Phonetic Structures of Montana Salish

Edward Flemming,
Department of Linguistics and Philosophy, MIT, Cambridge, MA 02139-4307.

Peter Ladefoged
Linguistics Department, UCLA, Los Angeles, CA 90024-1543

and
Sarah Thomason
Department of Linguistics, University of Michigan, Ann Arbor, MI 48109-1285.

Corresponding author: Edward Flemming

E-mail address: flemming@mit.edu

phone: +1-617-452-4183

fax: +1-617-253-5017

Abstract

Montana Salish is an Interior Salishan language spoken on the Flathead reservation in Northwest Montana by an estimated population of about 40 speakers. This paper describes the basic phonetic characteristics of the language based on data from five speakers. Montana Salish contains a number of typologically unusual consonant types. including glottalized sonorants, prestopped laterals, and a series of pharyngeals distinguished by secondary articulations of glottalization and/or labialization. The language also allows long sequences of obstruent consonants. These and more familiar phonetic characteristics are described through analysis of acoustic, electroglottographic, and aerodynamic data, and compared to related characteristics in other languages of the world.

1. Introduction

This paper has two aims. The first, as stated in the title, is to give an account of the phonetic structures of Montana Salish. But there is also a second aim, namely to demonstrate how current techniques of phonetic investigation can be applied so as to be able to construct a basic, but reasonably comprehensive, set of material for an archive of the sounds of an American Indian language. Such an archive must include examples of all the distinct sounds of the language, not just those that are less common in the world's languages. It should also be representative of a group of speakers, not just a single individual. In addition, it should include sufficient instrumental evidence, together with an interpretation of this evidence, to clarify important features of pronunciation. We hope that, in 200 years time, our archive of Montana Salish will be able to show what the language sounded like near the end of the twentieth century. No archive can ever be complete enough to provide answers to all the questions that future researchers might want to ask. But the failure to be able to provide everything does not mean that we should not try to provide as much as we can. This paper presents a first step in this direction for a North American Indian language. The paper and the recordings on which it is based are in the permanent UCLA Phonetics Archive which is part of the California Digital Library. An accessible copy of the archive and the Montana Salish material is available at http://archive.phonetics.ucla.edu/.

Montana Salish is an Interior Salishan language spoken on the Flathead reservation in Northwest Montana by an estimated population of about 40 fluent speakers. The language is most often referred to by linguists as Flathead, but the people themselves refer to it as Salish. Since the language family is also often referred to by linguists as Salish, we use the term Montana Salish to make it clear that we are discussing this particular Salishan language. This designation is also meant to make it clear that we include both of the major dialects of the language that are spoken on the reservation -- not only Salish proper (sometimes known as `Bitterroot Salish' because this tribe was moved to the reservation from the Bitterroot Valley to the south), but also the dialect of the Pend d'Oreille tribe, who were on the land before the reservation existed.

The two main branches of the Salishan language family, which comprises about twenty-four languages, are the Coast and Interior branches (see Thompson 1979:693 for a complete classification); Montana Salish belongs to the Southern group of the Interior branch. There are few published linguistic studies of Montana Salish, aside from word lists (but see Thomason & Thomason 2004 and six papers by S. Thomason in Salish Conference preprints volumes[1]). There are a number of descriptions of Kalispel and (especially) Spokane, which are closely-related dialects of the same (nameless) language (e.g. Vogt 1940, Carlson 1972, Bates & Carlson 1992, Orser & Carlson 1993).

This paper is based on recordings made in August 1992 at the Flathead Culture Center (now the Salish-Pend d'Oreille Culture Center) on the Flathead Reservation in Montana, thanks to the assistance of the then-Director of the Culture Committee, the late Clarence Woodcock. With the aid of a dictionary which is being compiled by the third author, we had constructed a word list illustrating all the major phonological contrasts, and containing additional material for examining sounds that were of particular phonetic interest. This list was then refined through extensive work with our three main language consultants: Harriet Whitworth, Plisiti (Felicite) Sapiel McDonald and Dorothy Felsman.

There was a great deal of discussion. Some forms in the original list were deleted as unknown or not exemplifying the sound sought, others were added, and the spellings were corrected. The complete list of words finally selected is given in the appendix.

Salishan languages have a complex morphological and phonological structure, which makes it impossible to illustrate contrasting sounds using simple minimal sets equivalent to (Californian) English ‘pot, tot, cot; bought, dot, got ...’ etc. As far as possible, words were selected in which the particular points to be investigated were in the roots. All the words in the original list were attested somewhere, primarily in materials collected in previous fieldwork by the third author or in materials prepared by the Culture Committee. Some of them were somewhat uncommon so that speakers had to be reminded of them before they could recognize them out of context. In some of the materials from which the words were drawn, particles and affixes that would occur with the words in normal, or at least the most common, contexts were omitted. But we have no doubt that all the forms elicited were considered to be proper Montana Salish forms by all our speakers.

When we had agreed on a satisfactory list of 274 words, we made a recording of the three consultants saying it. One of the authors supplied an English gloss as a prompt, Harriet Whitworth said the Salish word, and the other two consultants repeated the word after her. The consultants did have access to a version of the written list, but none of them was reading from it. We also made a recording in which each of these three consultants said the words in a frame sentence. The next day we got together a larger group of ten people consisting of all the Montana Salish speakers available in the Cultural Center at that time. We went through the whole list again, first rehearsing it, and then actually recording it. By this time the three main consultants were very familiar with all the words they were being asked to say. The rest of this larger group consisted of speakers with varying degrees of proficiency in Salish. For the present paper we will restrict our analysis to the three original consultants plus two male speakers, Clarence Woodcock, the Director of the Flathead Culture Committee, and the Associate Director, Antoine (Tony) Incashola. In this way we can be sure that we have a group of three women and two men who are clearly proficient native speakers of Montana Salish.

In this paper words will be cited in a surface phonemic transcription, using IPA symbols and following the majority pronunciation. The only problem raised by using an IPA transcription is that normal IPA practice is to transcribe affricates such as **tʃ** as equivalent to a sequence of the symbols **t** and **ʃ.** But in Montana Salish there is a phonological contrast between an affricate **tʃ** as in **ʔiɬtʃtʃéˀn** ’tender (as, a sore spot)’ and a sequence **t ʃ a**s in **stiʕît.ʃən** ‘killdeer’. In this paper **tʃ** will always represent an affricate; the cluster will be transcribed with a period between the two symbols, i.e. as **t.ʃ.**

Subphonemic features have not been noted except for the vowel **ə**, which has been transcribed, although its placement is largely or entirely predictable. This mode of transcription will be printed in bold face, e.g. **qʷ’ajəlqs** ‘priest (black-robe)’. Where narrower transcriptions are required, they will be enclosed in square brackets, e.g. [qʷ’ajəᵗɬqs]. Narrow transcriptions will also be used in labeling figures.

2. Vowels

2.1 Vowel Qualities

Montana Salish has five vowels, **i, e, a, o, u**. In addition there is a schwa-like vowel which appears in unstressed syllables only. Vowels do not occur in word-initial position; words that orthographically have an initial vowel are in fact preceded by a glottal stop. Table I contains words illustrating the vowel contrasts in stressed position, in the context **p_l,** except for a, which is in the context **j_l.**

Table I: Words illustrating vowel contrasts.

i	**pəlpîləlʃ**	'stagger'
e	**tʃ'upélsi**	'lonesome'
a	**jál**	'round'
o	**pólpəlqən**	'thimbleberry'
u	**púlsəm**	'he killed something'

Figures 1 and 2 show plots of the vowel formants for the female and male speakers. The formant measurements were taken from the stressed vowels of a word list designed to illustrate the vowel contrasts in similar environments, avoiding vowels adjacent to pharyngeal consonants (1-20 in the word list, excluding 1 and 9 to avoid pharyngeals). The formant values were determined from LPC and FFT spectra on a Kay CSL system. The axes are scaled according to the Bark scale, but are labelled in Hz, and show F1 and F2'. F2' is a weighted average of F2 and F3 calculated according to Fant (1973:52). The ellipses indicate two standard deviations from the mean along the principle components of each vowel distribution.

[FIG. 1. ABOUT HERE]

[FIG. 2. ABOUT HERE]

The mean values of the first three formants of each vowel, for the male and female speakers, are shown in Table II. It may be seen that the vowels are distributed in the vowel space much as in many five vowel languages, with the high back vowel [u] not being fully back.

Table II. Mean formant values of vowels in Hz for three female and two male speakers.

VOWEL	FEMALE			MALE		
	F1	F2	F3	F1	F2	F3
i	372	2645	3058	349	2062	2536
e	535	2181	2949	510	1738	2396
a	854	1603	2807	683	1389	2434
o	601	1170	2768	540	994	2222
u	407	1168	2893	355	1011	2265

2.2. Intrinsic Pitch

It has been found that the F0 of vowels varies with vowel height: other things being equal, high vowels have higher F0 than low vowels (Ohala and Eukel 1987, and references therein). We tested this generalization against the Montana Salish vowels by testing for a correlation between F0 and F1, as an indicator of vowel height.

[FIG. 3. ABOUT HERE]

Montana Salish places a high tone on accented syllables, so there is an F0 peak over the stressed vowels considered here. F0 measurements were taken at this peak. Then, to reduce the effects of inter-speaker variations in pitch range, the F0 measures were normalized. This was achieved by calculating the mean and standard deviation of the F0 distribution for each speaker individually, pooling all the vowels. Then F0 for each vowel token was converted to a number of standard deviations from the mean F0 for that speaker. F1 measurements were normalized using the same procedure. We found a highly significant, but not especially tight negative correlation ($r=0.4$, $p<.0001$) between the normalized F0 and F1 measures, in accordance with the generalization that higher vowels (i.e. vowels with lower F1) tend to have a higher F0. Figure three shows the mean normalized F0 for each vowel, error bars indicate the standard deviations. There is also a tendency for back vowels to have a higher F0 than the corresponding front vowels.

Generalizations concerning intrinsic vowel duration were not tested because our data set does not include a set of words with vowels in sufficiently similar environments for comparison.

3. Consonants

Overview: The consonant inventory of Montana Salish is shown in Table III. Words illustrating these sounds are shown in Table IV. We will first present general observations on the realization of these sounds, then turn to durational measurements, and more detailed discussion of the typologically unusual sounds in the Montana Salish consonant inventory: pre-stopped laterals, glottalized sonorants and pharyngeals.

Table III. Montana Salish consonant phonemes

	bilabial	alveolar	palato-alveolar	palatal	velar	lab. velar	uvular	lab. uvular	pharyngeal	lab. pharyn.	glottal
plosive	**p**	**t**			**(k)**	**kʷ**	**q**	**qʷ**			**ʔ**
ejective stop	**p’**	**t’**				**kʷ’**	**q’**	**qʷ’**			
affricate		**ts**	**tʃ**								
ejective affricate		**ts’**	**tʃ’**								
lateral ejective affricate		**tɬ’**									
fricative		**s**	**ʃ**			**xʷ**	**χ**	**χʷ**			**h**
lateral fricative		**ɬ**									
nasal	**m**	**n**									
glottalized nasal	**ˀm**	**ˀn**									
approximant				**j**		**w**			**ʕ**	**ʕʷ**	
glottalized approximant				**ˀj**		**ˀw**			**ˀʕ**	**ˀʕʷ**	
lateral approximant		**l**									
glottalized lateral approximant		**ˀl**									

Stops: If we include the palato-alveolar affricates, stops occur at five places of articulation, bilabial, alveolar, palato-alveolar, velar and uvular. At each of these places there is a voiceless unaspirated stop (see below for VOT measurements) and an ejective.

The uvular stops may be plain or labialized. The velar stops are nearly always labialized; nonlabialized **k** occurs only in two or three loanwords and there is no nonlabialized velar ejective. In addition to these pairs of stops, there is also a pair of alveolar affricates, and an unpaired alveolar lateral ejective affricate. All the ejectives are produced with a considerable lag between the release of the oral closure and the release of the glottal closure (see below for measurements). All the stops are clearly released, even in clusters and in pre-pausal position.

Laterals: The lateral approximant [**l**] and fricative [**ɬ**] are prestopped in most environments by most speakers, indicated in narrow transcriptions by a superscript stop, [**ᵈ**] or [**ᵗ**]. Depending on its context, the lateral approximant is realized as voiced **ᵈl**, or fricated **ᵗɬ** or **ᵈɮ.** When fricated, it can be phonetically similar to **ɬ**. In addition, as we have already noted, there is an alveolar lateral ejective affricate.

Glottalized sonorants: Nasals, laterals and central approximants all occur in both plain and glottalized forms. Typically, as we shall see below, the glottal constriction precedes the main portion of the sonorant.

Table IV. Words illustrating the Montana Salish consonants before **a,** or, in a few cases, before **e** or **o**.

bilabial		
p	**páʕas**	‘face is pale, grey’
p’	**p’aʕáp**	‘grass fire’
m	**máɬt**	‘mud’
ˀm	**ˀmeˀmstsú**	‘playing cards’

alveolar

t	**tám**	‘it’s not, wrong’
t’	**t’áq’ən**	‘six’
ts	**tsáqʷəlʃ**	‘western larch’
ts’	**ts’áɬt**	‘it’s cold’
s	**sáχʷ**	‘split wood’
n	**nás**	‘wet’
ˀn	**ˀneˀjxʷéˀws**	‘trade’
l	**láq’i**	‘sweatbath’
ˀl	**ʔəlˀláts**	‘red raspberry’
ɬ	**ɬáqʃəlʃ**	‘sit down!’
tɬ’	**tɬ’áq’**	‘hot’

palato-alveolar

tʃ	**tʃájɬqən**	‘cut hair’
tʃ’	**tʃ’áwən**	‘I prayed (it)’
ʃ	**ʃáll**	‘he got bored’

palatal

j	**jajáʔ**	‘maternal grandmother’
ˀj	**ˀjeˀjúkʷeʔ**	‘stingy’

velar

k	**kapî**	‘coffee’
kʷ	**kʷáteʔ**	‘quarter (money)’
kʷ’	**kʷ’áltʃ’qən**	‘lid, cover’
xʷ	**xʷáltʃst**	‘reach (for something)’
w	**wáˀləwəˀl**	‘long-billed curlew’
ˀw	**ˀwiˀwá**	‘wild’

uvular		
q	**qáχeʔ**	‘aunt (mother’s sister)’
q’	**q’áq’ɬuʔ**	‘vein’
qʷ	**qʷátsqən**	‘hat’
qʷ’	**qʷ’ájəlqs**	‘priest (black-robe)’
χ	**χáˀm**	’dry’
χʷ	**χʷáqʷ’**	‘to grind or file something’
pharyngeal		
ʕ	**ʕámt**	‘it’s melted’
ʕʷ	**ʕʷóˀl**	‘slippery (oily)’
ˀʕ	**jaˀʕəmîm**	‘gathering (as, rocks)’
ˀʕʷ	**ˀʕʷoˀjəntsú**	‘laugh’
glottal		
ʔ	**ʔáwəntxʷ**	‘you said it’
h	**háˀʕʷumskʷ**	loosen it!

==

3.1 Duration measurements

VOT: There are no contrasts based primarily on Voice Onset Time (VOT), but VOT for the oral stops varies according to place of articulation as shown in Figure 4. The interval measured is that between the release burst and the onset of periodic voicing in the waveform. These figures accord with the general tendency for dorsal stops to have longer VOTs than labial or coronal stops (Cho and Ladefoged 1999). Statistical analysis (ANOVA) reveals that the difference between these two groups is significant ($p < .05$).

The VOT for **p** and **k** are close to those reported for French voiceless stops by O’Shaughnessy (1981), but the VOT for Montana Salish **t** is considerably shorter. The

VOTs for **p**, **t** and **k** are all long compared to the values reported for voiceless unaspirated stops by Lisker and Abramson (1964) and at the high end of the range reported by Cho and Ladefoged (1999), but far short of contrastively aspirated stops. Cho and Ladefoged (1999) report a very wide range of cross-linguistic variation in VOT of unaspirated uvular stops. The VOT of 54 ms (s.d. 28) for **q** is around the middle of this range, and very close to the 56ms (s.d. 21) reported for K'ekchi q by Ladefoged and Maddieson (1986:22).

[FIG. 4. ABOUT HERE]

Glottal lag: In ejectives, the interval between the release of the oral closure and the release of the glottal closure was measured. The mean for each consonant is shown in Figure 5. As may be seen in Table V, these values are closer to those reported for ejectives in K'ekchi (Ladefoged and Maddieson 1986:22) and Navajo (McDonough and Ladefoged 1993:154-5) than the shorter lags found in Hausa ejectives (Lindau 1984).

[FIG. 5. ABOUT HERE]

Table V. Comparison of glottal lags (ms) for ejectives in three languages. Standard deviations are given in parentheses.

CONSONANT	MONTANA SALISH	K'EKCHI	NAVAJO	HAUSA
t'	65 (21)	-	108 (31)	-
ts'	123 (25)	-	142 (41)	-
tʃ'	102 (24)	-	144 (24)	-
tɬ'	87 (18)	-	157 (40)	-
k' or **kʷ'**	86 (26)	97 (38)	94 (21)	33
q'	81 (21)	92 (38)	-	-

Fricatives: Figure 6 shows the mean durations from onset of frication to the onset of voicing in the following vowel for initial fricatives. The differences in duration are not significant.

[FIG. 6. ABOUT HERE]

Nasals and laterals: The mean oral constriction durations of initial laterals and nasals are shown in Figure 7. In the case of the glottalized nasals, the interval from the onset of voicing to the release of the oral closure was measured. This would exclude any initial glottal closure. The nasal portion of the glottalized nasals is considerably shorter than the plain nasals.

[FIG. 7. ABOUT HERE]

3.2 Consonant clusters

Extremely complex consonant clusters are one of the most striking features of Salishan languages generally, and Montana Salish is no exception. An initial sequence of five consonants is exemplified in Figure 8, a spectrogram of the word **tʃɬkʷkʷtəˀnéˀws** ‘a fat little belly’. The initial palatoalveolar affricate is followed immediately by a voiceless alveolar lateral affricate, with no intervening vowel. This in turn is followed by a velar stop, again with no intervening vowel. This labialized velar stop is released, producing what, in a narrow phonetic transcription, could be considered a lax high back rounded voiceless vowel **ʊ̥** as the realization of **w**, which is then followed by another similarly released stop. Finally in this cluster there is an aspirated alveolar stop before, for the first time in this word, regular voicing occurs.

[FIG. 8. ABOUT HERE]

Figure 9 shows the word **tʃtʃts’éˀlʃtʃən** ‘wood tick’, in which there is also a complex sequence of voiceless sounds. In this utterance the two palatoalveolar affricates are followed by an alveolar ejective affricate. After the vowel in this word, there is another complex sequence in which the phonemically preglottalized lateral, which is realized as a glottal stop followed by an alveolar release into a voiceless alveolar lateral fricative, is itself followed by a palatoalveolar fricative, before what is underlyingly a palatoalveolar affricate. In this case the stop part of the affricate does not have a complete closure, and is accordingly symbolized **t̞**, the diacritic indicating a lowered position. Even longer clusters are possible, although not included in our recordings, e.g. **sxʷtʃʃt’sqá** ‘herdsman, shepherd’.

[FIG. 9. ABOUT HERE]

As is apparent from these examples, stops and ejectives are always strongly released, even in sequences of identical consonants, and in word-final position. Figure 10 provides a further illustration in the word **ppíˀl** ‘pint’. Stops are normally unaspirated (as discussed above, and as can be seen in the case of the second **p**), but in sequences such as this, the first stop is released with considerable aspiration. Since bursts provide crucial cues to the identity of a stop, this pattern of realization aids considerably in maintaining the perceptibility of all the consonants in a cluster. Fricatives follow stops or other fricatives without any intervening opening of the vocal tract (a close transition, in the sense of Bloomfield 1933:119). As observed by Wright (1996), the quality of fricative noise provides significant cues to place of articulation, so fricatives and affricates are less dependent on transitional cues than stops which may explain why sequences of these sounds are produced with close transitions, as exemplified by the **tʃtʃ** sequence at the beginning of figure 9. Sequences of fricatives followed by stops are also produced with close transitions.

[FIG. 10. ABOUT HERE]

While there is considerable freedom in combining consonants in a sequence, there are restrictions. The clearest to emerge from the present study is that sonorants and glottal stop generally do not follow obstruents in a cluster. They are usually separated by a vowel, although this appears to be optional in certain contexts described below. The vowel transcribed [ə], a transitional vowel of indeterminate quality, only occurs between a sonorant or glottal stop and a preceding consonant so we can regard this vowel as epenthesized in order to break up these sequences. The class of sonorants for the purposes of this rule consists of **l, m, n, w, j, ʕ, ʕʷ** and their glottalized counterparts. The requirement for a preceding vowel may serve to enhance the clarity of the contrasts between plain and preglottalized sonorants since the preceding vowel is at least partially creaky before a glottalized sonorant, but is usually modally voiced before a plain sonorant.

There are some exceptions to this distributional generalization. In particular, sequences of a fricative or affricate followed by a sonorant are sometimes produced without an intervening voiced vowel. This is particularly true of word-initial sequences of **s** followed by a nasal, e.g. the initial clusters of **sˀməˀlˀlá** ‘a nosebleed’ and **snéˀwt** ‘the wind’ were produced without any clear voiced vowel intervening. The two words exemplifying a lateral fricative followed by a glottalized lateral sonorant (**ɬˀleˀleputé** ‘harebell’ and **ɬˀlˀláq** ‘thin’) were consistently produced without a schwa breaking up this cluster, perhaps because of the similarity in articulation of the two consonants (see below for a similar phenomenon involving clusters of identical sonorants). Voiced schwas were sporadically omitted to yield other clusters of a fricative or affricate plus a sonorant (e.g. one utterance each of the words **tʃə̲níll** ‘infect’, **qəʔeseˀlíɬə̲ni** ‘we were eating’), although never from word-final clusters. Stops and ejectives were almost never followed by sonorants without an intervening voiced vowel. The only exceptions were utterances of the word **tɬ’áqəneʔ** ‘pocket’ by the two male speakers where the schwa was devoiced.

Similar phenomena have been observed in other Salishan languages, e.g. Shuswap (Kuipers 1974) and Thompson (Thompson and Thompson 1992), although in the latter language the schwa sometimes follows the sonorant rather than preceding it. Kuipers regards the schwa vowel as part of the realization of what is essentially a syllabic sonorant; however in Montana Salish it seems more likely that the schwa itself is the syllable nucleus since the following sonorant is often more plausibly assigned to the onset of the following syllable, e.g. in **sə̲ʕáptə̲ni** 'Nez Perce' and **ˀmə̲ˀnétʃ** excrement', the underlined schwas are found preceding sonorants, as expected, but the following sonorant is presumably syllabified with the following vowel in each case.

Sonorants are generally separated from other sonorants by a vowel also, but there are two systematic exceptions to this pattern. Sonorants which are identical (without considering glottalization) are not separated by a vowel , as in **sqəllú** 'tale' and **ʔəlˀláts** 'red raspberry' Secondly, in sequences of more than two sonorants, they need not all be separated by vowels; for example, in some utterances of **səˀnəmˀné** 'toilet' there may be two but not three epenthetic vowels. Sonorants which are nominally in word-initial position preceding consonants are in fact preceded by a glottal stop and a short schwa-like vowel, or are apparently syllabic and preceded by a glottal stop. Nasals are typically realized as syllabic in this environment, whereas laterals are typically preceded by a vowel.

3.3. Laterals

Montana Salish contrasts four laterals, a voiced lateral, a voiceless lateral fricative, a glottalized voiced lateral, and an ejective lateral affricate. We will consider the first two in this section; glottalized laterals are described in section 3.4, together with the other glottalized sonorants, and ejectives are described in section 3.5. In most environments, the voiced and voiceless laterals are usually produced with a brief stop closure or some other gesture that produces a burst-like transient at the beginning of the lateral. However, this does not always occur. Figures 11 displays two utterances of the same word, **laq'əm** 'he buried', one with and the other without a transient associated with the **l**. In the token on the left, produced by speaker FM, there is not only a transient shortly after the beginning of the lateral, but also evidence of a fricative component in the higher frequencies. We have transcribed this utterance with an initial **t**, but it is difficult to show that a voiceless alveolar stop occurred at the beginning of the word. In the utterance on the right, produced by speaker AI, there is no transient component.

[FIG. 11. ABOUT HERE]

Laterals are preceded by an evident stop closure in most word-internal environments. The context where they are more consistently produced without an initial stop closure is the case of the second lateral in a cluster of laterals. Note that such clusters are possible because similar sonorants are not separated by a schwa. Even here there is sometimes a burst between the two consonants, as illustrated in Figure 12, which shows the sequence of consonants in the middle of the word **p’əllitʃtʃ’** ‘turned over’. The first of these two laterals has a stop closure preceding it, and a burst as this closure is released. The second lateral has no such closure, but there is a transient in the spectrum, closely resembling that produced by the release of a stop. How this transient is produced is not clear to us at the moment. Such discontinuities suggest that, in these cases at least, the sequences are truly clusters of identical consonants rather than long consonants.

[FIG. 12. ABOUT HERE]

The voiced lateral is often fricated (as can be seen from the noise in the spectrogram of speaker FM’s production of **laq’əm** in Figure 11). It also devoices in word-final position and preceding voiceless consonants. The early portion of the lateral sometimes remains voiced or breathy, but otherwise the result of devoicing is very similar to the voiceless lateral fricative. Figure 13 compares **l** and **ɬ** before voiceless consonants. In the word on the left of the figure, **mí̩lkʷ'** 'always', there is considerable frication noise, but vocal fold vibrations can be seen (most easily in the waveform) in the first 50 ms. A slightly longer part is voiceless and fricative. In the word on the right, **ʔiɬtʃtʃéˀn** 'tender', there is a very short voiceless stop before the entirely voiceless **ɬ**. Maddieson and Emmorey (1984) found that voiceless lateral approximants have lower amplitude than voiceless lateral fricatives, relative to the amplitude of a following vowel. A similar measure did not reliably distinguish Montana Salish devoiced laterals from the voiceless lateral fricatives in similar environments, preceding voiceless consonants, supporting the auditory impression that the devoiced laterals are fully fricated.

[FIG. 13. ABOUT HERE]

Steven Egesdal (p.c.) has suggested that vowels are longer preceding the voiced lateral than preceding the voiceless lateral fricative, and that this difference persists before devoiced laterals. We do not have any well matched pairs to provide a proper test of this hypothesis, but there is a clear difference in duration of **e** in the most comparable pair, **ʔn̩tʃəˀméɬxʷ** 'rob' and **nqʷəˀnqʷəˀnˀnéls** 'kind person'. The vowel preceding the underlying voiceless lateral fricative averages 78 ms in duration, while the vowel preceding the devoiced lateral averages 162 ms (based on the three female speakers), suggesting that preceding vowel duration may be one basis for distinguishing these sounds.

There is clear evidence that devoiced laterals and voiceless lateral fricatives are phonologically distinct. As discussed above, sonorants are always separated from a preceding consonant by a vowel, while obstruents can form clusters. This rule treats devoiced laterals as sonorants: voiceless lateral fricatives can occur in clusters, whereas devoiced laterals cannot.

Table VI. Contrasts between devoiced laterals and voiceless lateral fricatives

UNDERLYING SONORANT **l**			UNDERLYING FRICATIVE **ɬ**		
q^{w}'ájəlqs	[q^{w}'ajə^{t}ɬqs]	'priest'	**tʃájɬqən**	[tʃajɬqən]	'cut hair'
tsáqwəlʃ	[tsaq^{w}ə^{t}ɬʃ]	'western larch'	**q'áq'ɬu**	[q'aq'ɬu]	'vein'
ɬáqʃəlʃ	[^{t}ɬaqʃə^{t}ɬʃ]	'sit down!'	**tʃ'átənɬq**	[tʃ'atənɬq]	'horsefly'

3.4. Glottalized Sonorants

Montana Salish contrasts glottalized and non-glottalized variants of the sonorant consonants **l, m, n, j, w, ʕ**. As discussed above, the glottalized sonorants group together with plain sonorants in requiring a preceding vowel. We will exemplify the general pattern of realization of glottalized sonorants with reference to the nasals, then turn to the specifics of the glottalized lateral and the glottalized glides. Glottalized pharyngeals will be discussed below with plain pharyngeals.

In almost all positions, glottalized sonorants are typically realized as a glottal constriction followed by the sonorant, i.e. they are preglottalized. As was noted above (see Figure 7), the voiced portion of the glottalized nasal is substantially shorter than that of the plain nasal. The glottal constriction is clearly apparent in an intervocalic environment, as in the word **sə^{ʔ}mú** 'mare' in Figure 14. As the two utterances represented in the figure indicate, there is some variation in the degree of glottal constriction. Often, as in the utterance shown on the left of the figure, there is complete closure of the glottis (the low frequencies evident on the spectrogram are due to the background noise). In other cases, as exemplified by the spectrogram on the right, the glottal constriction results in a creaky voiced portion of the nasal, without complete closure of the glottis. Glottalized nasals are preglottalized even before a voiceless consonant or in pre-pausal position, as in **sts'óˀm** 'bone'. In these cases, the nasal portion is devoiced or creaky.

[FIG. 14. ABOUT HERE]

These patterns of realization outlined are adhered to consistently except in clusters of glottalized sonorants. It seems that in these cases not all of the sonorants are realized with glottalization, but speakers vary as to which sonorants they glottalize. For example pronunciations of the word for 'soft' include [ɬəmˀmˀmóts], [ɬəmˀmːóts] and [ɬəˀmːˀmóts] suggesting an underlying representation with three glottalized nasals, **ɬəˀmˀmˀmóts**, not all of which are realized. Thompson and Thompson (1992) note a similar phenomenon in Thompson Salish (p. 45), but state that the initial glottalized sonorant always retains glottalization, which is not the case here.

As described above, plain laterals are typically prestopped. Glottalized laterals are also prestopped. The initial closure of the stop phase is glottal, sometimes, as in Figure 10, extending back to produce creaky voice in the previous vowel. This glottal closure is often not present at the end of the stop, so the release into the lateral is usually coronal. In some cases the glottal constriction results in creaky voicing in the lateral portion. There are no examples of the glottalized lateral in initial position in our data, but figure 25 shows it in final position. In final position and before voiceless consonants, the lateral is devoiced, as with non-glottalized laterals. Deglottalization may occur in clusters of glottalized laterals in the same way described for glottalized nasals.

Glottalized glides follow a similar pattern to the other glottalized sonorants. They are preglottalized in initial, intervocalic and final positions. The degree of glottal constriction varies, as may be seen in Figure 15, which shows the whole word **ʔesuˀwétʃiʔ** ‘lightning’ as spoken by AI in the upper part of the figure, and the middle section of this word as spoken by three other speakers, FM, HW and DF in the lower part. The first speaker, AI, has a full glottal stop, whereas the speakers in the lower part of the figure vary from a short glottal stop (FM), several vibrations of creaky voice (HW), to a hardly perceptible change in vocal fold vibration for the third speaker, DF. In final position, the glide portion is realized as a voiceless, or very creaky, version of the equivalent vowel. While the glottal constriction always occurs primarily during the transition into the glide, some glide transitions may be observed before glottal closure. This phenomenon is particularly marked in final and pre-consonantal glides. As in final position, glottalized sonorants generally take the form **ʔV̥** pre-consonantally, where **V̥** is the voiceless vocalic counterpart of the glide. However, **ˀw** is sometimes realized as **ʔw̥ə̥** in these cases. In one word, **ʔaˀjptsîn** ‘he talked fast’, the glottalized glide is realized consistently as post-glottalized: [ʔajʔptsîn]. It is not clear what conditions this particular realization, although the preceding glottal stop may be a factor.

[FIG. 15. ABOUT HERE]

3.5. Ejectives

We have aerodynamic records of the three female Montana Salish speakers, examples are shown in figures 16 and 17. In making these records, the test words were spoken with the word **tsu** ‘he said...’ before them. The top line in figure 16 is an electroglottographic (EGG) record from the larynx. This type of record cannot be quantified (except in the time domain), but it provides a good indication of the movements of the vocal folds. The middle line is the oral pressure as recorded by a small tube inserted between the lips, with its open end behind the alveolar ridge, and the third line is a record of the oral air flow. The arrows at the top show the moment of release of the bilabial closures. In the case of the ejective on the right of the figure, it may be seen that there is considerable laryngeal (EEG) activity both at that time and slightly before it. This activity is followed by an interval of about 100 ms before vocal fold vibrations begin. There is far less activity for the plosive on the left of the picture, and vocal fold vibrations begin almost immediately. There is considerably greater oral pressure for the ejective in the second word than for the plosive in the analogous position in the first word. The plosive at the end of the second word also has less oral pressure. The mean for 5 utterances (3 from one speaker, and one each from the other two) was 9.0 cm H_20 for the ejectives and 6.1 cm H_20 for the plosives. After the release of the plosive the oral flow rises to above 500 ml/s, whereas in the ejectives there is a comparatively small burst of oral flow, followed by a period in which there is no flow while the glottal closure is maintained. In this sound the vowel begins abruptly as the glottal closure is released.

[FIG. 16. ABOUT HERE]

Figure 17 shows the aerodynamic and laryngeal activity that occurred during the pronunciation of the Montana Salish phrase **tʃ’tʃéˀn** ‘Where to’, enabling us to compare a sequence of two affricates, one with a glottalic, and the other with a pulmonic airstream. We will omit consideration of the top line for the moment. The second line, the larynx record, reflects the laryngeal movements associated with the ejective. It cannot be taken as a direct indication of larynx raising and lowering, both because the gross movements of the larynx do not affect glottal impedance in a way that is directly proportional to larynx movement, and because this record has been band-pass filtered (30-5,000 Hz). If it had not been filtered, the small changes due to the opening and closing of the glottis (which were the major focus of the investigation) would have appeared insignificant in comparison with the large changes associated with the movements of the larynx. Nevertheless, the record clearly shows that there is much greater laryngeal activity during the closure of the ejective than there is for the following affricate. Both the larynx record and the nasal flow record show that in this token there is an epenthetic (non-contrastive) nasalized vowel after the initial ejective affricate, which did not appear in other tokens of this word. The aerodynamic records show that the oral pressure in the ejective was lower than that in the following pulmonic affricate, but the flow rate increases more sharply. The comparatively slow decreases in the pressure and the corresponding increases in the oral flow are typical of affricates.

[FIG. 17. ABOUT HERE]

Sequences of ejectives are generally not permitted in Montana Salish. Where they would be created by morphological processes, they are eliminated by deglottalization. For example, in **p’əllítʃtʃ’** ‘turned over’ the final cluster results from reduplication of root-final **tʃ’** and deglottalization of the first ejective of the cluster. Where there are more than two ejectives in a sequence, all but the final ejective are deglottalized. For example, there is a sound symbolic formation that involves repeating the last consonant of the root three times, as in **p’áttt’** ‘the sound of a cow-pie plopping’, from the root **p’át’** ‘cow pie’ (not included in our recordings). Deglottalization can also apply to the ejective lateral affricate, yielding a plain lateral affricate which does not otherwise occur. We do not have any examples of this sound in our recordings, but it appears in words like **i χʷitɬtɬtɬ’** ‘the sound of cracking sticks’ (from the root **χʷitɬ’**).

3.6. Pharyngeals

Montana Salish has a series of consonants that we will refer to as pharyngeals although we will see that they have a variety of articulatory and acoustic correlates and it is not clear that pharyngeal constriction is the most significant or consistent of these. However, these sounds correspond to the pharyngeal consonants identified in other Interior Salishan languages so we will continue to refer to them as such. These pharyngeal consonants are voiced approximants and can appear with secondary rounding and/or glottalization. In our recordings, most rounded pharyngeals appear before the round vowel **o** and unrounded pharyngeals mainly appear preceding or following the low, unrounded vowel **a**, but we have a few examples of these pharyngeals occurring in other environments, e.g. a rounded glottalized pharyngeal occurs before **u** in **səˀʕʷúʔ** ‘it got low (as of water)’ and a plain pharyngeal occurs between high front vowels in **stiʕít.ʃən** ‘killdeer’. Thomason’s field notes contain further examples indicating that rounded pharyngeals can also precede consonants and unrounded vowels.

The pharyngeals are often extremely vowel-like and have frequently been transcribed as the low back vowels **ɑ** for **ʕ** and **ɔ** for **ʕʷ.** Bessell (1992:92ff.) observes that this is a property of pharyngeals in a number of closely related Interior Salishan languages including Kalispel, Spokane and Colville-Okanagan. Several features distinguish pharyngeals from vowels, but not all of them are present to any significant degree in any particular utterance. We will exemplify each of these features from clear examples of pharyngeals in the following figures. The first is that pharyngeals are usually characterized by a marked lowering of the fundamental frequency. This effect has been observed with pharyngeals in other languages also (c.f. Maddieson, Spajić, Sands and Ladefoged 1993, on Dahalo, a Cushitic language). In the case of pharyngeals adjacent to an accented vowel, the lowering associated with the pharyngeal results in a dramatic pitch movement to the high tone of the accented vowel, as may be seen in the narrow band spectrogram on the right in Figure 18. (This spectrogram shows, on an expanded frequency scale, the fundamental frequency and the first seven or eight harmonics.)

[FIG. 18. ABOUT HERE]

Pharyngeals also generally have lesser intensity than the low vowels which they otherwise resemble, as exemplified in Figure 19, wide and narrow band spectrograms of the word **sχəʕáp** 'air' as spoken by speaker HW. This word was spoken on a rising pitch, and there is only a very small drop, or decline in the rate of pitch increase associated with the pharyngeal. In this word, the decrease in amplitude is a much greater mark of the pharyngeal consonant. The drop in intensity may sometimes (as in this figure) be more noticeable at higher frequencies and is thus probably due to a breathy laryngeal setting, which results in a steeper spectral tilt (Ladefoged, Maddieson and Jackson 1988). The breathiness may also be indicated by noise (as opposed to harmonic structure) in the upper part of the spectrum, as in Figure 19. Note that breathiness did not occur for the pharyngeal illustrated in the previous figure.

[FIG. 19. ABOUT HERE]

Finally, pharyngeal constriction has an effect on formants, raising F1 and lowering F2 (Alwan 1986, Bessell 1992). Montana Salish pharyngeals involve very open approximation, especially in intervocalic position, so the shift in formant frequencies between the pharyngeal and an adjacent low vowel is often slight. It can be seen in Figure 18, but there is very little movement in Figure 19, and virtually no observable movement in Figure 21. A more noticeable case of formant movement is illustrated in Figure 20, a spectrogram of part of the word **ʔinəʕʷóˀl** 'empty' in this case the lowering of F2 after the epenthetic **ə** is particularly noticeable, and the high F1 before the **o** is also evident.

[FIG. 20. ABOUT HERE]

Even in the absence of significant formant movements localized in the pharyngeal itself, the first two formants of both the pharyngeal and the vowel tend to be closer than in the related vowel in other environments. Table VII shows averages for F1 and F2 in **ʕʷó** and **ʕá** compared to **ó** and **á** in other contexts. The effects are more striking with **o**, because this is otherwise a higher vowel than **a**. There is no clear effect of the pharyngeal on **a** for the males, but there are only two tokens in this case. However, in general it is clear that the presence of a pharyngeal can cause lowering and backing of an adjacent vowel.

Table VII: mean F1 and F2 in pharyngeal-vowel sequences compared to vowels in other environments.

		F1 (Hz)	F2 (Hz)
females	ʕʷó	832	1016
	oó	601	1170
males	ʕʷó	566	931
	oó	510	994

	F1 (Hz)	F2 (Hz)
ʕá	940	1563
á	854	1603
ʕá	631	1264
á	683	1389

The absence of clear formants movements for a pharyngeal adjacent to a low vowel is comprehensible given that low vowels involve a pharyngeal constriction. More striking is an apparent case of a pharyngeal appearing between high front vowels, in the word **stiʕît.ʃən** ‘killdeer’, the only recording we have of a pharyngeal adjacent to **i**. We have transcribed this word with a pharyngeal, but none of the three utterances of it contain any indication of an actual pharyngeal constriction since F1 is low and F2 is high right through the sequence -**iʕi**-. The presence of a pharyngeal is suggested purely by the reduction in intensity, breathy voice quality and lowered F0 that are characteristic of this sound. If this is the regular realization of pharyngeals adjacent to /i/, it would imply that pharyngeal constriction per se is relatively unimportant compared to the laryngeal properties identified above, at least for these speakers. However, more examples of pharyngeals in this environment are needed before firm conclusions can be drawn.

In some utterances none of the characteristics of pharyngeals described above can be identified. The phonemic pharyngeal-vowel sequence then resembles a long vowel, as illustrated in Figure 21, a spectrogram of the same word as in Figure 19, **sχəʕáp** ‘air’, but spoken by a different speaker. This was produced by a male speaker, AI, so a larger number of harmonics are shown in the narrow band spectrogram on the right. But even considering the absolute difference in fundamental frequency between this male speaker and the female speaker in the previous figure, it is clear that pitch plays a smaller role in distinguishing the pharyngeal in this case. In the utterance shown in Figure 21 the pharyngeal is marked largely by the length of the vowel, with only a small drop in intensity and fundamental frequency in the middle. Much of the increased length can be associated with the epenthetic vowel that appears between the voiceless fricative and the pharyngeal. Because of the constant formant frequencies, in the figure legend we have transcribed this epenthetic vowel as **a** rather than **ə**.

[FIG. 21. ABOUT HERE]

In summary, Montana Salish pharyngeals seem to involve three basic elements: a pharyngeal constriction, lowered fundamental frequency and a change in voice quality. However, as noted, not all of these properties are observable in all utterances. Furthermore, a final example suggests some articulatory independence between the features associated with pharyngeals. The utterance of **ʔesəʕáts** 'it's tied, staked' shown in Figure 22 contains evidence of F0 lowering, and of F1 raising and F2 lowering, but the fundamental frequency has already been rising for some time when F1 and F2 achieve their closest proximity. This suggests that the pharyngeal constriction and fundamental frequency lowering associated with pharyngeals in Montana Salish are not directly physiologically connected, but rather are relatively independent correlates of the same phoneme.

[FIG. 22. ABOUT HERE]

As Bessell (1992) points out, there is also phonological evidence that, in spite of their vowel-like properties, the pharyngeals behave as sonorant consonants rather than vowels. As discussed above, under most circumstances a schwa vowel is inserted between a sonorant and a preceding consonant. Pharyngeals are treated as sonorants by this rule, so pharyngeals never follow consonants. The preceding schwa can be clearly observed in Figures 21. As we have seen, the realization of **ə** is highly dependent on the adjacent segments, so preceding a pharyngeal it can be close to **a** or **o**, as we transcribed it on the spectrogram in Figure 20.

[FIG. 23. ABOUT HERE]

Glottalized pharyngeals show some differences from other pharyngeals. Word-medially, as illustrated in Figure 23, they are generally realized as creaky-voiced pharyngeals, while word-initially they follow the general pattern of glottalized sonorants in Montana Salish in being preglottalized. Note that the creaky voicing often makes medial glottalized pharyngeals very hard to identify because they obviously do not share the breathiness characteristic of non-glottalized pharyngeals, and the creakiness can obscure the fundamental frequency of the pharyngeal. **ˀʕʷ** particularly can be hard to distinguish from glottalized **ˀw**. However, cues from formant structure are available, and where it can be determined, F0 is usually low during glottalized pharyngeals. Both these indications are present in Figure 23, where F1 and F2 during the pharyngeal are 990 Hz and 1490 Hz respectively. Figure 24 shows a medial rounded glottalized pharyngeal from the word **səˀʕʷuʔ** ‘it got low (e.g. water)’ that deviates from the patterns of realization just described. In this case, after the epenthetic **ə**, there is a full glottal stop. There is then a further epenthetic vowel, this time more like **u**, between the release of the glottal constriction and the onset of a pharyngeal constriction, which is indicated by the sharp drop in the amplitude of F2, and a slight rise in F1.

[FIG. 24. ABOUT HERE]

3.7. Truncation

One striking morphophonemic process deserves mention here: Montana Salish speakers have a strong tendency to delete everything after the stressed vowel in a word, unless otherwise unrecoverable grammatical information follows the stressed vowel. In practice, since so much verbal morphology is suffixal, this means that truncation is far more common in nouns than in verbs; indeed, it has resulted in re-lexicalization of many nouns, so that current speakers have no idea how the word originally ended, and the original coda does not surface upon the addition of a crucial grammatical suffix. An example is **tʃ'eˀmú** 'pet'. Etymological evidence shows that the original form was **tʃ'eˀmut(n)**, but for modern speakers, 'his/her pet', with the third person possessive suffix **–s**, is either **tʃ'eˀmúhs** (with an epenthetic **h**) or simply **tʃ'eˀmús**.

Truncation never results in relexicalization of verb stems as far as we have been able to determine. Except in lexicalized truncated forms, the process is generally optional, subject to discourse conditions and individual preference. But in some morphological contexts, some morphemes are obligatorily truncated. A few suffixes with strong stress, notable **–tsút** 'reflexive' and **–wéxʷ** 'reciprocal', are always truncated when they are word-final and when they precede a nonessential grammatical suffix, e.g. **joʕʷəməntsú** (from **joʕʷəməntsút**) 's/he got tensed up' and **qej esqʷ'əmənəwé** (from **es-qʷ'əm-n-wéxʷ-i**) 'we're wrestling'. In the latter example, imperfective aspect is already indicated by the prefix **es-**, so the final continuative suffix **–i** can be deleted without loss of information. But the addition of an imperative suffix, as in **joʕʷəməntsút-ʃ** ‘watch out!’, requires the full untruncated form. Similarly some stems seem to be truncated consistently when no crucial suffix follows, e.g. **χʷelé** ‘s/he hurried’ (but **χʷelétʃst-ʃ** ‘hurry!’). (See Thomason & Thomason 2004 for a detailed description of the truncation process.)

4. Coda

This description of Montana Salish has outlined the main phonetic characteristics of the language. But there are many points that are still not clear. For example, we do not know to what extent the variation in the realization of phones that we have noted is tied to particular individuals. To determine this we need to make further recordings and observe how consistent these speakers are. There are also some sounds for which we cannot provide convincing articulatory bases for the observed acoustic effects. This is particularly so in the case of the transients that appear in some laterals. We hope that future work will clarify these points. Meanwhile, the data presented here, and the recordings which are available to all interested researchers, remain as a first account of Montana Salish phonetics.

Acknowledgements

This paper is for the Salish people. We are especially grateful for the assistance of the then-director of the Culture Committee, the late Clarence Woodcock, and the Associate Director, Antoine (Tony) Incashola. We are deeply indebted to our three principal consultants: Harriet Whitworth, Plisiti (Felicite) Sapiel McDonald and Dorothy

Felsman. Thanks are also due to Joyce McDonough and Steve Egesdal. This research was supported in part by NSF.

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Appendix 1: Montana Salish word list

Forms are given in the surface phonemic transcription system used above. The headings in the list have been retained from our original fieldwork notes, so that others can appreciated why particular words are included.

FRAME SENTENCE: **tsu ___ tspists’éʔ** ‘He said ___ yesterday.’ (used in one recording session)

Vowels

1	**páʕəlqs**	grey dress
2	**pəlpîllʃ**	stagger
3	**tʃ’upélsi**	lonesome
4	**pólpəlqən**	thimbleberry
5	**púlsəm**	he killed something
6	**yál**	round
7	**séliʃ**	Flathead, Salish
8	**mîlkʷ’**	always
9	**ʔinəʕʷóˀl**	empty
10	**múlʃ**	cottonwood
11	**ʔáˀw**	ouch!
12	**ʔələʔéw**	father of a male
13	**ʔesəlíwti**	chapped
14	**ʔestóqʷ**	ravine, draw
15	**tʃ’úw**	it's gone
16	**ˀlˀláts**	red raspberry
17	**qétstʃ**	older brother (of a woman), aunt’s or uncle’s elder son
18	**tʃítsəntəm**	he met him
19	**ɬótst**	smashed

20	**ʔn̩ɬútskʷ**	soak

Consonants

21	**páʕs**	face is pale, grey
22	**p’əʕáp**	grass fire, timber fir
23	**p’úm**	brown, orange
24	**tám**	it's not, wrong
25	**t’áq’ən**	six
26	**t’áqʷən**	I licked it
27	**qáχeʔ**	aunt (mother's sister)
28	**qétstʃ**	older brother (of a woman), aunt's or uncle's elder son
29	**q’áq’ɬuʔ**	vein
30	**q’áˀwχeʔ**	yellow bell (flower)
31	**q’étt**	a hide, pelt
32	**q’éts’**	a sack; weave
33	**kapî**	coffee
34	**kʷáteʔ**	quarter (money)
35	**kʷén**	I took it
36	**kʷ’áltʃ’qən**	lid, cover
37	**kʷ’éˀnəm**	attempt, try
38	**qʷátsqən**	hat
39	**qʷásqʷîˀj**	blue jay
40	**qʷ’ájəlqs**	priest (black-robe)
41	**qʷ’át’χʷ**	bent; banana, cucumber
42	**qʷ’éts’t**	full
43	**tsáqʷəlʃ**	western larch (Larix occidentalis Nutt.)
44	**ts’ált**	it's cold
45	**ts’áχ**	fry; it's fried
46	**tʃájlqən**	cut hair
47	**tʃ’áwən**	I prayed (it)

48	**tʃ’átənɬq**	horsefly
49	**sáχʷ**	split wood
50	**ʃáll**	he got bored
51	**χáˀm**	dry
52	**χáq’**	pay
53	**xʷáltʃst**	reach (for something)
54	**χʷáq’ʷ**	to grind or file something
55	**mált**	mud
56	**máχeʔ**	glacier lily (Erythronium montanum)
57	**ˀmeˀmstsú**	playing cards
58	**ˀməˀnétʃ**	excrement, shit
59	**səˀnəˀmˀné**	toilet
60	**səˀmú**	mare
61	**sts’óˀm**	bone
62	**nás**	wet
63	**náqʷ’**	steal
64	**ˀneˀjxʷéˀws**	trade
65	**ˀneʔótsqěʔ**	when he goes out ...
66	**tʃ’tʃeˀn**	where to?
67	**láq’əm**	he buried
68	**láq’i**	sweatbath
69	**ʔəlˀláts**	red raspberry
70	**ppíˀl**	pint
71	**səˀláχt**	friend
72	**tʃtʃts’éˀlʃtʃən**	wood tick
73	**ɬáq’t**	wide, shovel
74	**ɬáqʃəlʃ**	sit down!
75	**tɬ’áqəneʔ**	pocket
76	**tɬ’áq’**	hot
77	**tɬ’áqʷ’**	beat one's wife

78	**wáˀləwəˀl**	long-billed curlew
79	**wénʃ**	dance the war dance
80	**ˀwîˀwá**	wild
81	**ʔesuˀwétʃiʔ**	lightning
82	**ʔiˀwéstən**	death camas
83	**ˀweˀwî**	meadowlark
84	**játəmskʷ**	shake it!
85	**jajáʔ**	maternal grandmother
86	**ˀjeˀjúkʷeʔ**	stingy
87	**ʃeˀj**	that, this

Pharyngeals

88	**ʔáwəntxʷ**	you said it
89	**ʕámt**	it's melted
90	**ʕájmt**	he's angry, mad
91	**ʔesəʕáts**	it's tied, staked
92	**stəʕán**	antelope
93	**sp’əʕás**	nighthawk
94	**səʕáptəni**	Nez Perce
95	**stʃsəʕó**	sunset
96	**sχəʕáp**	air
97	**p’əʕáp**	the grass/timber caught fire
98	**ʔipáʕ**	it's pale
99	**páʕs**	pale face
100	**χʷaχʷáʕ**	fox
101	**qʷ’aʕəntsú**	to coast, slide
102	**ʔesəjaʕsqé**	shy, reserved
103	**jaˀʕəmîm**	gathering (as, rocks)
104	**ʕʷóst**	lost
105	**ʕʷóˀl**	slippery (oily)

106	**ʕʷóˀllexʷ**	slippery ground
107	**ˀʕʷoˀjəntsú**	laugh
108	**ʔiháˀʕʷ**	loose
109	**háˀwumskʷ**	loosen it!
110	**máˀʕʷt**	broken
111	**tsáwəlʃ**	bathe, swim
112	**səˀʕʷúʔ**	it got low (as, water)
113	**ʔnsəˀʕʷóp**	drink up, get dry

Other interesting clusters

114	**p'əˀlp'əˀltʃ'əmîm**	she's turning it (the meat) over
115	**p'əllítʃtʃ'**	turned over
116	**χəˀlχəˀlléxʷ**	teeth
117	**ɬəˀmˀmˀmóts**	soft
118	**sqʷəllú**	tale
119	**sˀməˀlˀlá**	a nosebleed
120	**sɬesəˀlspé**	a little two-year-old
121	**tʃɬkʷkʷtəˀnéˀws**	a fat little belly
122	**kʷ'uˀlˀlí**	birth, born
123	**ttəˀwît**	youngest, young (boy)
124	**tʃtkʷt.ɬəˀní**	they were walking along a ridge
125	**tq'əˀntʃstá**	six days
126	**qʷej́ˀmˀm**	he was in a hurry

More pharyngeals

127	**ləʕáp**	sail; he sailed
128	**ʕátat**	hawk
129	**ʕáj**	bull trout

130	**sts’əʕál**	sickness
131	**ʔn̩papáʕ**	cliff, bank
132	**stiʕít.ʃən**	killdeer
133	**sxʷuʔúˀl**	steam

More ˀm

134	**kʷéˀmt**	and then
135	**ststsəˀmˀmélt**	children
136	**tʃ’ɬtstsəˀmú**	bead, beads
137	**sts’oˀmts’əˀm**	boil (inflamed swelling with pus)
138	**ʔistʃéˀmm**	I'm rejecting it
139	**ʔn̩tʃəˀméɬxʷ**	rob
140	**tʃ’əmpstém**	faint
141	**kʷtʃ’iˀm**	you're crazy, something's dark with your brain!
142	**ʔeˀmt**	feed
143	**heˀmîsheˀm**	mourning dove
144	**hetîˀm**	to tease
145	**ʔíˀmʃ**	he moved (camp)
146	**kʷkʷúsəˀm**	star
147	**skʷkʷ’íˀməlt**	young child
148	**ʔn̩ɬáɬəˀmqe**	a little black bear
149	**ɬəmɬaˀmá**	frog
150	**ɬəˀmáq**	got a burn
151	**ɬúˀmən**	spoon
152	**estɬ’eˀmstsú**	trouble
153	**ˀməˀlməˀlté**	quaking aspen
154	**méstəˀm**	father of a woman
155	**səˀmiˀmîʔ**	news

156	**ˀmiˀméˀyeʔ**	teach
157	**sɬəˀmχé**	a little grizzly bear
158	**sqt’îˀm**	scar
159	**ʔn̩qʷqʷ’osəˀmî**	dog
160	**súˀmənt**	to smell something
161	**ɬʃəˀméˀn**	a little enemy, a young enemy
162	**sʃutəˀméˀlt**	youngest daughter
163	**téˀm**	what?
164	**ʔi təˀnəˀmú**	nothing, it's nothing
165	**túˀm**	woman's mother
166	**t’əˀmám**	licked (ice-cream cone, sucker)
167	**st’ə́ˀmá**	cow
168	**ɬúˀlúˀlîˀm**	wire
169	**ʔi χáˀm**	he's dry
170	**ʔesχaˀmpəmî**	it's getting dry
171	**ˀjaˀjaˀmˀmíˀn**	farm hay rake

More ˀn

172	**ʔaχéˀneʔ**	handbag
173	**ts’sqáˀniʔ, ts’sqáˀneʔ**	chickadee
174	**iɬtʃtʃéˀn**	tender (as, a sore spot)
175	**tʃəˀnétʃs**	handshake
176	**stʃ’îˀn**	pika
177	**tʃ’itʃ’itəˀné**	alder tree
178	**tʃ’əˀnéyən**	snare
179	**ʔeˀnés**	he went, he left
180	**heʔéˀnəm**	eight
181	**skʷəˀnkʷî**	Indian potato

182	**kʷ’îˀnʃ**	how many?
183	**sméˀnxʷ**	tobacco
184	**mîˀnəm**	he painted
185	**tʃ’əɬəˀná**	one person, all alone
186	**ɬəˀnî**	knife
187	**səˀnˀnî**	sheath (for a knife)
188	**ʔespîˀn**	bent
189	**pəˀnîntʃ**	liver
190	**nqʷəˀnqʷəˀnˀnéls**	kind person
191	**qʷɬəˀnálqʷ**	white birch, paper birch
192	**səˀnsá**	tame
193	**sʃéˀnʃ**	rock
194	**tʃʃəˀnʃəˀnú**	eyeglasses
195	**tkʷtîn**	bullrush
196	**ʔeskʷ’ɬtəwîˀn**	short of, not quite enough
197	**ʔn̩t’oqʷtʃəˀné**	clap
198	**χəˀnút**	nine
199	**ɬχʷχʷəˀní**	hummingbird

More ˀl

200	**tstsîˀlʃ**	overnight camp, overnight stay
201	**stʃtsəˀlé**	mane
202	**səntʃ’əˀlé**	coyote
203	**ts’aʕəˀlétʃst**	his hand is aching
204	**xʷəˀlsté**	why?
205	**tʃtʃəˀléxʷ**	muskrat
206	**ʔiˀláˀwijeʔ**	great-great-grandparent, great-great-grandchild
207	**ɬkʷəˀlkʷaˀlî**	corn

208	**skʷkʷəˀl͡iˀl**	sunshine
209	**skʷ’îˀl**	porcupine
210	**lemtəwîˀlʃi**	he's getting happy
211	**ɬˀleˀleputé**	harebell
212	**ɬˀlˀláq**	thin
213	**kʷ’úˀləm**	he made something
214	**ʔmχʷóˀl**	cradle-board
215	**tʃənîll**	infect
216	**ʔol͡in**	belly
217	**ɬpəˀlpîˀlˀl**	he's staggering a little
218	**p’aq’əˀləwî**	firefly (it flashes)
219	**sp’əˀlq’é**	large intestine
220	**stʃ’ɬp’əˀlp’əˀlkʷ’î**	cigarette
221	**qəˀləwé**	step
222	**qəʔeseˀl͡iɬəni**	we were eating
223	**tʃsîsp’əˀl**	seven people
224	**ssaˀlú**	hail, hailstones
225	**ʃəˀlʃəˀltʃé**	salamander
226	**stəˀméˀlis**	relative
227	**təl͡ip**	break, shatter; it broke
228	**təˀlxʷé**	difficult
229	**t’éləm**	she sliced something (meat)
230	**ʔn̩t’pséˀlis**	splice
231	**ʔuttʃ’əˀlé**	safety pin
232	**ʔesəwéˀləm**	it's tilted
233	**wəˀləwéˀllʃ**	he's waddling
234	**ɬχəˀlpú**	dawn
235	**sχʷeʔel͡i**	camas
236	**jaˀl͡iˀl**	tangled

More ˀw

237	**səˀwéˀwɬ**	fish
238	**sxʷəˀweˀwéʔ**	the crier
239	**ʔn̩ts’áˀwkʷ**	weak, tasteless liquid (e.g. coffee)
240	**ts’éˀwstən**	washcloth
241	**tʃusəˀwî**	Chinese
242	**ʔn̩ʔemtéˀws**	wait
243	**ʔeˀwéti**	sneak up on
244	**héˀwt**	pack rat
245	**ɬuɬəˀwé**	thorn
246	**ʔm̩ttʃəˀwé**	balsamroot
247	**snéˀwt**	the wind
248	**sqəléˀw**	beaver
249	**q’əˀwî**	round stone with handle, for pounding
250	**qʷ’əléˀw**	pick berries
251	**ti(ʔ)itəˀwî**	horsemint

More ˀj

252	**siˀjéˀnp’**	greasy strips of meat
253	**siˀjeʔəˀjéʔ**	juneberry
254	**χʷχʷəˀjú**	whitefish
255	**sχʷtɬ’éˀj**	mountain goat
256	**χʷχʷəˀjé**	wild rose (entire plant)
257	**xʷéˀjt**	he's in trouble
258	**tqʷ’éˀj**	gum
259	**tamtəméˀj, tamtəmîʔ**	rare, not often

260	**ttʃéˀj**	urine
261	**ʃiˀjú**	pass through
262	**isúˀj**	cold, cool
263	**ʔiq’ʷóˀj, ʔiq’ʷóʕʷˀj**	calm (wind)
264	**q’aˀjé**	pinto
265	**q’eˀjmîn**	paper
266	**qéˀjs**	nightmare
267	**p’iˀjáq**	ripe
268	**tɬ’əméˀj**	few
269	**stʃ’éˀjt**	spider
270	**ts’əˀjú**	yet
271	**tsqaˀjé**	she dried (meat)
272	**tspɬéˀj**	brow (forehead)
273	**ʔaˀjptsin, ʕaˀjptsin**	he talked fast
274	**tʃaˀjuté(ʔ)**	they rode

Figure captions

Fig.1. Formants of the Montana Salish vowels from three female speakers (see text for details).

Fig.2. Formants of the Montana Salish vowels from two male speakers (see text for details).

Fig.3. Mean normalized F0 for each vowel, across five speakers.

Fig.4. Mean voice onset time (s) by stop category for five speakers.

Fig.5. Mean duration of glottal closure after oral release for each ejective (five speakers).

Fig.6. Mean duration by fricative type (five speakers).

Fig.7. Mean oral constriction durations by consonant type (5 speakers).

Fig.8. A spectrogram illustrating an initial sequence of five voiceless consonants in **tʃɬkʷkʷtəˀnéˀws** ‘a fat little belly’.

Fig.9. A spectrogram of the word **tʃtʃts’éˀlʃtʃən** ‘wood tick’.

Fig.10. A spectrogram of the word **ppíˀl** (in a narrow transcription **ppîḭ̯ᵗɬə̥**) ‘pint’.

Fig.11. Two pronunciations of **laqʼəm** ‘he buried’.

Fig.12. The sequence of lateral consonants in the middle of the word **pʼəllîtʃʼtʃ** ‘turned over’.

Fig.13. Spectrograms and waveforms of parts of **mílkʷʼ** ‘always’ and **ʔiɬtʃtʃéˀn** ‘tender’.

Fig.14. Spectrograms of **səˀmú** ‘mare’ as pronounced by speaker DF on the left and FM on the right.

Fig.15. Portions of **ʔesuˀwétʃiʔ** ‘lightning’ as spoken by speakers AI (top), FM, HW and DF (bottom, left to right).

Fig.16. Aerodynamic records of contrasting plosive and ejective in Montana Salish **tsu páʕs** ‘pale face’ vs. **tsu pʼəʕáp** ‘the grass/timber caught fire’. (See text for details.)

Fig.17. Aerodynamic records of a plosive and an ejective in the Montana Salish word **tʃʼtʃéˀn** ‘Where to’.

Fig.18. Wide and narrow band spectrograms of the pharyngeal consonant in the middle of the word **ʔesəʕáts** ‘it’s tied, staked’. Note that the narrow band spectrogram on the right has an expanded frequency scale, and the amplitude adjusted so that the harmonics are more clearly visible.

Fig.19. Wide and narrow band spectrograms of the pharyngeal consonant in the middle of the word **sχəʕáp** ‘air’ as spoken by speaker HW.

Fig.20. Wide and narrow band spectrograms of the pharyngeal consonant in the middle of the word **ʔinəʕʷoˀl** ‘empty’.

Fig.21. Wide and narrow band spectrograms of the pharyngeal consonant in the middle of the word **sχəʕáp** ‘air’, as spoken by speaker AI.

Fig.22. Wide and narrow band spectrograms of the word **ʔesəʕáts** ‘it’s tied, staked’. Maximum F0 lowering occurs at the time of the arrow at the top of the figure, above the narrow band spectrogram. Maximum F1 raising and F2 lowering occur at the time of the arrow below the wide band spectrogram.

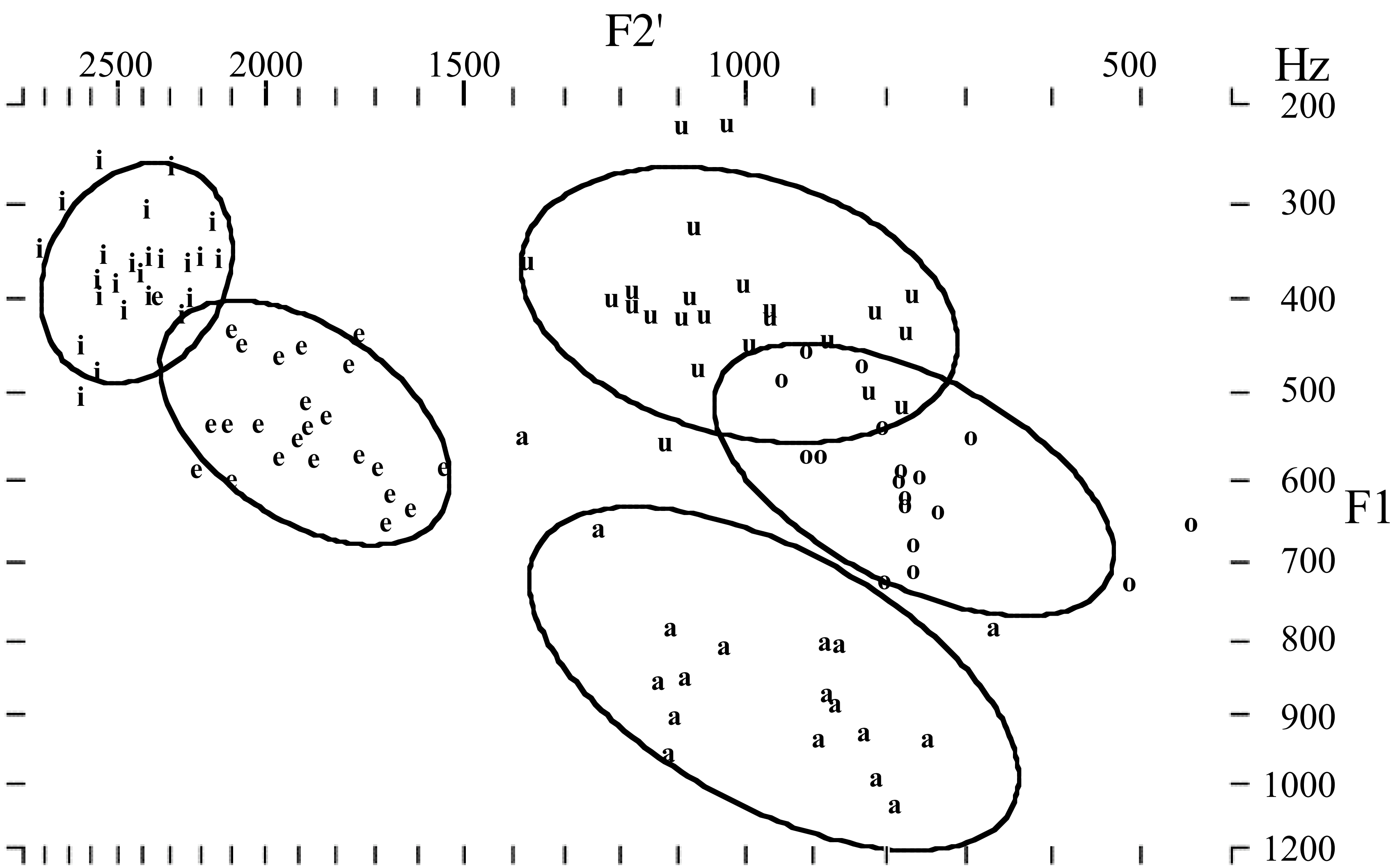
Fig.23. Wide and narrow band spectrograms of the pharyngeal consonant in the middle of the word **jaˀʕəmîm** ‘gathering (as, rocks)’.

Fig.24. Wide and narrow band spectrograms of the pharyngeal consonant in the middle of the word **səˀʕʷuʔ** ‘it got low (e.g. water)’.

[1] Thomason and Everett (1993); Thomason, Berner, Coelho, Micher, and Everett (1994); Thomason (1996); Thomason (1999); Thomason (2002); Pharris and Thomason (2005).

Figure

Figure 1



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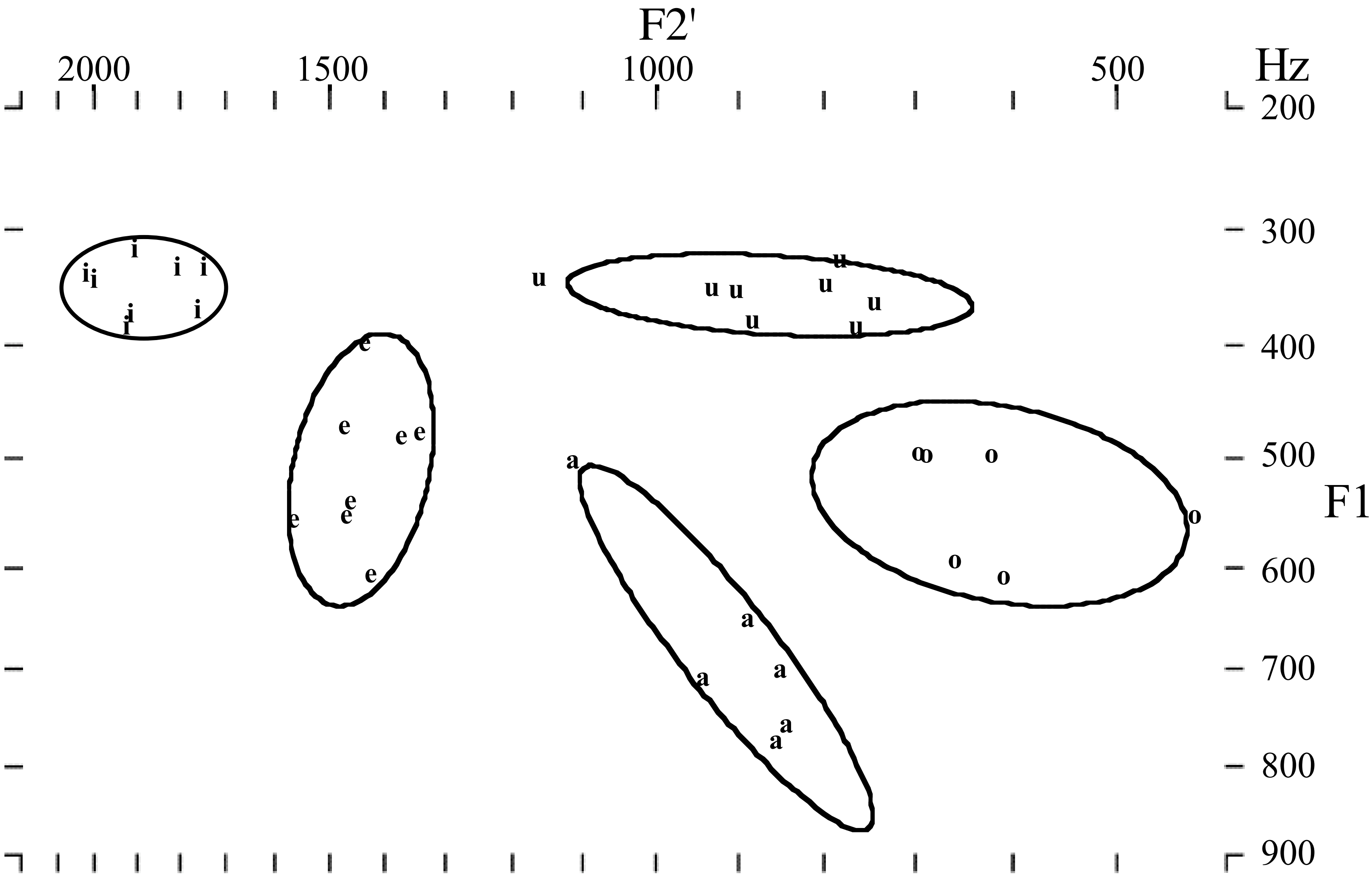

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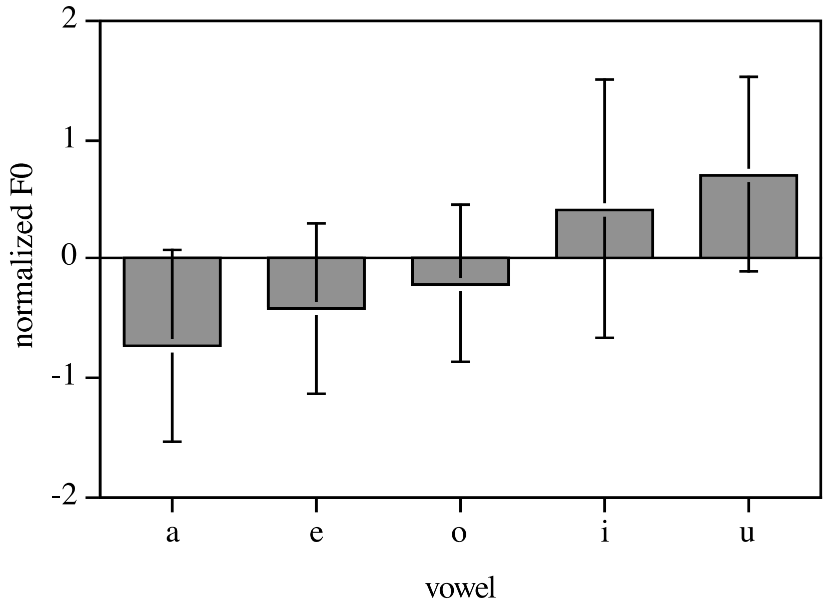

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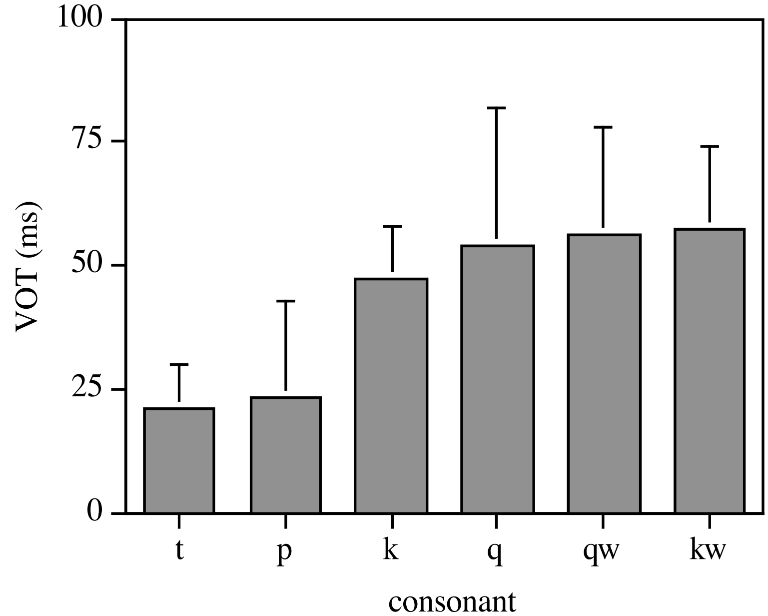

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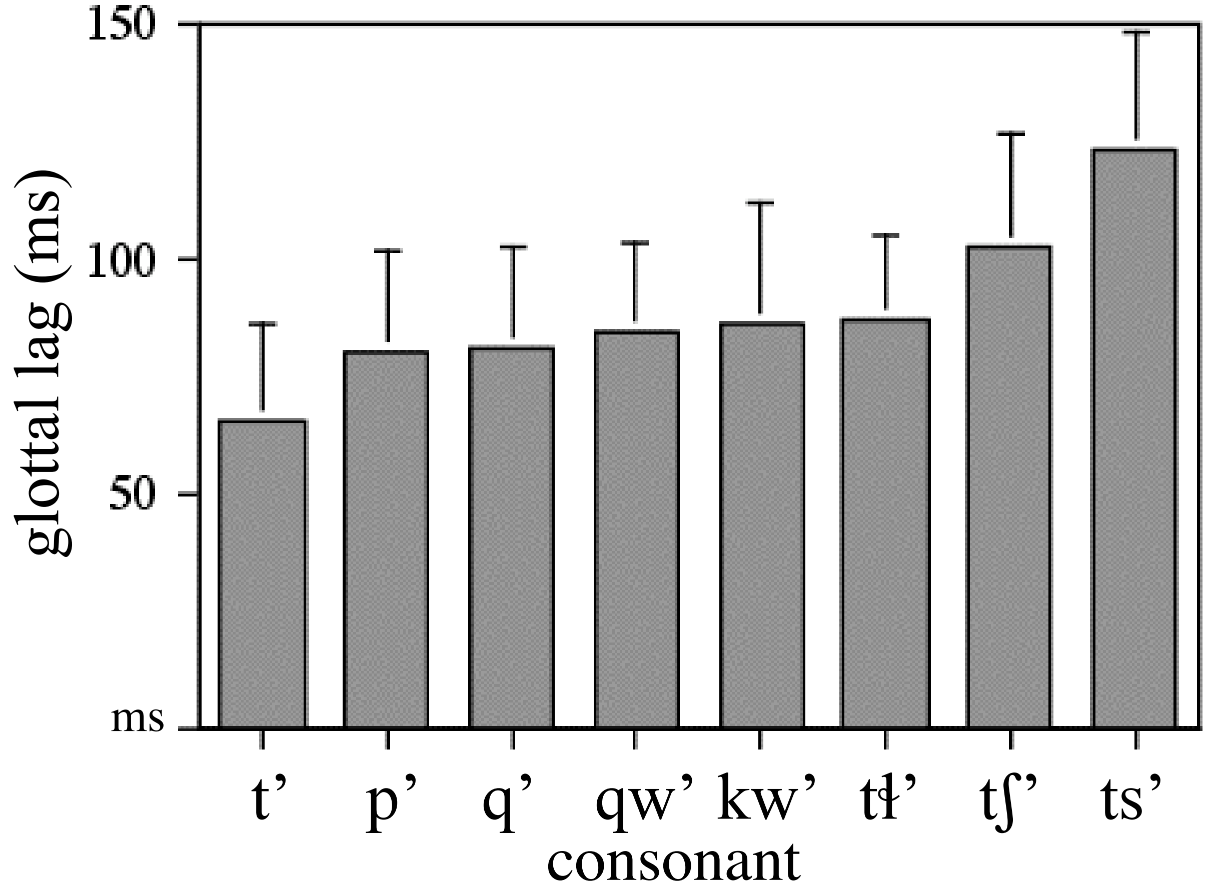

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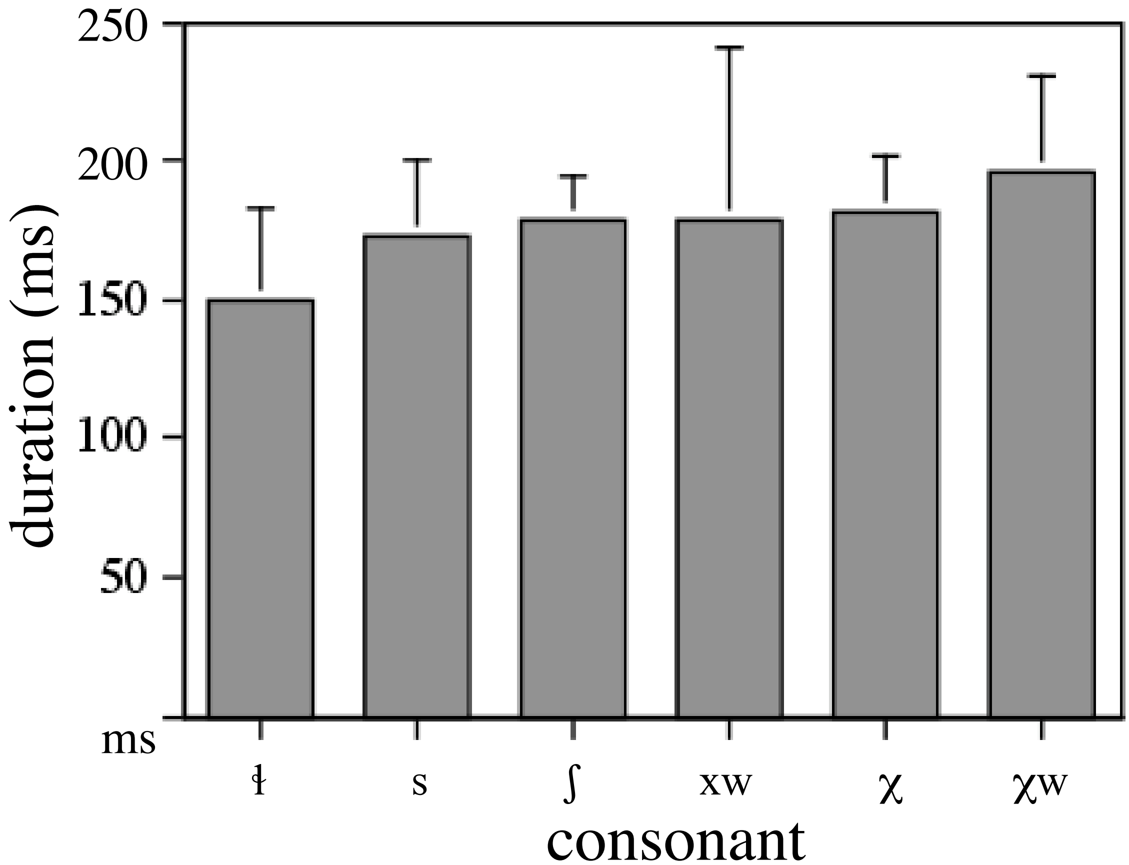

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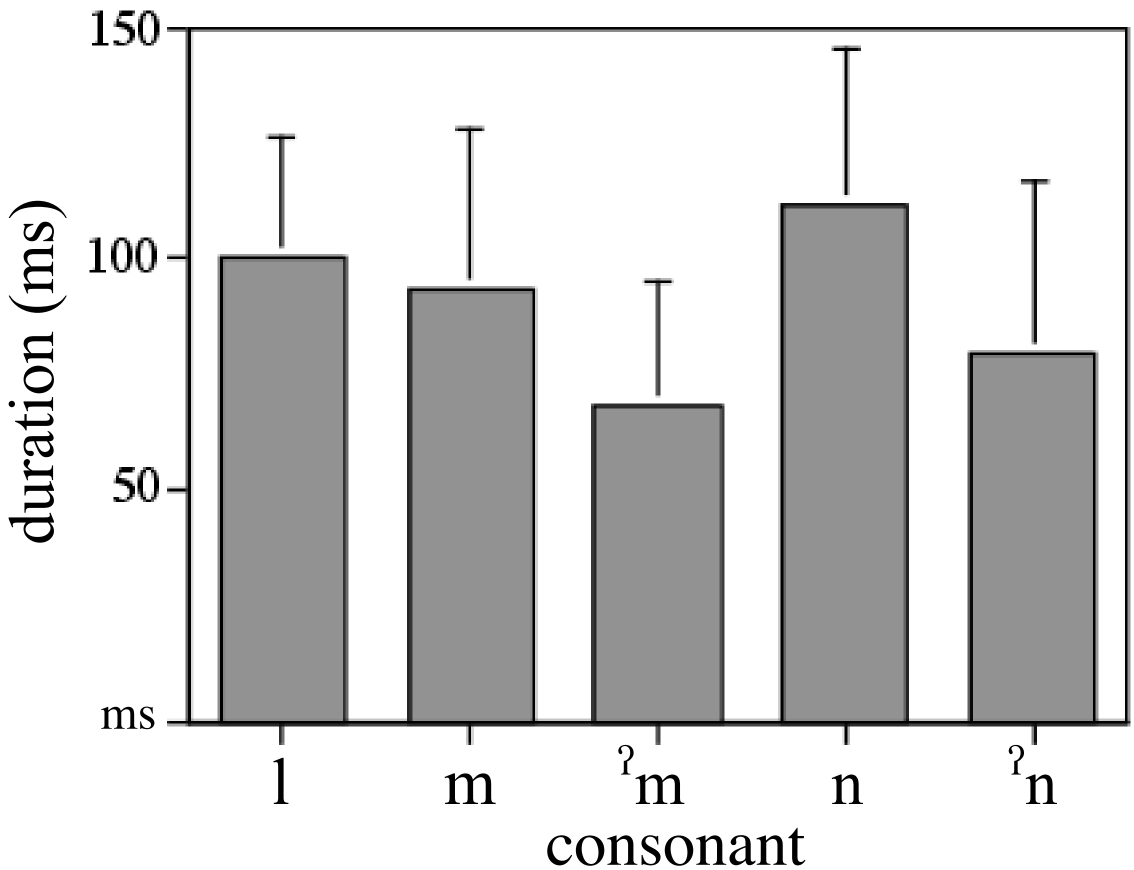

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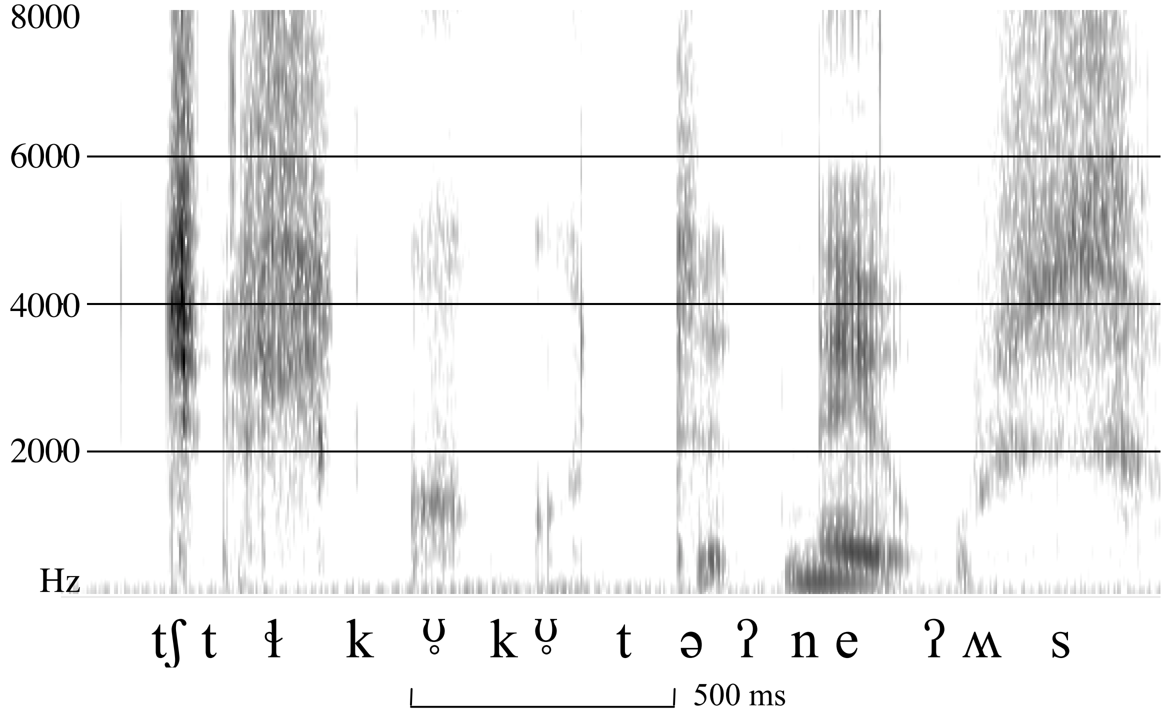

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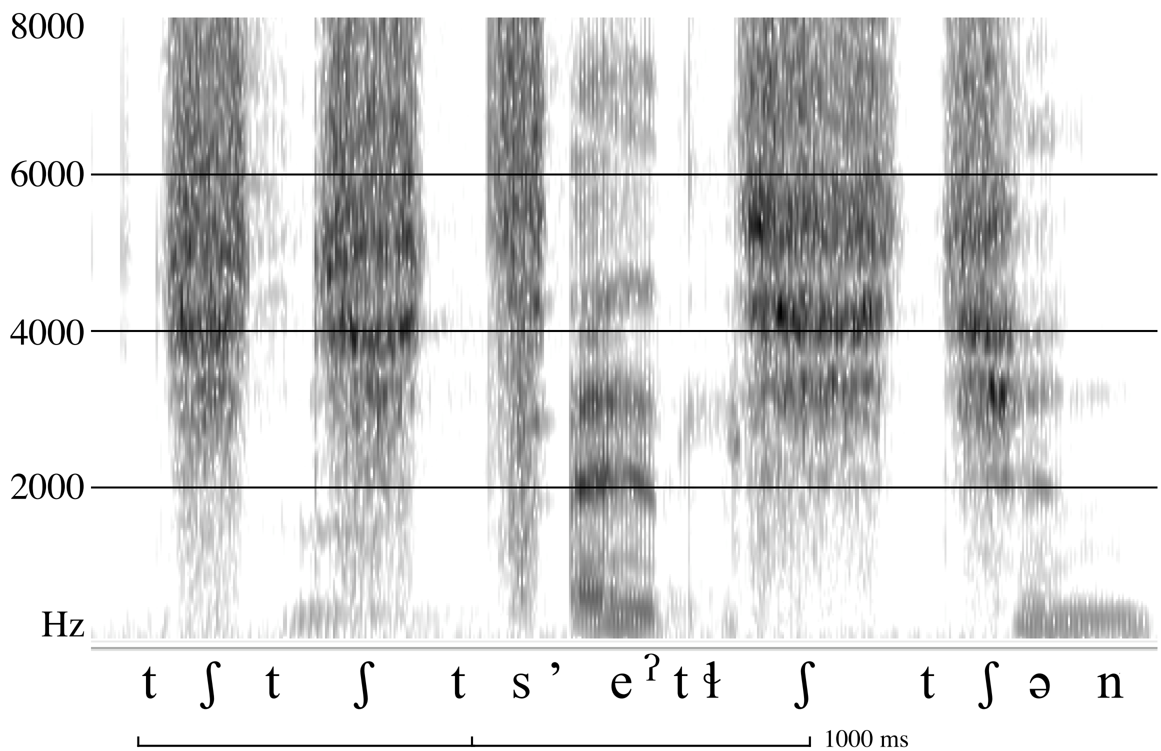

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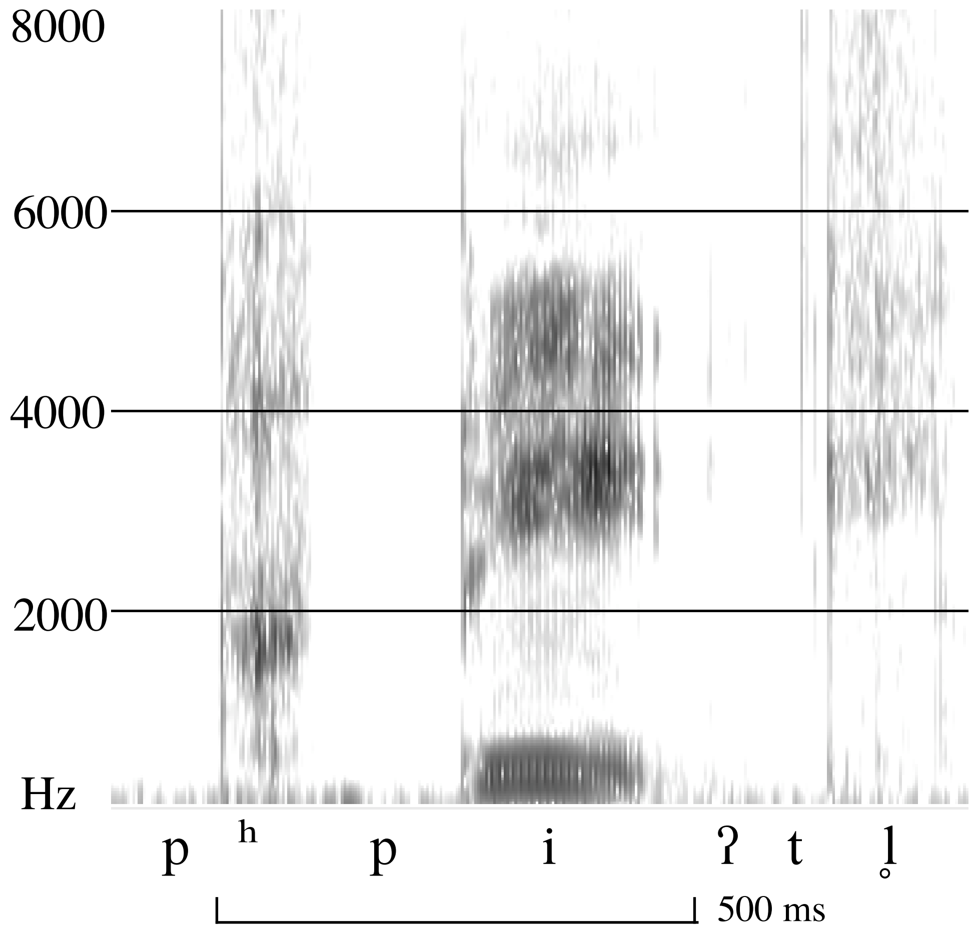

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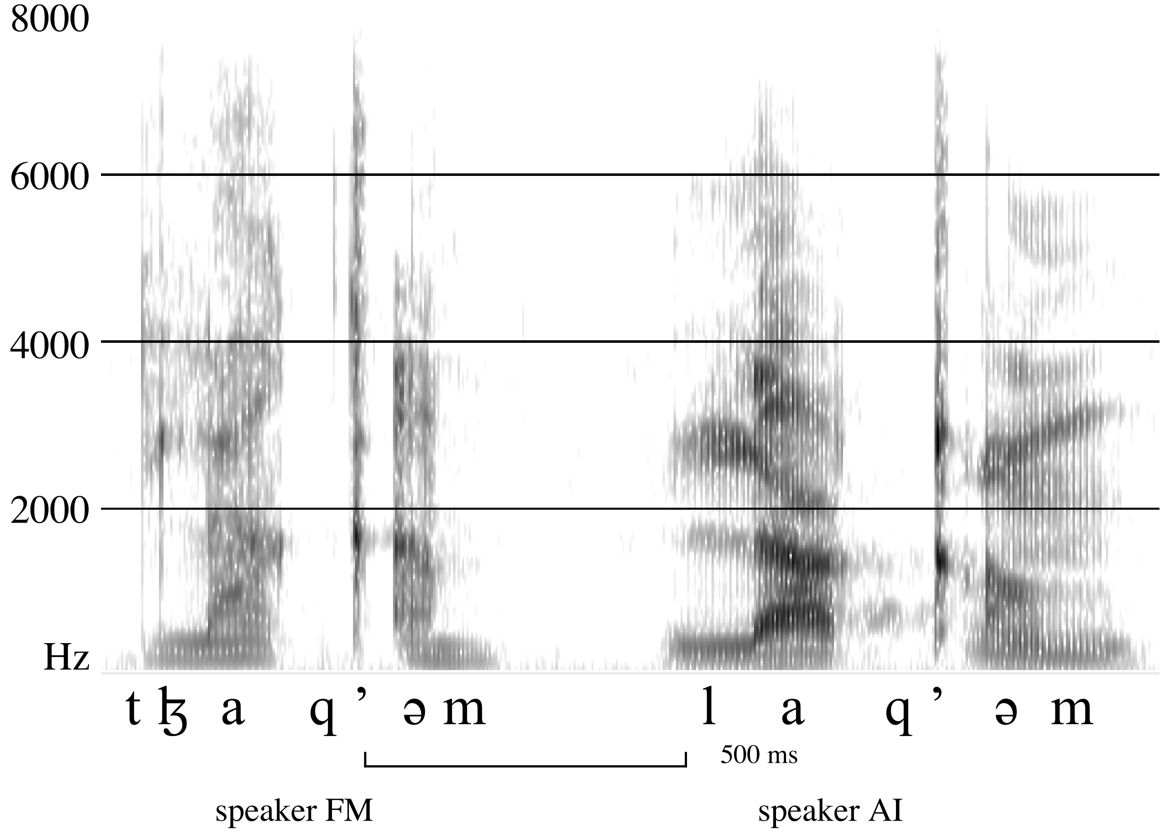

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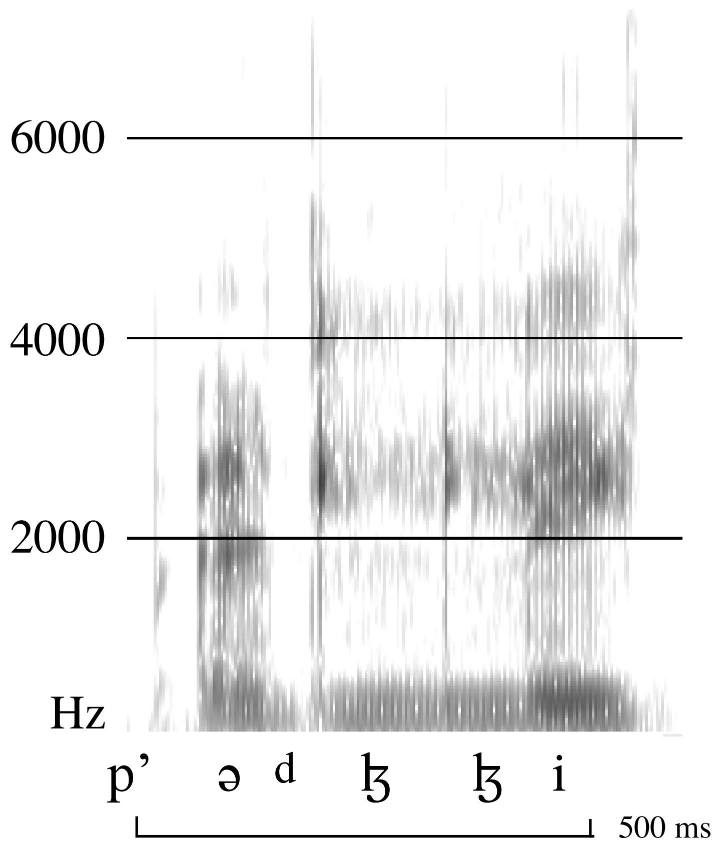

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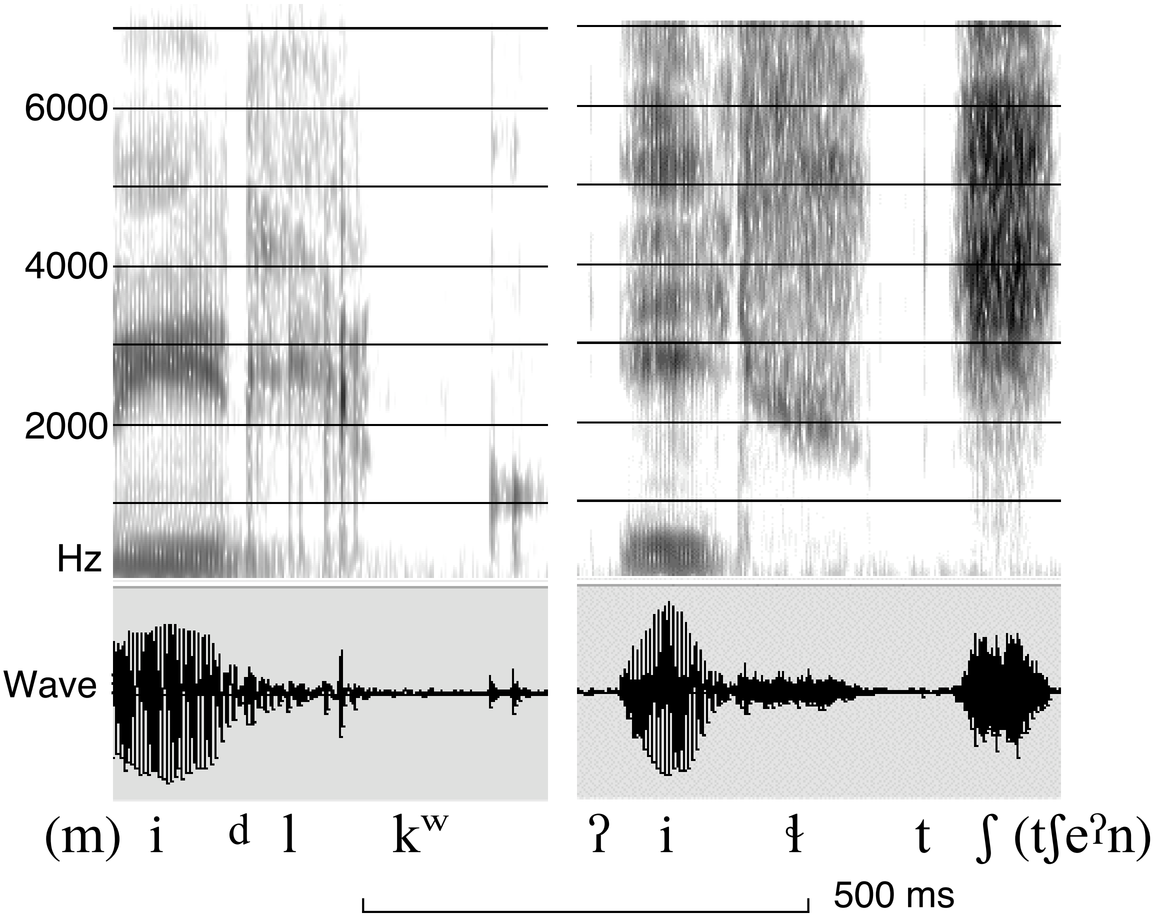

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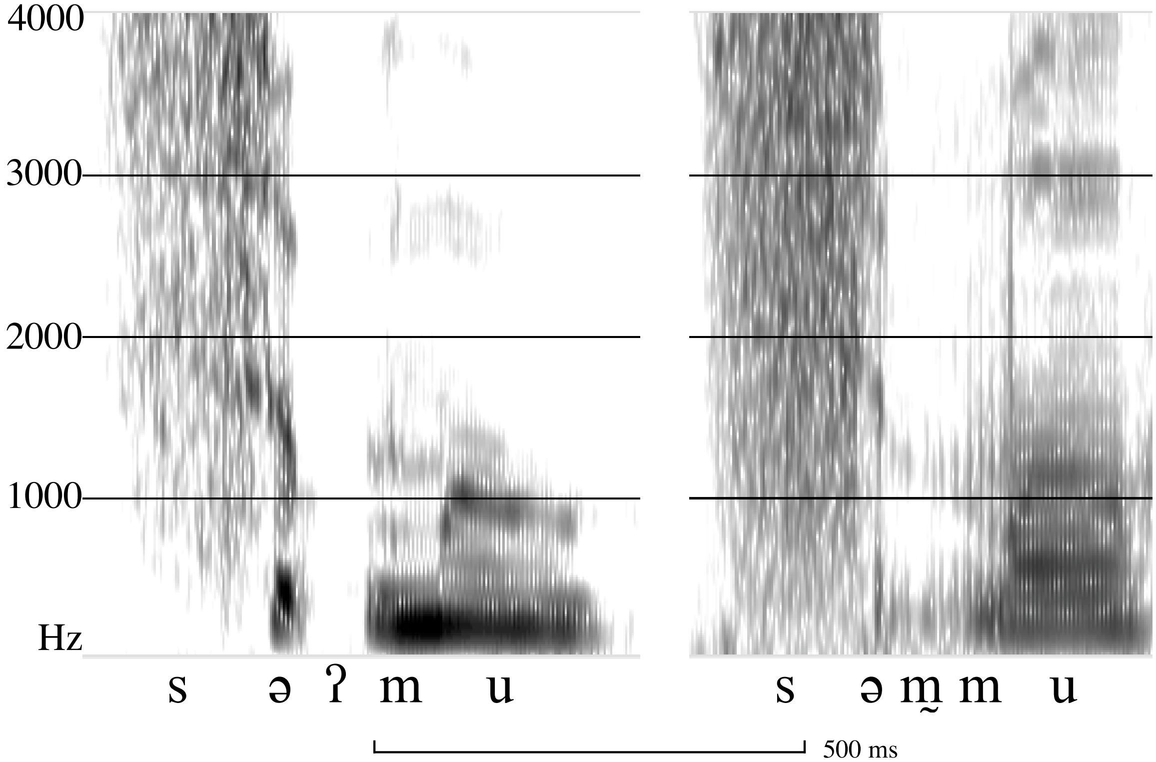

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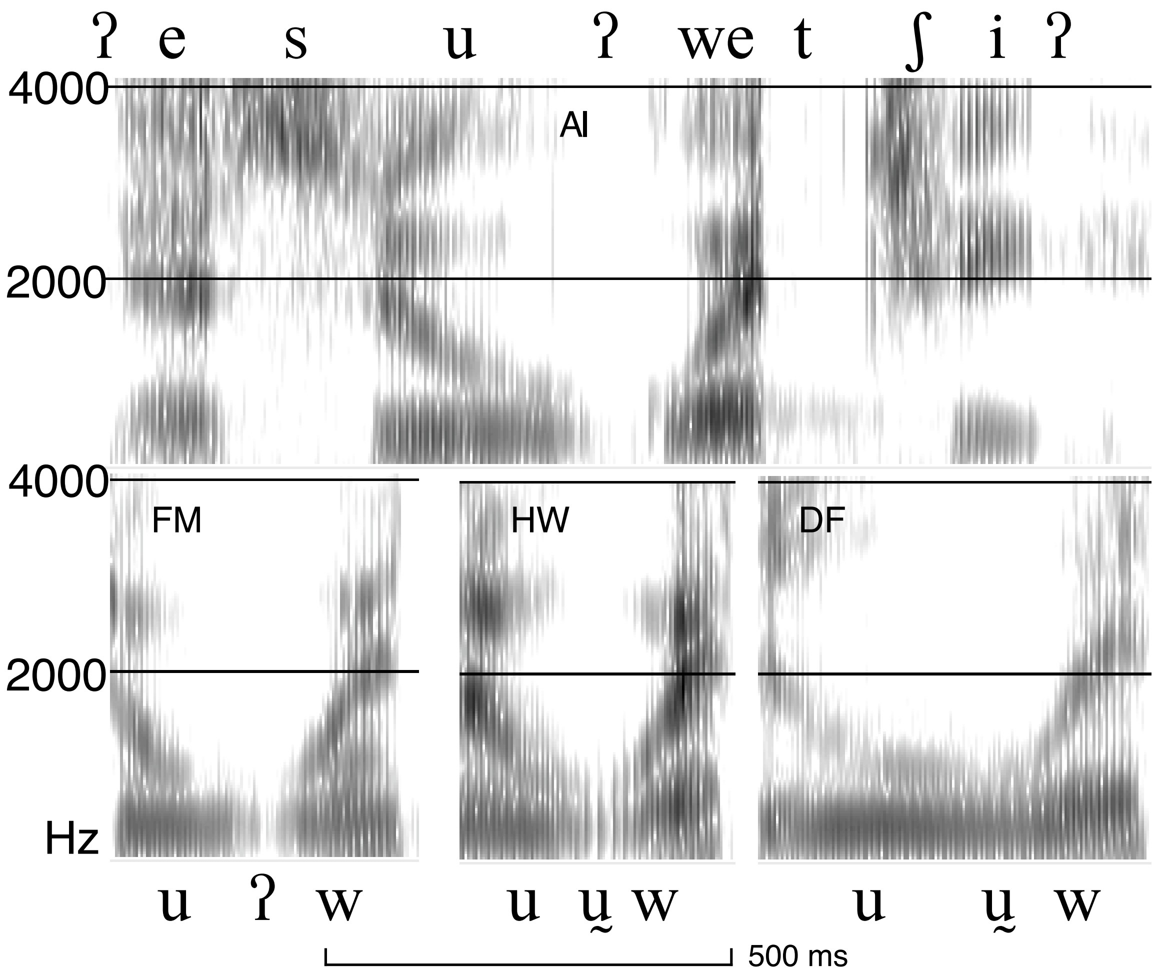

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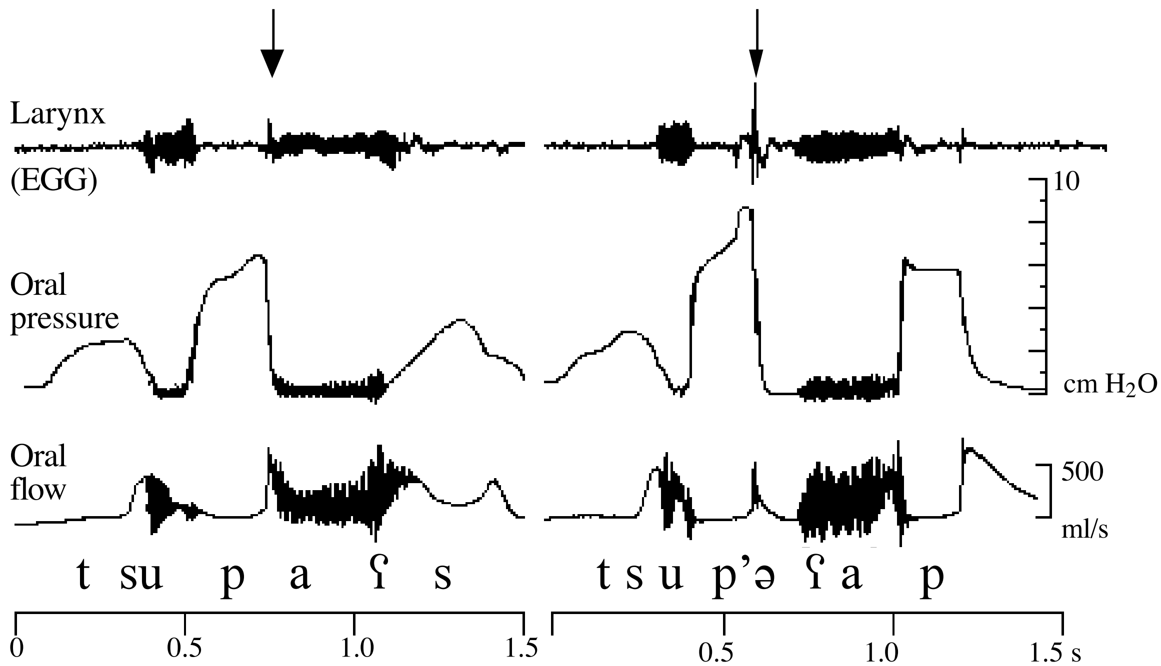

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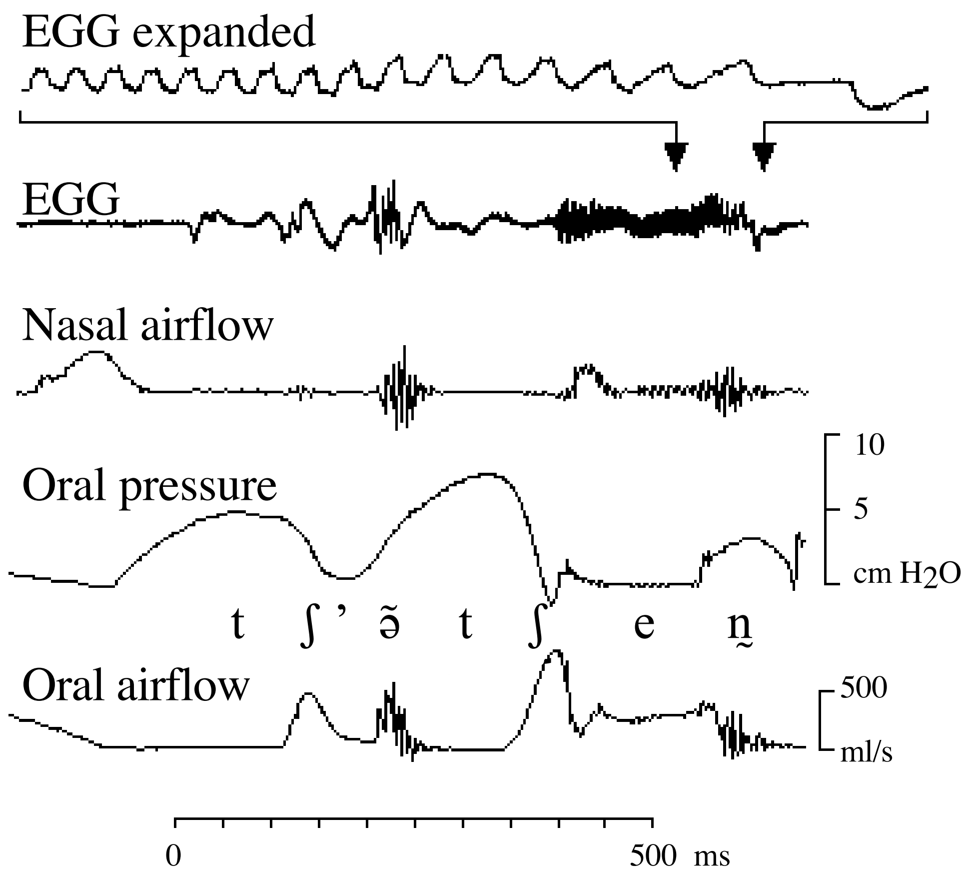

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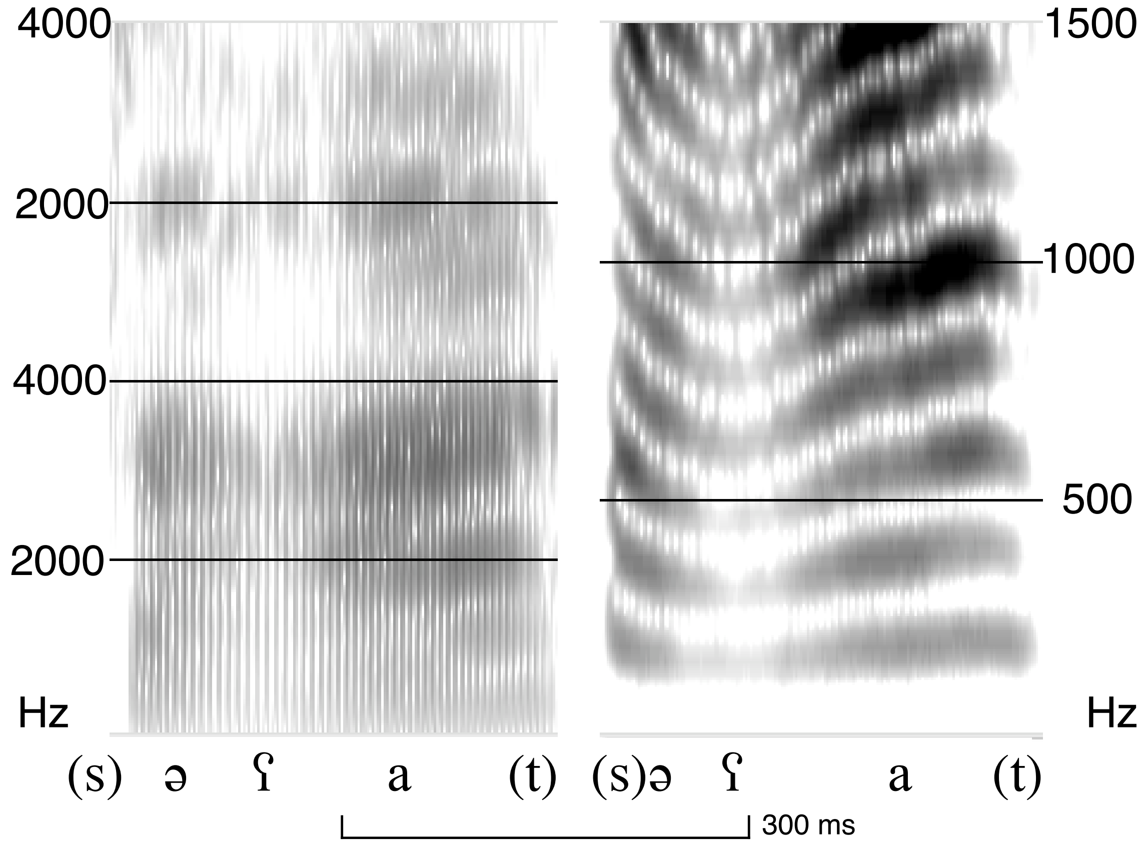

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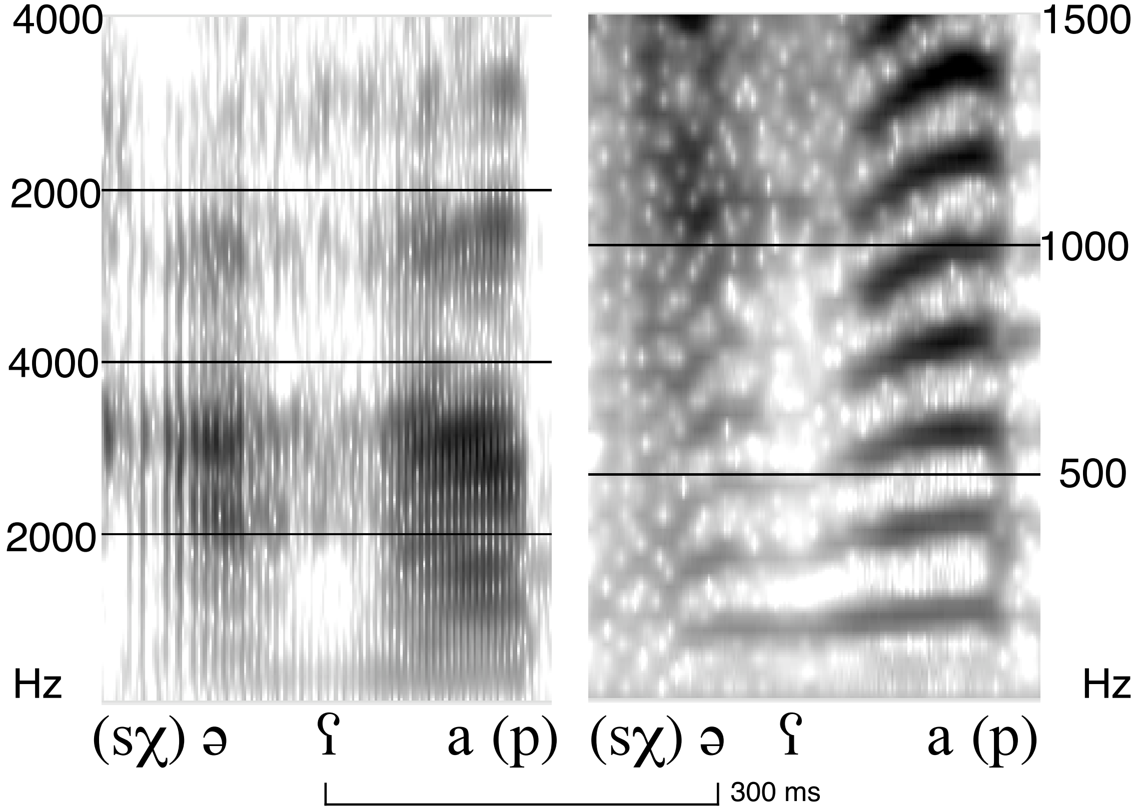

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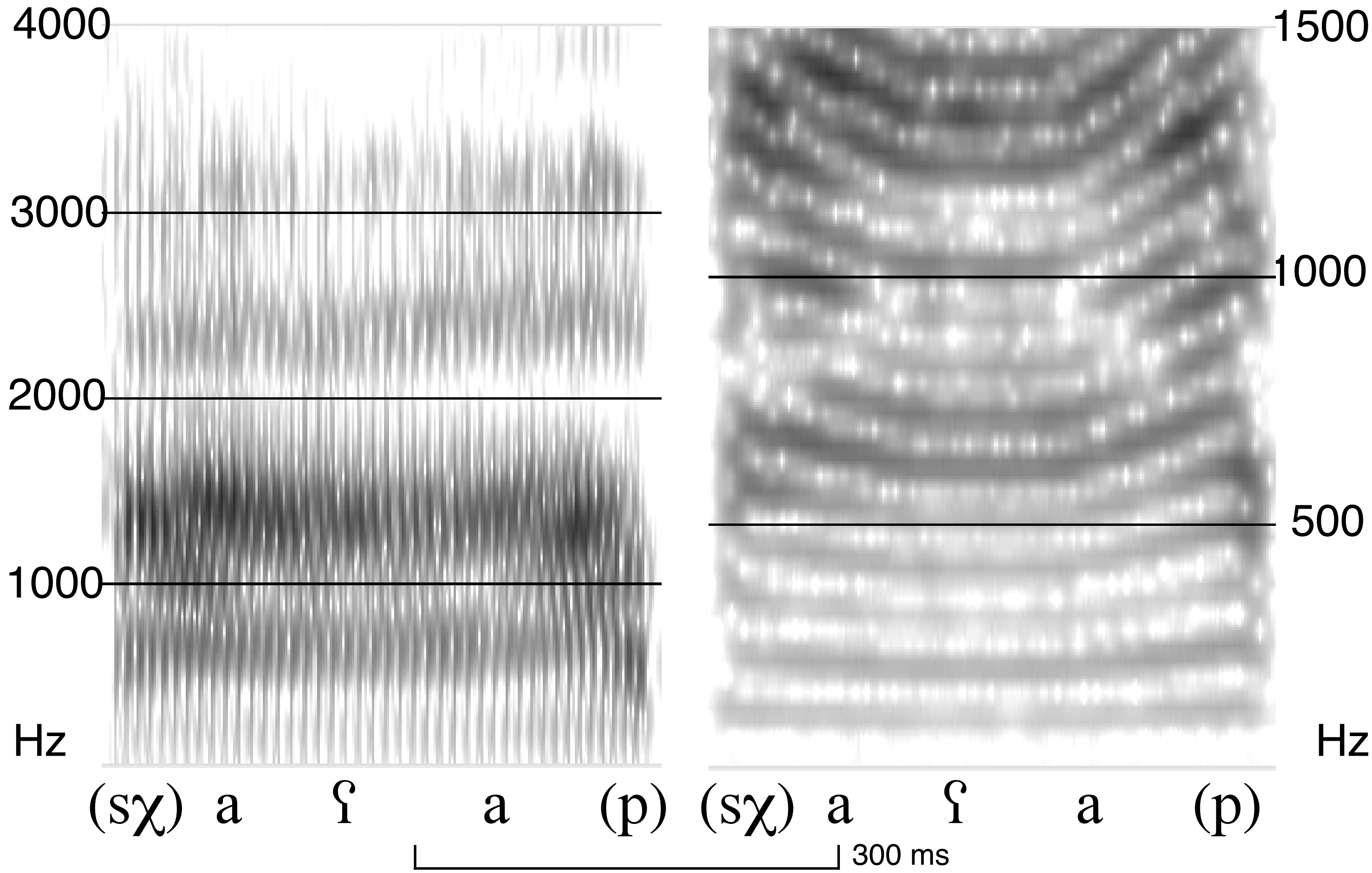
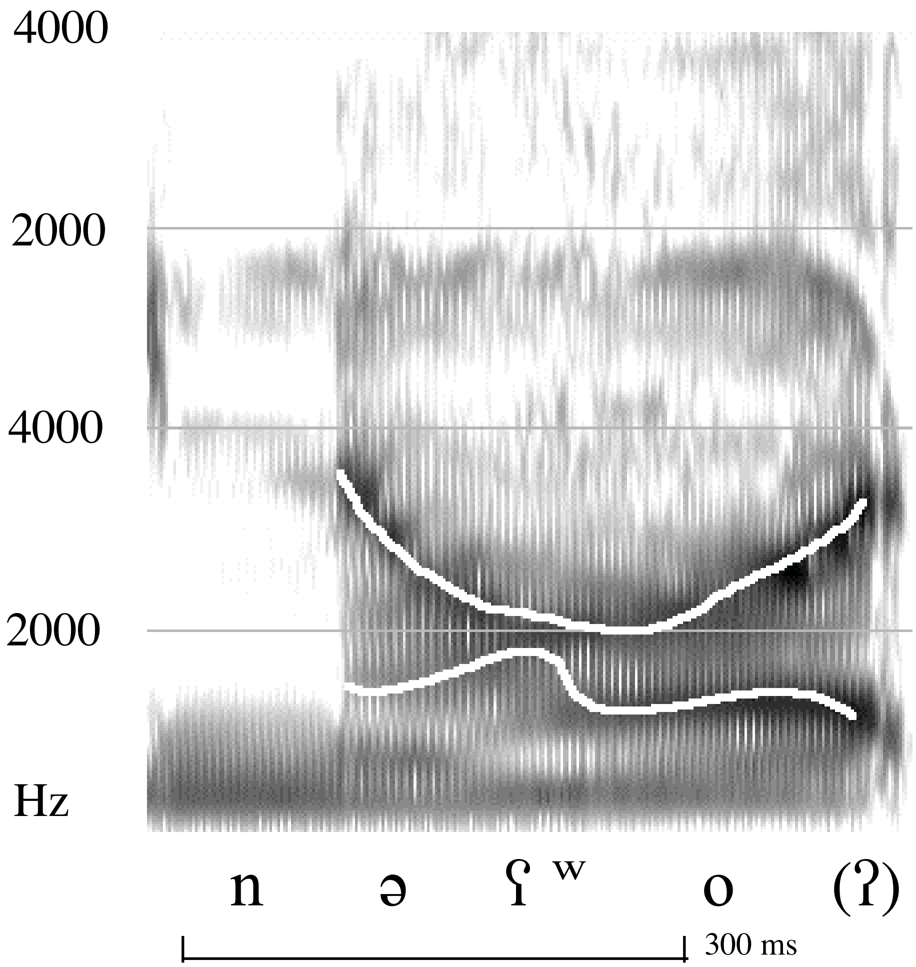


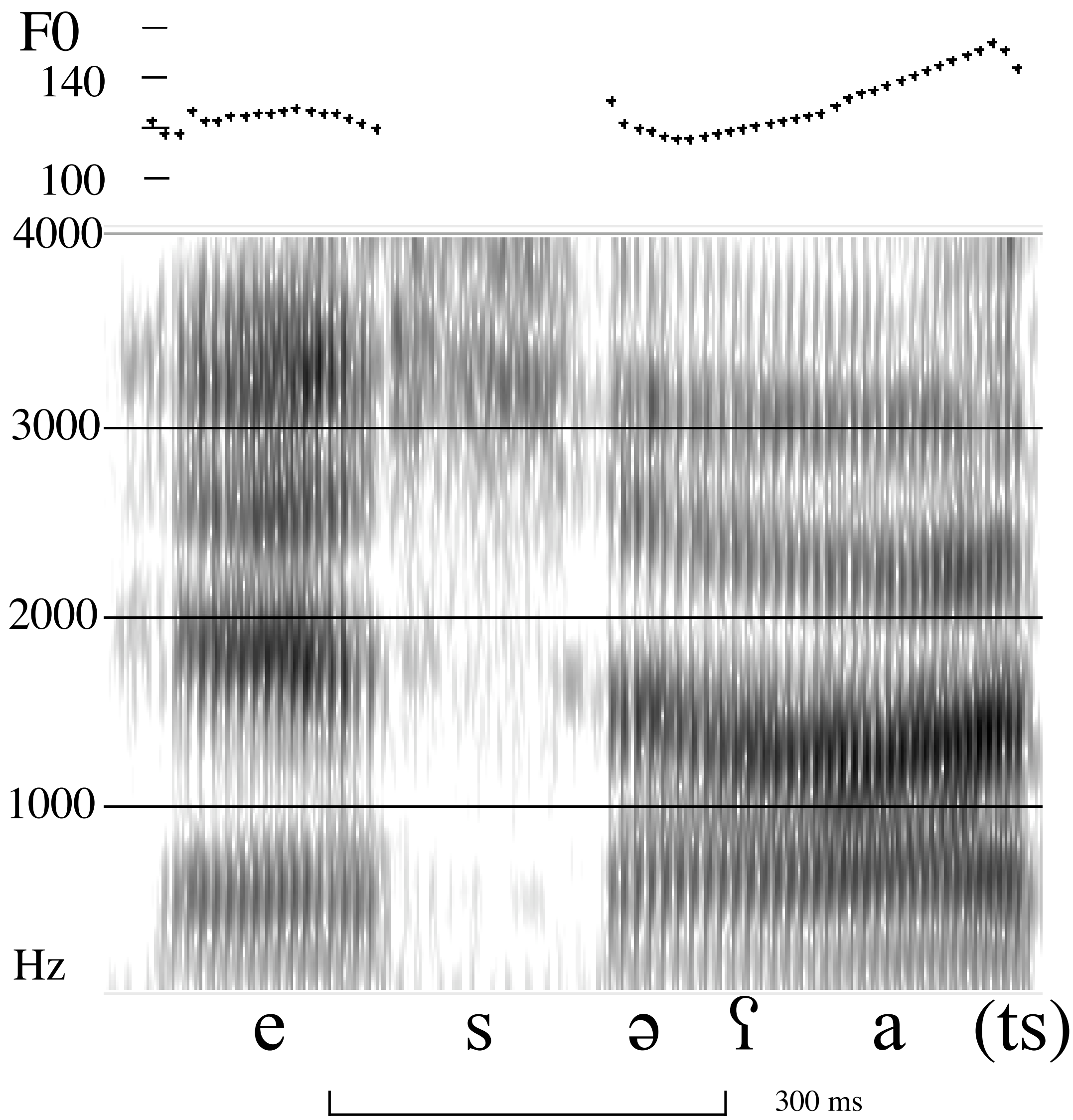
Figure

Figure 21



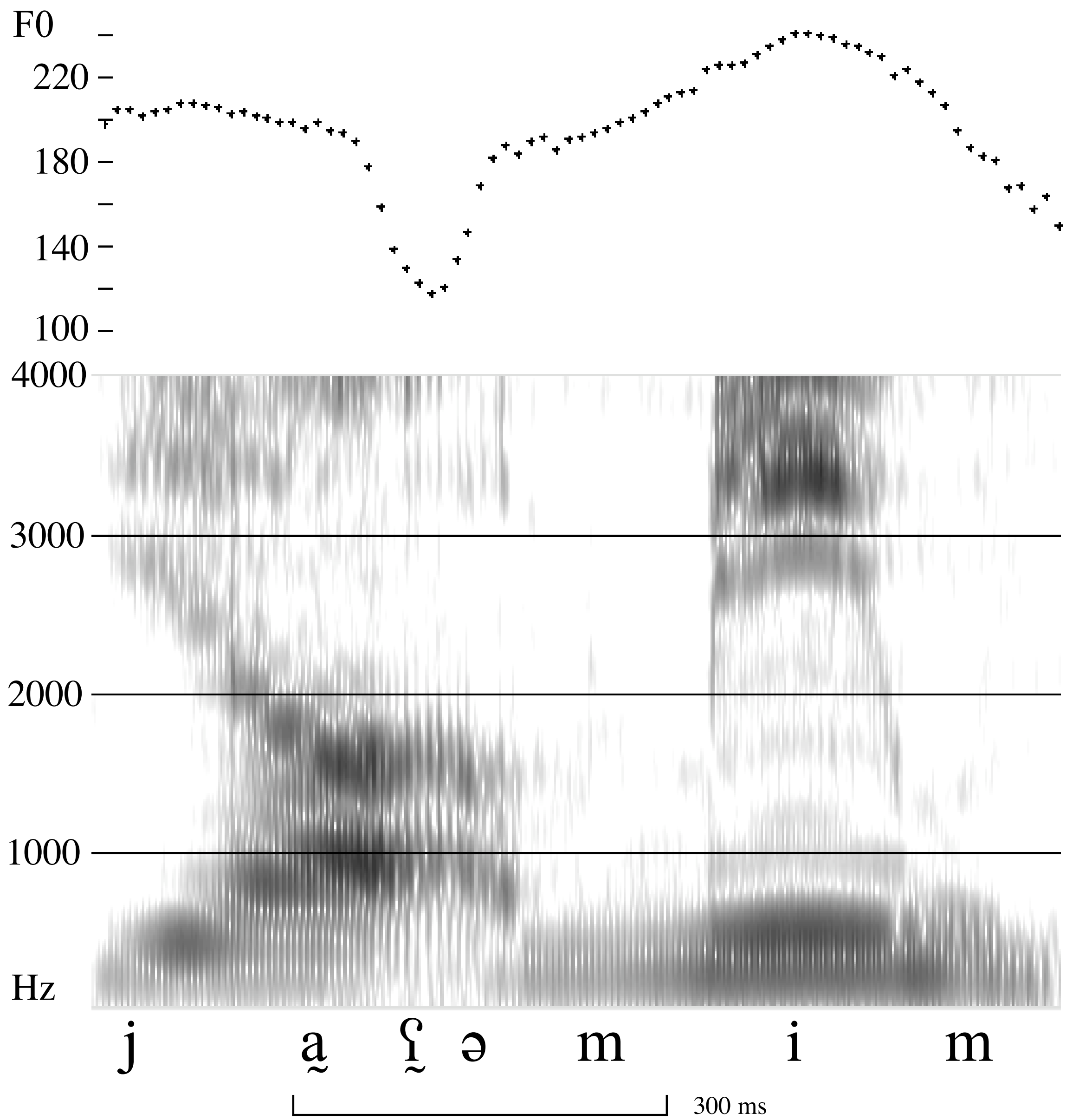
Figure

Figure 22



Figure

Figure 23



Figure

Figure 24