h* aspiration

One researcher in particular, Craddock (2006), gives a diachronic analysis of this aspiration phenomenon based on Espinosa (1930-1946), Rael (1937), Bowen (1952) and Ross (1975). In his discussion of systematic changes in TNMS, he deals in detail with the most frequent phonetic changes, one of which is the maintenance of word-initial aspiration of *h* (historically /f-/) that disappeared in normative Spanish in the sixteenth century (Craddock, 2006:206). According to Craddock this phonetic change may have the most intricate history of all of the phonetic changes he lists. This word-initial *h* aspiration, he reaffirms, is present in a great number of New Mexican words. Craddock (2006) relists several words that Espinosa (1909) originally provided. To indicate the presence of aspiration, Espinosa transcribed the tokens that have initial *h* aspiration with a “j”. See Table 1.

TNMS	<i>jígado</i>	<i>jilar</i>	<i>jiel</i>	<i>jervir</i>	<i>jeder</i>	<i>jayar</i>
Spanish	<i>hígado</i>	<i>hilar</i>	<i>hiel</i>	<i>hervir</i>	<i>heder</i>	<i>hallar</i>
TNMS	<i>joyo</i>	<i>jongo</i>	<i>jondo</i>	<i>josco</i>	<i>jurtar</i>	<i>juir</i>
Spanish	<i>hoyo</i>	<i>hongo</i>	<i>hondo</i>	<i>hosco</i>	<i>hurtar</i>	<i>huir</i>
TNMS	<i>jumo</i>	<i>juella</i>				
Spanish	<i>humo</i>	<i>huella</i>				

Table 1. *New Mexican words with word-initial aspiration of h adapted from Craddock (2006:206).*

Espinosa (1909) asserts that aspiration in the words listed above is the result of [f-] > [h], but that the phonetic realization of this aspiration [f-] > [h] was confused with the phones [x] and [h], which resulted from the changes to the sibilants of Medieval Spanish, i.e. [ʃ], [ʒ] > ([x] and [h]). Moreover, Espinosa (1909) reports

aspiration in New Mexican words, which corresponds to an initial /f/ that was maintained in normative Spanish. See Table 2.

TNMS	<i>Jilomena</i>	<i>Jelipe</i>	<i>jogón</i>	<i>julano</i>	<i>juí</i>	<i>jué</i>
Spanish	<i>Filomena</i>	<i>Felipe</i>	<i>fogón</i>	<i>fulano</i>	<i>fui</i>	<i>fue</i>
TNMS	<i>juerza</i>	<i>juego</i>	<i>juerte</i>			
Spanish	<i>fuerza</i>	<i>fuego</i>	<i>fuerte</i>			

Table 2. *New Mexican words with aspiration of /f/ conserved in normative speech adapted from Craddock (2006:206).*

After analyzing and comparing additional words from Rael (1937), Bowen (1952) and Ross (1975), Craddock concludes that this phenomenon is not a simple dichotomy characterized by loss of word-initial /h/ on one hand and maintenance of it and subsequent merger with /x/ </f/ and /z/ on the other (Craddock, 2006:206). What occurs in TNMS, he states, is an incomplete diffusion of the change /h/ > ø. In other words, word-initial aspiration of /h/ was maintained in a series of words in TNMS until the moment when it was confused or merged with the velar fricative /x/, product of the medieval alveopalatal sibilants, and therefore never went through the stage of change which involved the loss of aspiration.

With regard to these medieval sibilants, Spanish had six by 1492; three sets of voiced and voiceless pairs. The phones of the first set were either produced as alveolar affricates ([tʃ] and [dʒ]), or were becoming lamino-alveolar fricatives ([s] and [z]) toward the end of the 15th century. The phones of the second set were apico-alveolar fricatives ([ʃ] and [ʒ]). Finally, the phones of the third set were palato-alveolar fricatives ([ç] and [ʝ]). Some researchers hypothesize that this system was very unstable, and that by 1550 a leveling occurred in which the voiced phones were devoiced leaving the voiceless sibilants [s], [ʃ] and [ç]. By 1650, in northern Spain the palato-alveolar grooved fricative [ç] was pronounced in a more posterior region, possibly as a way of dealing with the phonological instability present, and became a voiceless velar fricative [x] and even developed a more salient frication pronunciation ([χ]) in northern and central Spain. In southern Spain, the [ç] was shifted even farther posterior becoming [h].

In addition to Craddock (2006), Lapesa (1981) also concludes that in the Iberian Peninsula the [h], which was preserved from Latin F-, was confused or merged with the velar [x] (reflex of [ç] and [ʝ]), which also became more aspirated like the [h]. As further evidence of this phonological confusion or merger, the first witness

of [h] as the pronunciation of the graphemes *g* and *j* (as cited in Lapesa, 1981:362), appears in early works like *Cancionero de obras de burlas* by Juan Viñal from 1519 and *Tragedia Policiana* by Sebastián Fernández from 1547. Lapesa (1981) also affirms that from Andalusia the aspiration [h] for [x] passed quickly to the Canary Islands and America. He asserts that the pronunciation of *x*, *g* and *j* as [h] is attestable in Spain from 1519 and in America from 1558, and that in 1980 it was the norm in the Antilles, New Mexico, the extreme north of Mexico, the northern part of the California Peninsula, the eastern and southern coasts of Mexico, the Yucatan, Central America, Panama, Colombia, Venezuela, the coast of Ecuador, and the northern coast of Peru. According to Lapesa (1981), the rest of Hispano-America pronounced a [x] less velar than the Castilian and the [h] of /f-/ is conserved to varying degrees throughout America in vulgar and rustic Spanish.

Lloyd (1987) discusses a similar evolution of these fricative sounds and states that it is not especially the position of the posterior fricative that distinguishes Andalusian and American Spanish from Castilian, but the degree of closure, which tends to be much greater in Castilian, producing greater friction. Here, it appears as though he is making reference to the Spanish post-velar (or uvular) fricative [χ] of northern and central Spain. Lloyd (1987) concludes that the lesser degree of friction found in Andalusian and American Spanish, is undoubtedly due to the identification of the new [x] with the old [h].

Another researcher, Blake (1988), offers a slightly different explanation of the *h* aspiration phenomenon generally, and not in TNMS, based on his philological examination of writing conventions. He shows that the medieval graph *f* in early Medieval Spanish documents was itself ambiguous representing in the spoken vernacular either a labiodental [f], a glottal [h], or even a null realization [∅] (in certain dialects). Based on his data, he concludes that *labiodental [f] and glottal [h] were accepted as distinct phonemes in the literate speech community sometime between 1275 and 1375, at the very latest* (Blake, 1988:58), before which a single written *f* adequately captured all allophonic or dialectal variation. Subsequent orthographic vacillations, hypercorrections, and f-doubling strategies demonstrate the confusion most literate speakers suffered. Blake (1988), however, investigates only two variants of aspiration in his diachronic analysis of the data, namely, [h] and [∅]. The present study will examine not only [h] and [∅] variants in phonetic detail, but also [x] and any other possible variants.

2.4. Research questions

In summary, Latin had both /f/ and /h/. The /h/ was lost, but later /f-/ aspirated to [h] in Spanish. From the six medieval Spanish sibilants, which are reduced to three voiceless sibilants, develop the [x] and [h] in northern and southern Spain respectively. These sounds, along with /f-/ > [h] are carried to the Americas, and are confused and merged in some varieties. An analysis of Espinosa's (1909) description of the aspiration reveals that he labeled this phonetic variant as a voiceless pharyngeal aspirate [x], but his phonetic description of this variant is similar to a modern voiceless glottal fricative [h]. Based on Espinosa's work (1930-1946), and in an effort to characterize the history of Spanish in the United States, Craddock (2006:212) concluded that aspiration [h] was maintained in a series of words until at one point in the 17th century it was confused with the velar fricative /x/, which developed from the palato-alveolar sibilants as detailed above. Craddock (2006) based his analysis of this phenomenon on previous impressionistic data and was not concerned with the phonetic details of this sound change, but rather with giving a diachronic analysis and explanation of the phenomenon. Finally, Bills and Vigil (2008) note the presence of orthographic *h* aspiration as well, but do not focus on phonetic details either, and although they do report variable aspiration in the form of [x] and [h], they do not specify in which tokens or environments these variants occur or their relative individual frequency.

TNMS, then, as has been reported, is characterized by having both [x] and [h] as realizations for word-initial *h*. Some studies (Craddock, 2006; Blake, 1988) have also attempted to account for this aspiration diachronically, but to date no phonetically detailed studies of this phenomenon have been carried out. The present study, therefore, seeks to determine the variants of aspiration present in this data set. We hypothesize that [x] and [h] will be present, that the [h] will be most frequent, and that for historical reasons, other variants, including [χ], may be present.

3. METHODOLOGY

3.1. Participants

There were six participants in the present study. Three of the speakers were female (ages 56, 58, 65) and three were male (ages 54, 59, 69). All of the participants are sequential bilinguals. That is to say, their first language was Spanish and they learned English at some point later when they attended public schools. All of the speakers belong to the middle/lower class and did not take formal classes in

Spanish. In this sense, they are representative bilingual speakers of the traditional New Mexico Spanish spoken in Taos.

3.2. Data collection

After the details of the study were reviewed and informed consent was given, the speakers were asked to orally translate¹ sixteen English words whose Spanish equivalent contained word-initial /h/, and to use the word in a carrier sentence, as in (2) and (3), respectively. The variants used by Speaker 5 for /h/ is transcribed below the tokens. He produced [χ], [x] and [h] for word-initial /h/. A detailed phonetic analysis of the variants realized will be given below in the next section.

- (2) *¿Cómo se dice (to find) en español?*
How do you say to find in Spanish?

¿Lo puede usar en una frase?
Can you use it in a phrase?

Speaker 5

<i>Hallo.</i>	<i>Yo hallo leña en la montaña.</i>
[χ]	[x]
I find.	I find wood in the mountain.

- (3) *¿Cómo se dice (smoke) en español?*
How do you say smoke in Spanish?

¿Lo puede usar en una frase?
Can you use it in a phrase?

Speaker 5

<i>Humo.</i>	<i>En el invierno se mira mucho humo.</i>
[x]	[h]
Smoke.	In the winter one sees a lot of smoke.

¹ This translation exercise was possible because the participants were bilingual and it was used in order to elicit unguarded and more spontaneous speech. Moreover, most participants in a previous related study, were not able to read in Spanish (either due to problems with vision or literacy). This translation method also allowed the researcher to investigate tokens with *h* in specific contexts, without influencing the participants' pronunciation.

The list of words elicited appears in Table 3. These tokens were chosen because they provided orthographic *h* before each of the five phonemic Spanish vowels and included four of the words (#13 through #16) that Bills and Vigil (2008) confirmed as having aspiration in TNMS. The participants' speech was recorded using a steady-state digital Marantz PMD-660 audio recorder at a sampling rate of 44,100 Hz and was analyzed using Praat (Boersma and Weenink, 2007) speech analysis software. In some cases, the speakers gave a translation other than the one sought. For example, instead of *hediondo* for 'stinky,' some provided *perrodo*, in which case the interviewer asked if they knew of any other terms for the token elicited. For this reason, not all of the tokens elicited have the sought for translation containing orthographic *h*. A complete list of these results is provided in the results section.

1	<i>hablar</i>	5	<i>harina</i>	9	<i>hilo</i>	13	<i>hallar</i>
2	<i>hacer</i>	6	<i>helar</i>	10	<i>hojas</i>	14	<i>humo</i>
3	<i>hacha</i>	7	<i>hijo</i>	11	<i>hormiga</i>	15	<i>hediondo</i>
4	<i>hambre</i>	8	<i>hija</i>	12	<i>horno</i>	16	<i>hervir</i>

Table 3. *Elicited items.*

All of the word-initial /h/ segments of the tokens were analyzed auditorily, spectrographically and categorized. Then, after the categories were determined, the variants were coded. In addition, the phone preceding the orthographic *h* in the carrier phrase tokens was determined and analyzed for the words that showed aspiration.

4. RESULTS

4.1. Phonetic descriptions, spectrograms, waveforms and descriptions of the variant categories

In general, fricatives involve two articulators constricting narrowly in the oral cavity and creating turbulence as air passes through. The [h] is treated as a fricative in the present study. Ladefoged, however, stated that instead of the source of the noise for [h] being air forced through a narrow gap, it is actually turbulence or the random variations in air pressure *caused by the movement of the air across the edges of the open vocal folds and other surfaces of the vocal tract* (Ladefoged, 2005:58). Therefore, the [h] may be considered a voiceless consonant, and as such, spectrograms of [h] may show turbulent formants, especially in intervocalic

position (Quilis, 1999:269). The [h] also shows high frequency energy present spectrographically (Ladefoged, 2005:58) and aperiodicity in the waveform.

The non-sibilant fricative [x] is articulated in the posterior region of the vocal cavity. The dorsal portion of the tongue is raised to the soft palate (velum) where the airstream is forced through a slit-like space causing turbulence (Quilis, 1999:253; Hammond, 2001:227). The vocal folds do not vibrate and the sound is pulmonic. Spectrograms of [x] fricatives show high-frequency noise or energy, and, like [h], in some cases have noisy formant structures usually similar to the adjacent vowel formant structures (Real Academia Española, 2011:184). The waveform of [x] is characterized by aperiodicity as well.

The [χ] is a non-sibilant fricative articulated in a farther posterior region of the vocal cavity. The dorsal region of the tongue body is lifted to the velum, where turbulence occurs as the airstream is forced through the space, which in the uvular variety of this phone involves significant airflow against and around the uvula causing it to vibrate (Real Academia Española, 2011:194) and be very strident (Hammond, 2001). The vocal folds do not vibrate and the sound is pulmonic. Spectrograms of [χ] fricatives have high-frequency noise or energy, and, like [h] and [x], in some cases have noisy formant structures usually similar to the adjacent vowels. The waveform of [χ] is also characterized by aperiodicity.

Preliminary auditory and spectrographic analysis confirmed that in addition to non-aspirated variants ([ø] and [g]), aspiration of orthographic *h* was present in some tokens and that this aspiration was characterized by phonetic, inter-speaker and intra-speaker variation. The variants were classified into five categories. See Table 4. Although this aspiration may be considered gradient in nature, three distinct aspirated variants were defined and categorized, namely a voiceless glottal fricative [h], a voiceless velar fricative [x], and a voiceless post-velar fricative [χ].

An interrater reliability test was carried out using these five categories. A number was assigned to each token containing word-initial orthographic *h* variants in the entire corpus and then a random number generator was used to generate 100 numbers. The audio files for the tokens corresponding to the random 100 numbers were extracted using Praat and were given to a second rater who is a linguist with experience analyzing Spanish speech and spectrograms in Praat. Using the descriptions of how the variants were classified into categories by the first rater, but not the first rater's ratings, the second rater analyzed the spectrograms of the tokens and rated the orthographic *h* segments. The results of the Cohen's Kappa test showed good agreement between the raters with a Kappa of .71.

category #	phonetic symbol of variant	phonetic description
1	[Ø]	no phone present
2	[g]	voiced alveolar stop or approximant [ɣ]
3	[h]	voiceless glottal fricative
4	[x]	voiceless velar fricative
5	[χ]	voiceless post-velar fricative

Table 4. *Categories of variants observed.*

Spectrograms of the five categories of variants from the data will now be presented along with the criteria used to categorize them. All three aspirated variants were observed in two of the 16 tokens, i.e. *hediondo* and *humo*, and in both cases, were produced by three different speakers (two females and one male).

The format of the following spectrograms includes a waveform appearing at the top of the figure, the spectrogram, with Hz on the y axis in the middle, the transcription below the spectrogram, and duration on the x axis measured in seconds at the bottom of the figure. The dotted horizontal lines indicate Hz in units of 1,000 and the dotted vertical lines delineate the phones as much as is practically possible. Below each spectrogram appears the description of the phonetic variant including the criteria established by the first rater, which were used for categorization. The spectrogram settings in Praat were set to view range between 0.0 and 11,000.0 Hz. In addition to analyzing the spectrograms and waveforms, auditory analysis was used to analyze and code the variants into categories, and in the interrater reliability test.

In Figure 1, the speaker did not produce any aspiration or any type of phone for the word-initial orthographic *h* in *hilo*. Note the complete absence of energy in the spectrogram and waveform. The absence of any perceivable phone or energy was used to categorize the null variants.

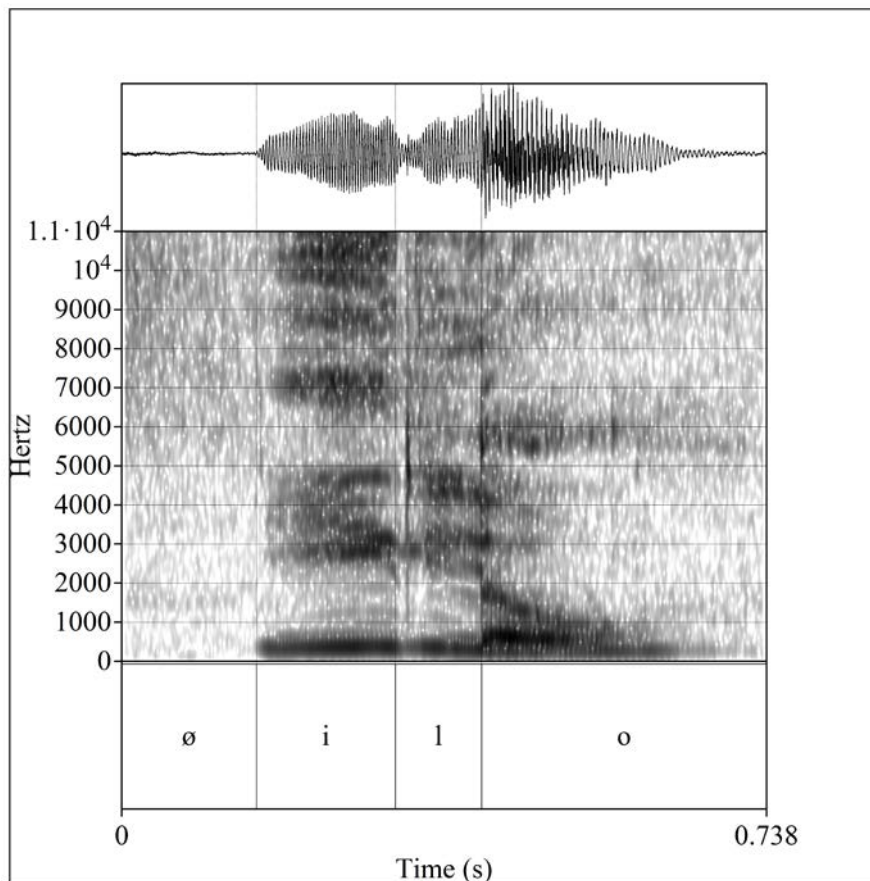


Figure 1. Waveform, spectrogram and phonetic transcription of hilo showing [ø].

In Figure 2, the speaker did not produce any aspiration for the word-initial orthographic *h* in *los huesos*, but rather, a voiced velar stop [g] that is audible but appears a little weak in the spectrogram. Note the lack of energy in the waveform and spectrogram between 1,000 hertz to 4,000 hertz, the slight voicing in the preceding segment, and minimal burst visible in the energy between 8,000 and 11,000 Hz. In addition to auditory analysis, the relatively low amplitude in the waveform and weaker energy in the spectrogram were used to categorize this variant. In some cases, these voiced velar phones may appear as voiced velar

approximants [ɣ]. Given that the focus of the present study was on aspirated fricative variants, whether the voiced velar phones were stops [g] or approximants [ɣ], was beyond the scope of the current study.

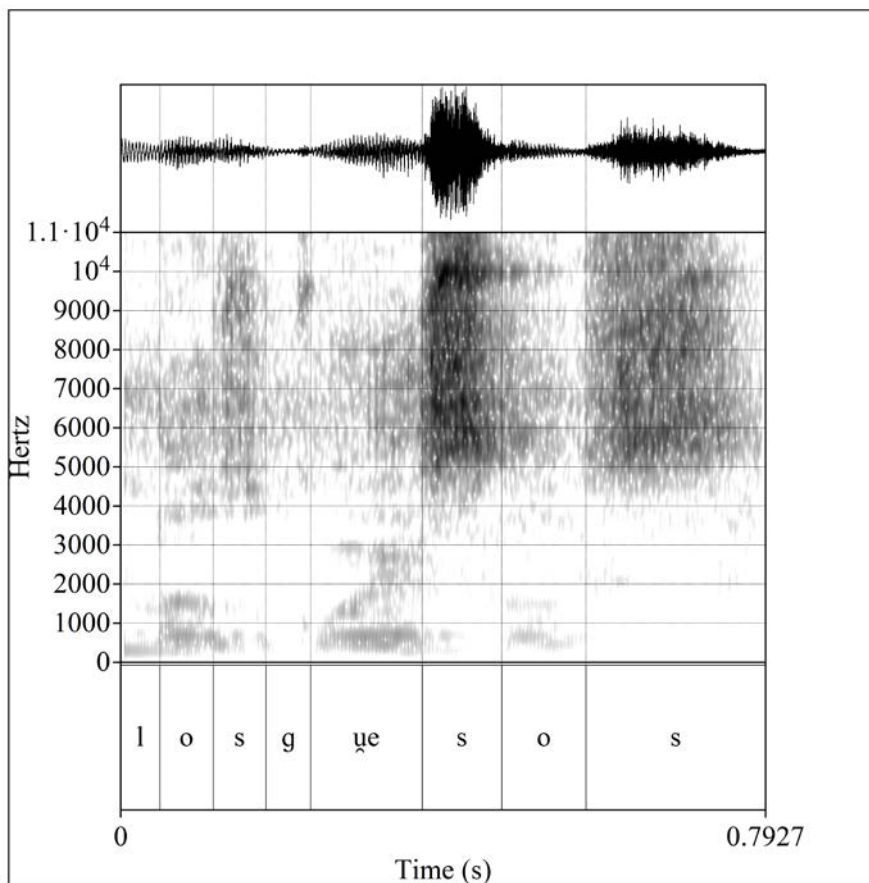


Figure 2. Waveform, spectrogram and phonetic transcription of *los huesos* showing [g].

We will now present spectrograms of all three aspirated variants as produced by the three different speakers in the carrier phrase of the token *hediondo*. In one of the examples, the token is preceded by *bien* and in two by *muy*.

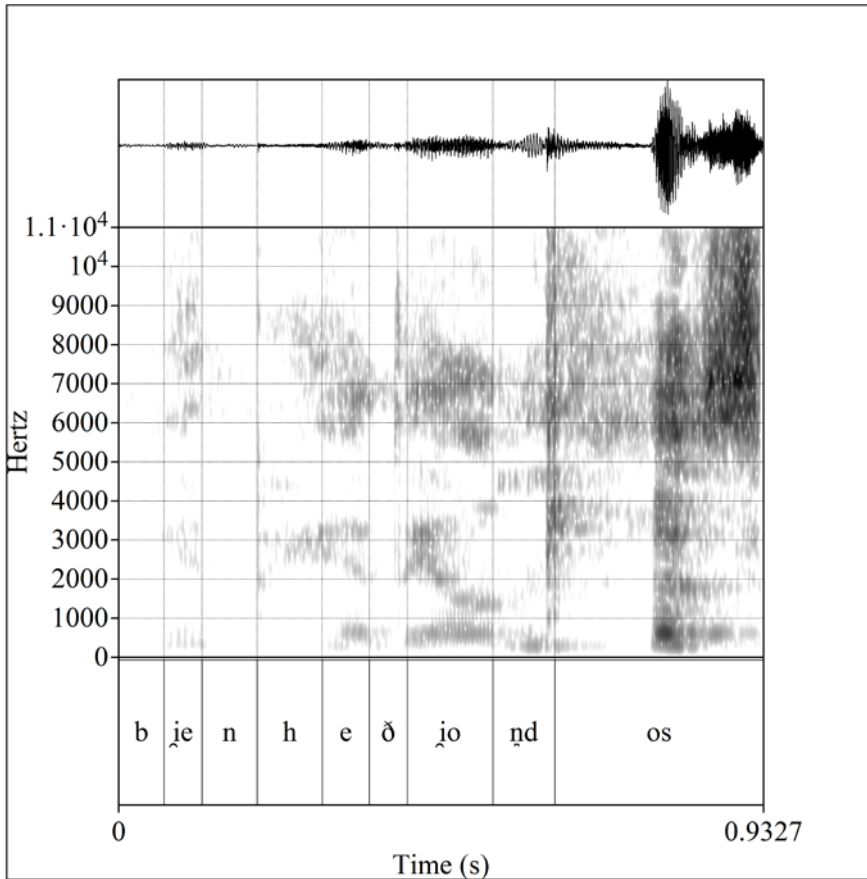


Figure 3. Waveform, spectrogram and phonetic transcription of bien hediondos showing [h].

The [h] of *hediondos* in Figure 3 has a waveform that is characterized by relatively low-amplitude aperiodicity and higher concentrations of energy present between 2,000 and 4,000 Hz and 6,000 and 9,000 Hz. The segment exhibits friction and formants with the same characteristics as the neighboring vowel [e]. The relatively low amplitude in the waveform and weaker energy in the spectrogram were used to categorize this variant.

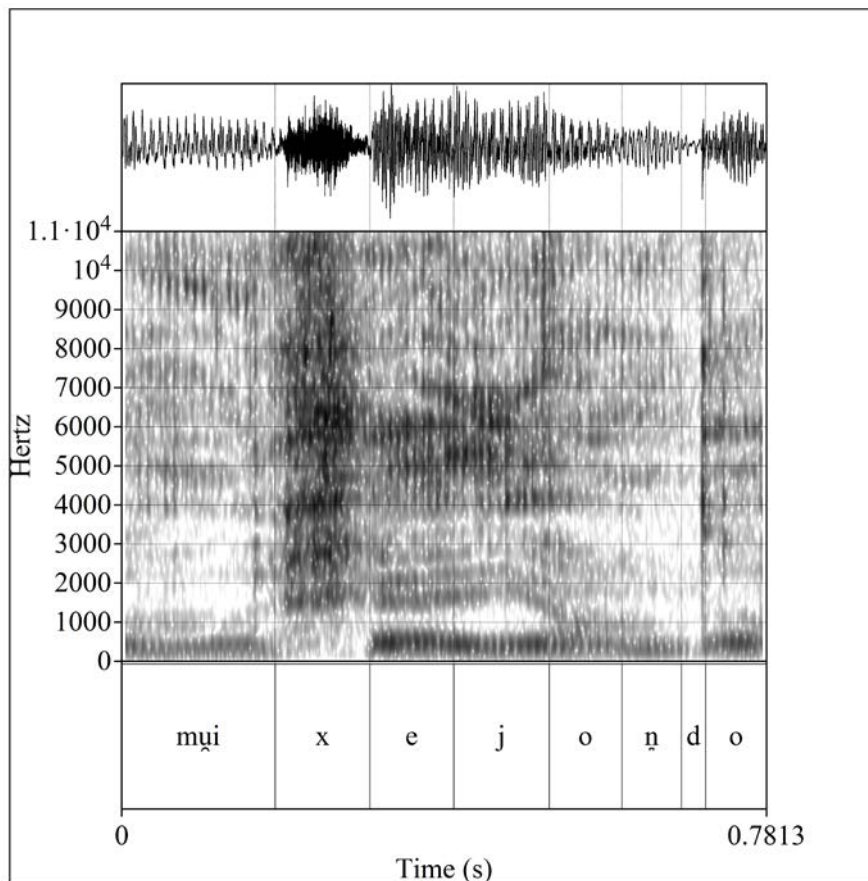


Figure 4. Waveform, spectrogram and phonetic transcription of *muy hediondo* showing [x].

Figure 4 provides an example of [x], also for *hediondo*, which is characterized by relatively high-amplitude aperiodicity in the waveform and higher concentration of energy present continuously between 1,000 and 11,000 Hz. The segment exhibits formants that are also present in the neighboring vowel [e]. F2, F3, and F4 are clearly visible. The relatively higher amplitude in the waveform and stronger energy in the spectrogram were used to categorize this variant. The speaker deleted the first 'd'.

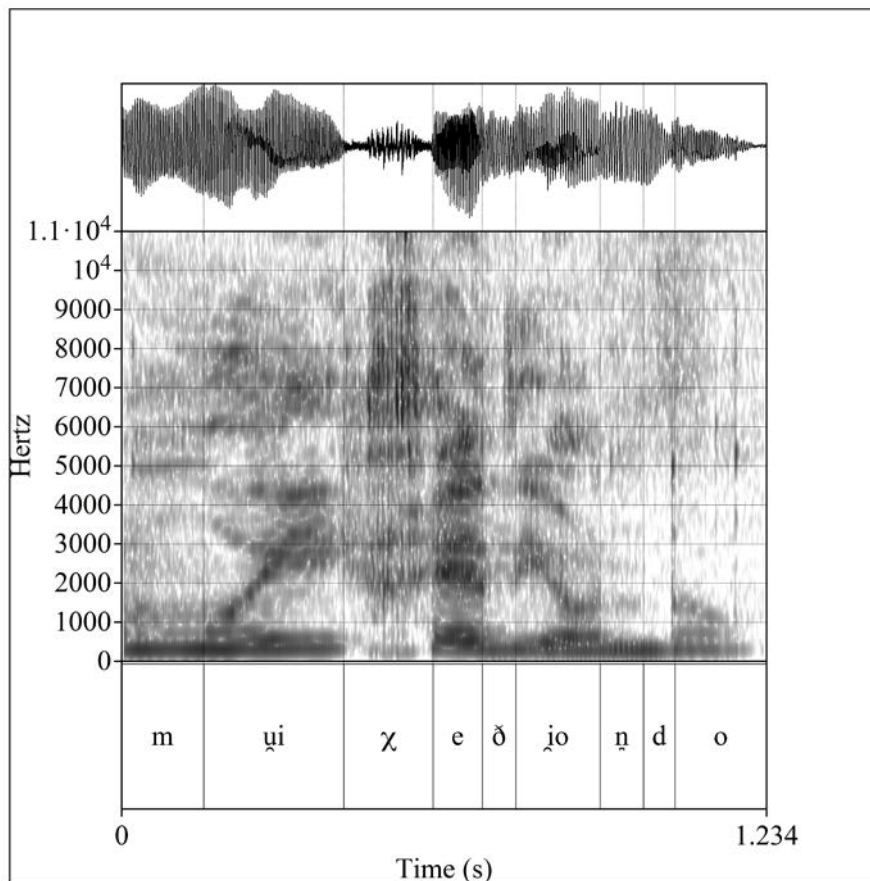


Figure 5. Waveform, spectrogram and phonetic transcription of *muy hediondos* showing [χ].

The [χ] of *hediondos* in Figure 5 shows aperiodicity in the waveform, but also periods characteristic of vibrations made from the strong airflow against and around the uvula causing it to vibrate (Real Academia Española, 2011:194). The pulses of this vibration are also visible in the spectrogram. There are higher concentrations of energy present between 1000 and 4000 Hz and between 5,000 and 10,000 Hz. The segment exhibits friction and formants that are also present in the neighboring vowel [e]. F2 through F4 are visible. Although impressionistically this phone does not sound like it is voiced, compared to the [x] in Figure 4, there is

a faint voicing bar present below 500 Hz. This voicing is not strong enough to characterize this phone as a voiced uvular fricative [ɣ]. The high amplitude in the waveform and strong energy in the spectrogram along with greater periodicity and vibration pulses were used to categorize this variant.

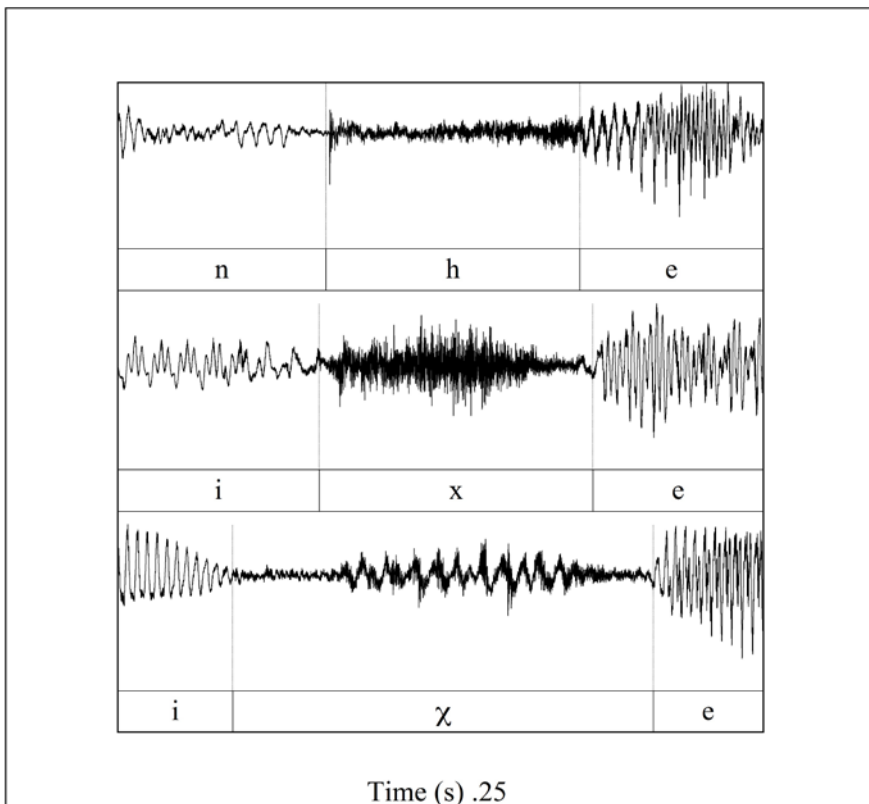


Figure 6. Comparison of waveform of all three variants.

Finally, Figure 6, above, provides a comparison of the waveforms for the three variants displayed above in Figures 1-3. The differences described above are especially salient in this figure, which provides detail of the waveforms.

4.2. Frequency and distribution of [h], [x] and [χ]

Of the 16 tokens analyzed, tokens 1-12 (in Table 3 above) did not have any instances of aspiration. Results from all 16 words show that [ø] was the most prevalent, at 82%. See Table 5. The voiceless velar fricative [x] was the second most frequent variant at 11% and appeared in the tokens *hallar*, *humo*, *hediondo*, *hervir*. The voiceless glottal fricative [h] occurred 8 times (4%) in *hallar*, *humo* and *hediondo*. There were three instances of the post-velar [χ] in *hallar* and *hediondo*, and two speakers produced a velarized stop before the diphthong in *hueso* [gue.so].

variant	[ø]	[x]	[h]	[χ]	[g]	Total
N. and %	172 (82%)	24 (11%)	8 (4%)	3 (1%)	2 (1%)	195 (100%)

Table 5. Total word-initial h variants of all 16 tokens.

Results for tokens 13 through 16 (*hallar*, *humo*, *hediondo*, and *hervir*) show that 69% of the time the word-initial *h* is aspirated (as [h], [x] or [χ]) by these speakers from Taos. The voiceless velar fricative [x] is the most frequent at 47%. See Table 6 for the distribution of the phonetic variants and percentages by speaker.

speaker	phonetic realizations				total
	[x]	[ø]	[h]	[χ]	
1	3	1	2	1	7
2	2	8	2	0	12
3	3	3	1	1	8
4	6	0	0	0	6
5	5	0	2	1	8
6	5	4	1	0	10
total	24 (47%)	16 (31%)	8 (16%)	3 (6%)	51

Table 6. Variants of *hallar*, *humo*, *hediondo*, and *hervir* by speaker.

Table 7 provides a distribution of allophones by speaker for the isolated token and the token in the carrier phrase, where the preceding phone is also indicated. For example, in one carrier phrase, participant 2 said, *Me gusta hervir pollo* and the phone preceding the aspiration is [a]. A dash indicates that the speaker did not provide the token sought. This was either because the speaker skipped providing the token, but provided the token in a phrase, or because they provided a different

token than the one sought. For example, instead of *hallar* for ‘to find’, speaker 1 provided *buscar*. As is apparent from the data in Table 7, some of the speakers also repeated the token more than once seeking the translation, or in their phrase.

Part.	<i>hallar</i>		<i>humo</i>		<i>hediondo</i>		<i>hervir</i>	
	token	preceding phone	token	preceding phone	token	preceding phone	token	preceding phone
1	-	-	[ø]	[e] [x] [e] [x] [l] [x]	-	[i] [χ]	[h]	# [h]
2	3 [ø]	[a] [ø] [o] [ø]	[ø]	[o] [ø]	[ø] [h]	[n] [h]	[x]	[a] [x]
3	[χ]	[e] [x]	[ø] [h]	[o] [x]	[ø]	[i] [ø]	-	[a] [x]
4	-	[o] [x]	-	[l] [x]	[x]	-	2 [x]	[a] [x]
5	[χ]	[o] [x]	[x]	[o] [h]	[x]	[i] [x]	[x]	# [h]
6	[ø]	[a] [ø]	[ø]	[l] [ø]	[x]	[a] [x] [n] [x] [a] [h]	[x]	[n] [x]

Table 7. Distribution of word-initial h variants by participant for tokens 13-16.

preceding segment	phone				Total
	[ø]	[h]	[x]	[χ]	
#	10	5	9	2	26
[a]	2	1	4	0	7
[e]	0	0	3	0	3
[i]	1	0	1	1	3
[o]	2	1	3	0	6
[l]	1	0	2	0	3
[n]	0	1	2	0	3
Total	16	8	24	3	51

Table 8. Distribution of preceding phone for word-initial h variants of tokens 13-16.

The majority of the tokens elicited lacked any form of aspiration. However, the tokens previously reported in the literature (Bills and Vigil, 2008) as having aspiration in the form of [h] or [x], are indeed characterized not only by the presence of both the voiceless velar [x] and glottal [h] fricatives, but also by three instances of the post-velar [χ].

Table 8 summarizes the preceding segments for each of the variants. The most frequent environment was initial position at 26 occurrences, with [∅] and [x] being the most frequent variants. All the other preceding segments have [x] as the most frequent variant, with the exception of [i], which is evenly distributed among [∅], [x] and [χ].

5. DISCUSSION AND CONCLUSION

The results of the present study confirm the presence of word-initial *h* aspiration, which is restricted to certain words. This aspiration occurs only 28% of the time, but the results from this study confirm that TNMS speakers from this data set aspirate orthographic word-initial *h* not only as [h] and [x] variants, but also as a post-velar variant [χ] in some instances. With regard to the research question hypotheses, we confirmed the aspiration that Espinosa (1909) observed over a century ago. Moreover, as reported by Bills and Vigil (2008), this aspiration was manifest as voiceless glottal fricative [h] and voiceless velar fricative [x] variants. However, the previously unreported variant of a voiceless post-velar fricative [χ] was also observed. Recent phonetically detailed studies investigating other phonetic phenomena both in TNMS and in other varieties of Spanish, have also found previously unreported variants, i.e. studies on rhotics (Vigil, 2018). Unlike hypothesized, the [h] was not the most frequent variant, but rather the [x], which represented 69% (24/35) of the aspiration. Of the aspirated *h* segments, the [h] occurred 8/25 for 23%. There was inter-speaker and intra-speaker variation present. Finally, the results of the present study offer the first spectrographic analyses of variable realizations of word-initial *h* and give a valuable synchronic and descriptive account of this phenomenon.

The presence of [χ] for *h* inspired further post-hoc analysis. We searched the corpus of the present study for other non-*h* occurrences of post-velar [χ] variants. In the carrier phrase for the token *hueso*, for example, Speaker 1 produced a [χ] for the *j* of *jamón* in the statement, *El jamón que hicimos para la Navidad tenía hueso*. See the spectrogram in Figure 5 of [χ] in *jamón*. We found that Speaker 1 had seven other tokens in the carrier phrases with this [χ] variant: *afuera* (twice), *fumar* (twice), *fuma*, and *hoja* (twice). Speaker 5 produced a [χ] for the *j* of *hija* in the

carrier phrase, *Mi hija es la menor*, and two other speakers produced [x] variants for the *f* in *fumar*, and *perfumándose* in carrier phrases as well.

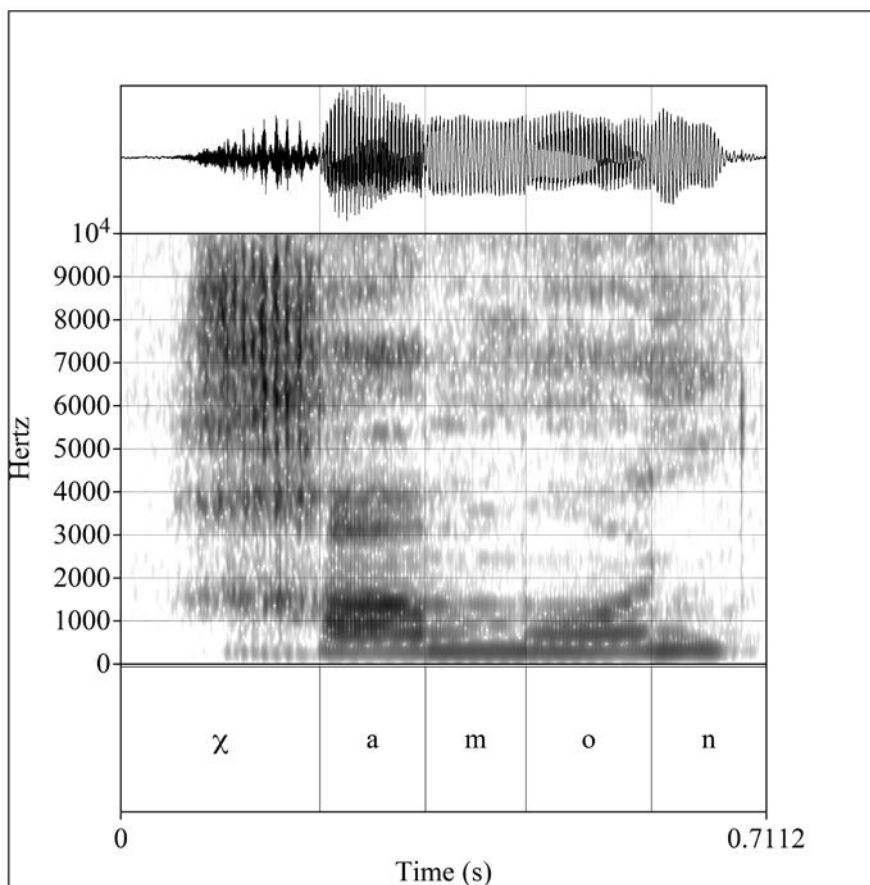


Figure 5. Waveform, spectrogram and phonetic transcription of *jamón* showing [χ].

In conclusion, word-initial aspiration of *h* in TNMS was reported as far back as 1909 and has been attested to in several studies. For example, Bills and Vigil (1999, 2008) reported the presence of both [x] and [h] for word-initial *h* for the entire New Mexico and southern Colorado region. However, these studies did not provide phonetic detail and did not specify the frequency and distribution of the

variants. The present study fills this void in the literature by providing phonetic and spectrographic detail of the phenomenon of word-initial *h* aspiration. Moreover, not only does the present study confirm aspiration ([h], [x]), it shows the presence of this aspiration in the form of [χ], a voiceless post-velar (or uvular) fricative. This finding lends support to Craddock's (2006) conclusion that the presence of word-initial aspiration of *h* was maintained in a series of words in TNMS until the moment when it was confused or merged with the velar fricative /x/, (a reflex of medieval /ʃ/, whose variants became [h], [x] and [χ]), and therefore, never went through the stage of change which involved the loss of aspiration. The presence of [χ] also speaks to the gradient nature of the word-initial *h* realizations from [h] to [x] to [χ]. Gradience in Spanish phonetics has recently received greater attention in Spanish phonetics and phonology, e.g. /s/ lenition (File-Muriel and Brown, 2011).

This aspiration phenomenon, therefore, provides another distinctive characteristic of TNMS, which serves to differentiate it as a traditional variety of Spanish with features dating back to the 16th century. Moreover, the phonological implications are that some speakers of TNMS have the following complicated structure (which is also characterized by great variability) in their phonemic and phonetic inventories: word-initial /h/ → [x], [χ], [h], [Ø], /x/ → [x], [χ], [h] and /s/ → [h], [x] (as in word- and syllable-initial fricatives such as *nosotros* and *siempre* Espinosa (1909: 118). The present study might suggest that [χ] could be a potential variant of /s/. Finally, more research needs to be done on this phenomenon, and more targeted data with the segments in all environments need to be elicited, collected, and analyzed from a greater number of speakers. An analysis of the variants of /x/, i.e. *j*, *ge* and *gi* should also be carried out to see the frequency and distribution of not only [χ], but the other variants [h] and [x].

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