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The phonetic and phonological effects of obsolescence in Northern Paiute

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Abstract

Structural changes in a language are considered nearly inevitable consequences of language death (Campbell and Muntzel 1989, Wolfram 2002). The literature on sound change in endangered languages has focused on whether the changes are internally or externally motivated, and, therefore, the difference between categorical sound shifts and gradient phonetic effects has been overlooked. This paper discusses sound change in Northern Paiute through two experiments that investigate the difference between categorical changes in the phonological inventory and subphonemic variation within a category. The paper argues that sound change in obsolescing languages may take one of two predictable paths: substitution or approximation/expansion of phonological categories in the moribund language.

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1 Introduction.

The literature on sound change in endangered languages has largely focused on whether the changes are internally or externally motivated (cf. Campbell and Muntzel 1989, Woolard 1989, Dorian 1993, among others). This has left the differences between categorical phonological shifts (eg. /p^h/ shifting to /f/) and gradient phonetic effects (eg. the expansion of the category aspirated voiceless bilabial stop to include productions with increasingly shorter voice onset times) largely overlooked. The distinction between the two paths of sound change is critical as categorical shifts can obliterate phonological contrasts that are present in the traditional, pre-contact varieties of obsolescing languages. Gradient phonetic effects, however, may have minimal impact on the native structure of the language. In a recent paper, Yu (in press) demonstrated that subphonemic changes occur in Washo, a moribund language, without neutralizing any phonological contrasts. Yu compared the quantity alternation patterns of Washo speakers recorded in the 1950s and 1960s to individuals who are in their seventies today. He measured the tonic vowels and post-tonic consonants to examine whether the pattern had atrophied along with the community's language loss. While he concludes that the young generation has maintained the pattern found in the older speakers, Yu found that the contemporary generation of speakers had a less distinct category boundary between short and long consonants, and that overall the younger generation had shorter post-tonic consonant closure durations than the older generation.

There is little doubt that moribund languages experience changes of a type or at a pace unlike more viable languages (Campbell and Muntzel 1989, Wolfram 2002). Obsolescing languages are in contact with other more dominant languages, and community shifts to a dominant language can have devastating effects on the linguistic structures of the language.

This observation stands in contrast to traditional views of sound change which often consider it a gradual internal process where the phonetic realization of a phonological category is subtly altered until it enters new phonological space. The purpose of this paper is to determine the relationship between the subphonemic and phonological inventory effects of moribundity on Northern Paiute. I examine the maintenance of a three-way lenis/fortis contrast in the consonant inventory using acoustic data from three generations of Northern Paiute speakers. A change in place of articulation of the coronal sibilant is investigated using production data from two generations. I argue that these two sound changes are taking distinctly different paths of approximation/expansion through subphonemic variation and transfer through a categorical shift in place of articulation, respectively.

Expansion is a term used by Labov (1994:321-323) to describe the increased category size of a sound. Under expansion, a sound can encroach on the phonetic space of another phoneme or it could increase its own phonetic space to intensify a difference between two given sounds. Trudgill and Foxcroft (1978) introduce approximation and transfer as two paths toward sound change to account for two different types of vowel mergers. Approximation occurs when two phonologically distinct vowels shift in the direction of each other until they are acoustically indistinct. Sound changes involving approximation are comprised of imperceptible subphonemic changes prior to the completion of the change. A phonological category is transferred when one phonological category is adopted and implemented into a lexical item as a form of lexical diffusion until it completely replaces the previously existing category. Approximation and expansion share an underlying path of gradient, subphonemic variation. They can, therefore, be classified together into a single sound change route. Conversely, transfer assumes that the sound change was a categorical shift or an articulatory leap. In the language contact literature, transfer is analogous to substitution where a phoneme from one language replaces a phoneme in another either in one phonological environment or all together (Weinreich 1953, Thomason and Kaufman 1988). Both transfer and approximation/expansion affect the phonological profile of a language, but in very different ways. Approximation can result in the formation or loss of phonological categories. One sound can gradually approximate another such that only one phonological slot is vacated while the other joins a phonological category, or two sounds can come to reside in a novel acoustic space leaving the two original phonological spaces empty. Transfer can potentially involve an articulatory leap within a phonological system whereby one sound suddenly shares an acoustic space and category boundary with another, thereby obliterating a contrast.

The paper is structured as follows. Section 2 provides previous descriptions of sound change in endangered languages along with background to the traditional internally- versus externally-motivated dichotomy these authors originally presented. I argue that while this distinction is important, it is also interesting to examine sound changes in terms of subphonemic variation and categorical changes. The Northern Paiute communities, the speakers, and their socio-cultural dynamic are presented in Section 3. The experiments investigating the lenis/fortis contrast and sibilant change are reported in Sections 4 and 5, respectively. The paper concludes with a broader prediction of the paths toward sound change in moribund languages.

2 Sound change and language loss.

The number of investigations describing sound change in endangered languages is rather limited. Moreover, the descriptions are primarily phonological in nature, which means they inherently cover categorical changes. Andersen (1982) makes predictions about the types of phonological reduction expected in speakers who are undergoing linguistic attrition compared to the speech of a monolingual or dominant speaker of the same language. Speakers of an obsolescing language are expected to make fewer phonological distinctions, yet maintain phonological distinctions in the endangered language that also exist in the dominant language, and phonological distinctions with a low functional load are to be lost prior to those with a high functional load (p. 95). Phonological distinctions will be maintained if identical patterns exist in the dominant language or if the distinctions carry a high functional load.

Campbell and Muntzel (1989: 186-188) cite Andersen's predictions and claim that few linguists would disagree with them, providing several examples from Campbell's own work to support Andersen's predictions. For example, they recount the loss of vowel length contrasts, the merger of /ts/ and /s/, and the elimination of voiceless continuants in dialects of Pipil (Southern Uto-Aztecan) that are highly endangered (Campbell and Muntzel 1989: 186-187, citing Campbell 1985). Tuxtla Chico Mam (Mamean; Mayan), a language described as being nearly extinct has merged /q/ with /k/ (Campbell and Muntzel 1989: 186, citing Campbell 1988).

As mentioned above, the debate within this literature has often been centered on the motivations for these sound changes. Campbell and Muntzel argue that Andersen's use of the word 'distinctions' leaves the burden of changes in an obsolescing language on external motivations. They prefer the use of 'unmarked', arguing that the structural changes pervasive in obsolescing languages include the "overgeneralization of unmarked features". Using markedness as the selectional criteria crucially keeps language change in obsolescing languages as an internal process (Campbell and Muntzel 1989: 188). The authors present several cases of the overgeneralization of unmarked features in attriting languages. In these cases phonological features present in the obsolescing language that are absent in the dominant language are amplified. For example, Jumaytepeque Xinca (a linguistic isolate) has glottalized consonants in certain morphological environments; however, one of the last speakers produced every consonant with glottalization. Speakers of Guazacapan Xinca (a linguistic isolate) are noted to have also glottalized in excess (Campbell and Muntzel 1989: 189). In Teotepeque Pipil devoiced /l/s have been overgeneralized to occur in all positions, not just word-finally (Campbell and Muntzel 1989: 189, citing Campbell 1985). These patterns, argue Campbell and Muntzel, are internal and arise from "imperfect learning of the moribund language and nothing to do with Spanish" (p. 198).

Cook (1989) and Miller (1971) have also argued for more internal motivations for sound change in obsolescing languages. Phonological variation in two indigenous languages of Canada is described by Cook. He presents evidence for categorical sound changes in Chipewyan and Sarcee (both Athabaskan languages) that are not regular across the speech community. Rather than interpreting this sound change as an incomplete transfer process, he says the changes cannot be "attributable to a particular age group, community, or style."

Miller (1971) examined the effect of language atrophy on phonological changes in Shoshoni. Shoshoni is a Central Numic language closely related to Northern Paiute spoken in the Great Basin. Miller describes that the linguistic differences between the younger and older speakers are vast, and illustrates changes in both vowels and consonants. For example, four processes can affect Shoshoni medial consonants: spirantization, gemination, preaspiration, and prenasalization. Younger speakers tend to substitute one process for another or spirantization is simply adopted as the default since it is the most frequent process in Shoshoni (Miller 1971: 119).

Woolard (1989) argues against Campbell and Muntzel's view of change in moribund languages as internally motivated. She claims that the hyper-glottalized consonants in Xinca described in Campbell and Muntzel (1989) are, in fact, externally motivated. The fact that Spanish does not have glottalized consonants in its inventory has motivated the overgeneralization of the feature in Xinca (p. 363). Descriptions of the changes in Dyirbal and K^{w}ak^{ʔw}ala discussed below are also presented as externally motivated changes by Schmidt (1985) and Goodfellow (2005), respectively. Schmidt describes language change across generations in Dyirbal (Pama-Nyungan) as a function of proficiency in the dominant language of the area, Australian English. She describes the modifications made to the grammar of Dyirbal by younger speakers who have increased usage of English compared to older generations. Schmidt (1985: 191) assumes that "instances of phonological interference in [Young Dyirbal] pronunciation" are the result of "differences between English and [Traditional Dyirbal] sound systems"; in other words, they are externally motivated.

A more recent description of the effects of language obsolescence on a moribund language is given by Goodfellow (2005). Goodfellow's investigation of the K^{w}ak^{ʔw}ala-speaking (Wakashan) people of British Columbia explores the changes in the language as a result of influence from English (p. 3). Goodfellow considers the changes attributable to K^{w}ak^{ʔw}ala contact with English as compared to internally driven phenomena. She (2005: 134) describes the youngest speaking generation as using fewer phonological distinctions and "bas[ing] more consonants on the English distinctions." These phonological changes all affect consonants that are not present in the English phonemic inventory. Changes include loss of word-medial glottal stop and the frequent loss of glottalization in consonants resulting in phonological neutralization in all but the eldest generation (p. 135). One particularly interesting loss for the youngest generation is that of the uvular series. Most young speakers substitute a velar for the uvular sound, merging two series of dorsal stops. Yet, the young generation remains mindful of the palatalization rule, whereby a velar palatalizes when preceding a vowel. Young speakers still follow this rule, but only when the velar is an underlying velar and not the velar used in place of a uvular (p. 135-136). This suggests there has been no degradation to their abstract knowledge of phonological rules in even the youngest $K^w ak^{ʔw}$ala speakers.

Dorian (1993: 135) expresses doubts over the distinction between internally and externally motivated changes in a situation of language contact. She warns that changes converging toward a dominant language are not always due to external factors and divergent changes are not always internal. In her description of East Sutherland Gaelic, an endangered language spoken in Scotland, Dorian (1978: 35) claims that while English lexical borrowings are commonplace, the language "retains its structural integrity for the most part, and the amount of interference in the individual bilingual's speech is only small to moderate, although varying to be sure from individual to individual and setting to setting." Still Dorian documents two sound changes – a subphonemic change and a categorical change – across young and oldgenerations of speakers. She reports that young speakers do not nasalize phonemically nasalized vowels as strongly as older speakers, although no speakers are said to have lost the contrast altogether (p. 58). Also, Dorian describes young speakers as "probably" showing influence from English when they replace /ɲ/ with [ŋ] and /ç/ with [x] (the latter is a feature of Scottish varieties of English). Younger speakers often also substitute [ɹ] or [l] for /ɫ/ (p. 174).

It has been difficult for researchers to conclusively prove whether convergent or divergent changes in obsolescing languages have been due to exclusively internal or external motivations. It is clear, however, that categorical changes, the loss of allophones, and subphonemic variation are all characteristics of sound change in obsolescing languages. Andersen's predictions are not always successful; for example, word-initial /ŋ/ in Young Dyirbal is retained (Schmidt 1985) and abstract phonological knowledge is maintained. However, categorical changes with the transfer of a dominant language phoneme for an obsolescing language phoneme are particularly common, and in many cases (e.g., Kʷakˀʷala) the transfer is not complete and sounds are able to surface in a variety of distinct forms. The extent to which similar phonological changes have occurred in Northern Paiute are considered through instrumental phonetic investigations below. The language community in which this is examined is introduced in the next section.

3 Northern Paiute.

Northern Paiute territory extends from eastern Oregon across into the western corner of Idaho, south in western Nevada and into pockets of the Sierra Nevada along the spine of eastern California. Data from two communities are used in the investigations to follow: Mono Lake Northern Paiute (MLNP) and Carson Desert Northern Paiute (CDNP). MLNP and CDNP are members of the southern dialect category of Northern Paiute (Liljeblad 1966, Nichols 1974). These two dialects are not identical, but, crucially, they share a feature that distinguishes the southern dialects of Northern Paiute from the northern dialects: the three-way contrast in consonant type. This feature is discussed in more detail in Section 4.

MLNP is a severely endangered dialect of Northern Paiute with 15 or fewer speakers (author's field notes). All of the remaining speakers are middle-aged and beyond. MLNP has been undergoing what Campbell and Muntzel (1989: 185) term “gradual language death”. Such cases of language death are characterized by a generational shift to the dominant language that is accompanied by a period of bilingualism. This type of language obsolescence situation is typified by a proficiency continuum that correlates primarily with age.

CDNP is a dialect of Northern Paiute originally spoken east of Reno, Nevada in the Carson Desert. The language data from CDNP come from archived field recordings made in the early 1950s (Steve & Wheat, 1950-1952).

3.1 Consultants.

Autobiographies of MLNP speakers shared during fieldwork sessions suggest the shift to English is quite recent. Table 1 presents the birth years of the consultants who participated in the experiments. All of the consultants are women. MLNP consultants B2 and B3 were monolingual until they began attending school. The eldest MLNP consultant, B1, learned English early in her youth along with MLNP from an English-speaking relative. C1 is the youngest MLNP speaker. Older siblings introduced English into C1's home by the time she was born. MLNP was C1’s first language, but schooling and the cultural climate have dictated that English has been her dominant language through life.

INSERT TABLE 1 ABOUT HERE.

The last remaining individual, A1, was a consultant in the early 1950s for Margaret Wheat. The Berkeley Language Center was able to provide high-quality digital recordings collected by Steve and Wheat (1950-1952). These recordings provide the earliest recordings of Northern Paiute from the area. A1 was a speaker of CDNP. She lived in the areas of Fallon and Stillwater, Nevada in the Carson Desert for the course of her life.

The consultants in Table 1 can be easily divided into three generations based on date of birth: Generation A consisting of A1; Generation B composed of B1, B2, and B3; and, Generation C which is limited to C1. With these three generations, I will compare how the language has changed in terms of the phonetic realizations of the lenis/fortis contrast as reliance on English has increased in the lives of Northern Paiutes. The investigation of sibilant place of articulation is relegated to the two extant generations of speakers.

4 Investigation 1: Lenis/fortis contrast.

MLNP and CDNP make a three-way contrast within its stops and affricates. Oral obstruents are contrasted as lenis, voiced fortis, and fortis, while nasal obstruents are distinguished by lenis and fortis categories. Table 2 illustrates the consonant inventory of MLNP and CDNP. The three-way contrast is manifested word-medially and at conditioned morpheme boundaries; word-initially, contrasts are neutralized to fortis.

INSERT TABLE 2 ABOUT HERE.

In Western Numic, Nichols describes careful speech as preserving a greater distinction between the lenis and fortis categories. He notes, nonetheless, that the auditory differences between the lenis and fortis categories are minimal (Nichols 1974: 31-32). Thornes (2003) differentiates the lenis and fortis contrast of Oregon Northern Paiute in terms of the strength of articulation. Fortis consonants are produced with a “full and forceful occlusion” of the articulators, whereas in the production of lenis consonants the articulators are slack (Thornes 2003: 28). These impressionistic claims about the fortis and lenis categories have been made by Nichols and Thornes without investigating any phonetic data. The current investigation will help determine the phonetic realizations of the phonemic differences between these categories and the clarity of their category boundaries. The next section outlines the investigation I conducted to determine the robustness of the phonetic cues of the lenis/fortis contrast in MLNP and examine how the contrast has fared in contact with English across three generations of speakers.

4.1 The meaning of the labels lenis and fortis.

Lenis and fortis are poorly defined descriptive terms that are often misapplied to contrasts. According to Ladefoged and Maddieson (1997: 95-98), fortis can refer to the increase of respiratory energy or to the increase of articulatory energy. Lenis means a decrease in the amount of energy exuded by the speaker. The increased output of energy associated with a fortis consonant can correlate with increased oral pressure and increased closure duration. They also report that lenis consonants have more variation in closure type which explains the large number of fricative allophones that are paired with the lenis oral stops in Northern Paiute. In order to determine the best acoustic correlates of the contrast and to explore the potential generational differences, several acoustic measurements were taken, as described in the methods section below.

4.2 Methodology.

A wordlist containing the lenis, voiced fortis, fortis stop consonant types at all places of articulation was compiled. Also included in the wordlist were the lenis and fortis nasal sets. A minimum of five words from each phoneme category was included in the list. The wordlist for the MLNP speakers was elicited in a single fieldwork session. Present at the session were B1, B2, B3, and C1. Upon their turn, speakers were instructed to say the word three times. The recordings were made on a Marantz PMD670 solid-state recorder using a dynamic Shure microphone. The microphone was held by a fieldworker approximately four inches from the speaker's mouth. The words used from A1 were not as systematic as those from Generations B and C. These are from archived field recordings, elicited over half a century ago. Some of the lexical items differed from those of MLNP for dialectal reasons.

Initial impressions of the MLNP recordings showed that some tokens, particularly members of the voiced fortis series, had both significant voicing throughout the closure and a burst release. It was determined that three measurements would be taken: consonant closure, release, and percent of the closure that had visible vocal fold pulses (percent voiced). Closure duration was defined as the offset of a high amplitude vowel portion until the burst release or the onset of the following vowel. In the cases where the lenis consonant was lenited to the point of frication, the closure duration was measured as the offset of the preceding vowel to the onset of the following vowel. For tokens with a visible release in the MLNP data, the feature was measured from the burst of the stop release to the commencement of vocal fold vibration for the following vowel. Quality was an issue with the CDNP recordings due to background noise and poor recording equipment. It was determined that the only reliable method of examining the contrast in CDNP was to label the consonants in a single total duration, combining the closure and release durations into one label.

All vowels and intervocalic consonants were labeled in Wavesurfer (Sjölander and Beskow 2005) by the author. Duration values were extracted from the label files and statistical analysis were executed on said values. Nasal durations and vowel formants were also labeled and extracted, but are not discussed in this paper. A number of outliers were removed from the A1 labels. These were likely due to human error in the labeling process.

4.3 Analysis and results.

Since a generation variable would be conflated with speaker in a repeated measures ANOVA with the entire data set, separate analyses were conducted for each speaker for each of the acoustic measurements. A1's data was only included in the analysis for total duration for the reasons specified above.

Total duration. The first round of ANOVAs for the stop series included total consonant duration (closure duration + release duration) as the dependent variable to create a set of comparisons to Generation A. Consonant category (fortis, voiced fortis, and lenis) was the independent factor for each speaker's ANOVA. All speakers showed a significant effect of consonant category on total consonant duration: A1 (F[2, 241] = 471, $p < 0.001$); B1 (F[2, 204] = 480, $p < 0.001$); B2 (F[2, 208) = 365, $p < 0.001$); B3 (F[2, 183] = 283, $p < 0.001$); and C1 (F[2, 209) = 281, $p < 0.001$). Post-hoc Tukey's tests revealed that all speakers distinguished between each category when paired with another ($p < 0.001$). Mean total duration values are shown in Figure 1.

INSERT FIGURE 1 ABOUT HERE.

Closure duration. A second series of ANOVAs was implemented for the analysis using closure duration as the dependent variable. Speakers B1, B2, and C1 had effects of consonant category: B1 (F[2, 204] = 288, $p < 0.001$); B2 (F[2, 208) = 284, $p < 0.001$); and C1 (F[2, 209) = 165, $p < 0.001$) Post-hoc tests found differences between all three categories for these speakers

($p < 0.001$). B3 also had an effect of consonant category ($F[2, 183] = 136$, $p < 0.001$). Post-hoc testing revealed that while significant differences were made between lenis/fortis and lenis/voiced fortis pairs ($p < 0.001$), the difference between fortis/voiced fortis pairs was just beyond the level of significance ($p=0.07$) for B3. Speakers' mean closure duration values are presented in Figure 2.

INSERT FIGURE 2 ABOUT HERE.

Release. ANOVAs were submitted with the release duration as the dependent variable and the consonant categories as the independent variable. Main effects were found for all of the speakers: B1 ($F[2, 205] = 92$, $p < 0.001$); B2 ($F[2, 208) = 122$, $p < 0.001$); B3 ($F[2, 183) = 134$, $p < 0.001$); and C1 ($F[2, 209) = 85$, $p < 0.001$). All speakers in Generation B reliably differentiated the consonant categories with release duration ($p < 0.001$). C1 distinguished lenis/voiced fortis and lenis/fortis ($p < 0.001$), but had insignificant results for fortis/voiced fortis pairs. Mean release duration values are plotted in Figure 3.

INSERT FIGURE 3 ABOUT HERE.

Percent voiced. The final series of ANOVAs was submitted with the percent voiced data as the dependent variable. B1 and C1 had main effects of percent voiced (B1: $F[2, 204] = 92$, $p < 0.001$; C1 $F[2, 209] = 173$, $p < 0.001$) and produced reliable differences between all category comparisons ($p < 0.001$). While B2 also had an effect of percent voiced ($F[2, 208] = 322$, $p < 0.001$) and she voiced lenis/fortis and fortis/voiced fortis pairs differently ($p < 0.001$), there was no difference in her degree of voicing lenis and voiced fortis stops. B3's ANOVA returned significant ($F[2, 183] = 391$, $p < 0.001$); she voiced lenis/fortis and fortis/voiced fortis pairs significantly differently ($p < 0.001$), as well as lenis/voiced fortis categories ($p < 0.05$). Figure 4 presents the mean percent voiced values for the speakers.

INSERT FIGURE 4 ABOUT HERE.

Standard deviations were calculated for closure duration, release duration, and percent voiced. As standard deviation is a measure of the amount of variance in the data, a high standard deviation implies that a speaker did not produce a consonantal category with consistent closure duration. Standard deviation values for the release and percent voiced data did not vary much across speakers. Closure duration standard deviations, however, illustrated that the productions of C1 were much more variable as indicated in Table 3.

INSERT TABLE 3 ABOUT HERE.

4.4 Discussion.

The data presented above illustrates that all speakers of MLNP in Generations B and C are maintaining the contrasts between the lenis, voiced fortis, and fortis categories using a combination of phonetic features. Closure and release duration cue the difference between lenis and the fortis categories, while voicing distinguishes the fortis from the voiced fortis category. The contrast for Generation A appears to be distinguishable based on the total duration measure.

For C1, three additional facts need to be noted. Despite the overall maintenance of her consonant categories, there is a general increase in closure duration that distances her average value from that of other speakers, perhaps as an attempt to increase its distinctiveness compared to American English voiceless stops. Second, this expansion of the closure duration feature is accompanied by increased variation in production. Lastly, there is also the possible interpretation of both fortis categories as aspirated American English stops; the release duration values of C1's fortis and voiced fortis categories both lie above the threshold for the English voicing contrast. The distribution of the data does not indicate a categorical shift to the American English category, but rather suggests the approximation of the release gestures for the fortis and voiced fortis categories. These findings support the assertion made in Campbell and Muntzel (1989) in which the authors predict that variability in production increases as a function of the level of language obsolescence. C1, as the youngest speaker, has used MLNP less than other speakers of earlier generations. Yu (in press) had similar results with his data from Washo. The extant speakers maintain the phonological patterns of the deceased generation, but the categories were less distinct for the extant speakers. This trend suggests that, perhaps, ultimate generations of speakers of obsolescing languages may not necessarily lose contrasts, but exhibit increased subphonemic variation, causing the category boundaries to become less discrete due to decreased usage frequency.

This experiment illustrated the robustness of the categories for the three-way consonant contrast in MLNP and CDNP. While increased variation in consonant closure durations, expansion of the fortis closure duration, and approximation of fortis and voiced fortis release durations was found in the youngest speaker of the language the categories remained distinct.

This finding along with Yu (in press) suggests that increased subphonemic variation without neutralizing phonological contrasts is a symptom of language atrophy.

The next experiment investigates a change in the place of articulation for the sibilant in Generations B and C. I argue that this sibilant sound change is following a different path.

5 Investigation 2: Sibilants.

All dialects of Northern Paiute have a coronal sibilant. The place of articulation for this sibilant has been described in a variety of ways. Thornes (2003: 31) states that the place of articulation for the coronal sibilant in Oregon Northern Paiute is between the alveolum and the alveo-palatal region. He also describes a phonological rule in Northern Paiute whereby the fricative palatalizes in the context of [i] that reveals some variation between generations of speakers. For example, older speakers typically use [pişa] 'good, well', whereas younger speakers pronounce the same word [piʃa] (Thornes 2003: 39). According to Thornes, this division between younger and older speakers lies between the ages of 65 and 70 years of age.

Following Liljeblad (1966: 4), the sibilant can be articulated in several places by different parts of the tongue, ranging from apico-dental, apico-supra-dental, apico-alveo-dental, and lamino-pre-palatal. The apico-dental and apico-supra-dental tokens are recorded, however, only from bilingual Paiute-English speakers who use English as their everyday form of communication. Liljeblad continues to state that there is "no lamino-alveolar articulation in Northern Paiute as spoken by monolingual or, on the whole, elderly persons. Thus, there is an approximation but no strict phonetic equivalent to English [š]" (Liljeblad 1966: 5).

Interestingly, both linguists describe younger, bilingual speakers as producing the sibilant in ways that distinguish their production from older generations of speakers with younger speakers approximating English categories. Experiment 2 has two goals: the first goal is to determine the generational differences in the production of the sibilant, and the second goal is to understand the variable nature of the palatalization rule.

5.1 Methodology.

Since the question at hand was articulatory in nature, the appropriate method of investigation was static palatography. Static palatography involves the application of a black substance to a speaker's tongue. The speaker is instructed to produce a word that contains a single consonant involving the tongue as an active articulator. Then, a mirror designed for entry into the mouth is inserted into the oral cavity reflecting an image of where the tongue contacted the palate. A digital picture is taken to store the palate image for future analysis. Alternatively, linguagrams can be produced using a similar methodology. In linguagrams the palate is painted and the articulation is reflected on the tongue. During the production of a word, the black substance is transferred to the tongue from the palate. The consultant then sticks out his or her tongue and a photograph is taken.

The words used for this investigation are shown in (1)-(3). Speakers from Generation B produced each word once for the palatograms. The speaker from Generation C produced each word twice, as both linguagrams and palatograms were attained from her. These particular words were selected so as to determine the reflex of the sibilant palatalization rule discussed above – (1) and (3) evaluate this rule - and, (2) was selected as a means of determining the default place of articulation in MLNP.

(1) *pisa* 'good, well'

(2) *saa* 'fry, cook'

(3) *sii* 'a variety of wild onion'

Three consultants participated in this experiment, two individuals from Generation B: B1 and B2; and, the single individual from Generation C. The palatograms and linguagrams were taken by creating a mixture of four parts carbon powder to one part cocoa powder and enough olive oil to create a thick paint-like substance. The mixture was applied to either the tongue or the palate using a small brush. After the production of each word a picture was taken and the consultant washed out her mouth to prepare herself for the next token.

5.2 Results and analysis.

The palatography results for C1 illustrate that her default place of articulation for the MLNP sibilant is laminal dental, as shown in her production of *saa* in Figure 5. The laminal part of her tongue is making contact with the central incisor and the apex of the tongue is, presumably, braced against the bottom teeth. This is a common production of the American English /s/ (Shadle 1991, Dart 1991, Ladefoged and Maddieson 1997). It is evident from the results that C1 palatalizes her MLNP sibilant in the general environment of /i/. For both *sii* and *pisa* the tongue contacts the palate near the lateral incisor and curves inward. The linguagrams illustrate that in the palatalized contexts the tongue is deeply grooved. This is apparent from the strip down the middle of the tongue where there is no paint, typical of the production for American English /ʃ/ (Ladefoged and Maddieson 1997: 148-149).

INSERT FIGURE 5 ABOUT HERE.

For B2 we see the same articulation pattern for *saa* and *sii*. In these productions the tongue remains in contact with the palate until the canine. The tongue appears to curl in behind the alveolar ridge, but we see no evidence of apical lingual contact. We only find palatalization in *pisa*, and here we see lingual contact terminating at the first bicuspid. In the production of *pisa*, the width of contact is also greater.

INSERT FIGURE 6 ABOUT HERE.

In the palatograms attained from B1 lingual contact generally ends on the vicinity of the canine. This pattern holds for both *saa* and *sii*. On the left side of the image it appears the tongue made slight contact on the central incisor. In the palatalized environment, B1 creates lingual contact until the bicuspid. Also, as in the production of *pisa* for B2, the contact area is wider.

5.3 Discussion.

Articulatory descriptions of the productions of the sibilant by the older generation following the palatograms closely follows Liljeblad's description of the sound as a laminal pre-palatal. This place of articulation for the sibilants in Generation B is a palatalized alveolo-palatal fricative, akin to the Mandarin Chinese and Polish fricatives symbolized by the IPA symbol /ɕ/, but with a retroflexed tongue position. The palatalized version of this sound in MLNP following the high front vowel /i/ is a version of /ɕ/ with increased lingual contact and an articulation that is placed further back in the mouth. Conversely, C1's sibilants appear to be articulated as typical American English productions of /s/ and /ʃ/. Following Thornes (2003) and Liljeblad (1966), this is predicted for a speaker her age. As mentioned above, both Thornes and Liljeblad report younger speakers producing the sibilant in a place different from the place where it is produced by elders.

Hamann (2003: 94-106) describes a tendency for languages to avoid retroflexed consonants after /i/ for a combination of perceptual and production reasons. Acoustic cues for retroflexion are stronger in a VC sequence than in an CV sequence, but these stronger cues are masked by the difficulty in producing a high front vowel before a retroflexed segment. Retroflexion is articulatorily defined as a backed, bunched tongue, an articulatory position that results in an extremely low F2. A principal characteristic of the high front vowel is its extremely high F2. In order to facilitate articulation, the retroflex loses its bunched tongue position and palatalizes, approximating an articulatory position that will much more readily produce the high F2 of /i/. This common pattern motivates the palatalization of /ʂ/ in B1 and B2. Because C1 has shifted the sibilant place of articulation, these phonetic motivations no longer underlie her phonological rule. Instead, she is free to palatalize her sibilant in any /i/ environment. After consulting field recordings, it is clear that C1's sibilant productions after /i/ are not always palatalized. This falls nicely in line with data from her peer-group of Oregon Northern Paiute speakers. Thornes (personal communication) describes younger speakers who use Anglicized fricatives *occasionally* palatalizing in pre-/i/ environments.

It is important to note that this change causes no ill effect for the intelligibility of the language as no phonological contrast is neutralized. Such a change is rather common in contact-induced changes and is included in the Thomason and Kaufman (1988: 75) typology of contact induced structural effects. In cases of intense contact, phonological borrowing includes the phonemicization of allophonic alternations. C1 appears to be doing something similar; in her shift from /ʂ/ to /s/, she has adopted a phoneme from English to serve as her MLNP sibilant and she has further recruited the phoneme /ʃ/ from English to serve as the MLNP allophone. The maintenance of abstract phonological knowledge in the obsolescing language shown here with C1's allophony and Goodfellow's (2005) speakers' adherence to phonological rules applying to velars that have merged with underlying uvulars strongly contradicts theories stating last generations of speakers lose linguistic competence, although C1's allophony may be "incompetent" from a traditional point of view.

More importantly, what has been the path of this sound change? The conclusion must be speculative because of the lack of longitudinal data from C1, but it is conceivable that the American English sibilant was substituted for the Northern Paiute sibilant. It is highly implausible that this sound change occurred as the result of approximation from the traditional sibilant to the Americanized /s/. A more likely path to the change involves transfer where /s/ was incorporated into her MLNP system during a period of heavy English use or, perhaps, during her concurrent acquisition of the two languages as a child.

A strikingly similar place of articulation shift is described in Young (2007) for two Taiwanese Mandarin speakers. These two speakers are first generation Taiwanese-Americans who spoke little English until entering school. Young reports that the series of alveolo-palatals /tɕ^{h}/, /tɕ/, and /ɕ/ have shifted to /tʃ^{h}/, /tʃ/, and /ʃ/ in their speech, despite their exposure to the unadulterated Taiwanese Mandarin of their parents. The nearly identical findings reported in this paper suggest that fricatives, or at least palatalized fricatives, are more susceptible to inter-generational place of articulation shifts.

6 Conclusions.

This paper has examined sound change in Northern Paiute, a moribund indigenous language of North America. Experiment 1 investigated a three-way contrast lenis/fortis contrast across three generations of Northern Paiute speakers. While the contrast was maintained within the phonological systems of each individual, it was found that C1, the youngest speaker of language, had increased subphonemic variation as compared to older speakers.

The second experiment examined a shift in the place of articulation for the language's sibilant from a palatalized alveolo-palatal sibilant /ç/ to an American English alveolar fricative /s/ for the youngest speaker. In addition, a more palatalized allophone of the traditional sibilant was also lost by the youngest speaker and replaced with the American English /ʃ/. The articulatory leap from /ç/ to /s/ is analyzed as a categorical sound change as opposed to a change that occurred via a series of subtle imperceptible shifts. A sudden categorical shift in sibilants suggests that not all sound changes in obsolescing languages are the consummation of subphonemic variation resulting in the approximation of two sounds. The path a particular sound change takes may depend on the phonological system of the contact language. American English /s/ is minimally different from the Northern Paiute sibilant making a categorical shift in place of articulation possible. The descriptions of the substitution patterns for rhotics in Young Dyirbal (Schmidt 1985) and /ñ/, /¸c/, /ë/ in East Sutherland Gaelic (Dorian 1978) include the application of perceptually and articulatorily similar phonological categories from the local varieties of English to the obsolescing language. From the descriptions seen here, it can be generalized that when phonological categories in moribund and dominant languages are similar they may experience transfer-like sound changes.

Gradient sound changes do not follow the pattern described for transfer. In Northern Paiute, the unique three-way lenis/fortis contrast does not have an equal phonological counterpart in American English, perhaps deterring transfer from taking place. The three-way contrast can be viewed as a three-way distinction in the timing of the closure duration and vocal fold vibration. Subtle changes in these timing relationships result in the gradient expansion of the phonetic space the fortis category occupies for Generation C and the approximation of release duration in the fortis and voiced fortis categories. The looser category boundaries in singleton and geminate consonants in Washo reported by Yu (in press) and the decreased nasalization of phonemically nasalized vowels in East Sutherland Gaelic described by Dorian (1978) are also gradient changes caused by alternations in timing relationships. Changes in singleton and geminate consonant categories relate to closure duration timing like that of Northern Paiute. Modifications to the timing of the lowering of the velum in phonemically nasalized vowels result in vowels that are less nasalized. In these languages, changes in timing cause gradient subphonemic effects. It can be predicted that phonological categories in obsolescing languages that rely on specific timing relationships will experience approximation-like sound changes, not phoneme substitution.

Subsequent research will show how far the predictions about phonological similarity and timing relationships and their implications for sound change in moribund languages will go. Several questions regarding these predictions remain to be addressed. For example, how similar must the sounds in the moribund and dominant languages be in order to qualify for transfer of a phonological category? It is clear from the Northern Paiute data that in moribund languages gradient phonetic changes are not always precursors to categorical changes but are changes of a different type. Given the proper time course, the paths of these changes may, nevertheless, end with the same result: the merger of two phonological categories.

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Tables and figures

Subject	Date of birth	Dialect
A1	1876	Carson Desert Northern Paiute
B1	1921	Mono Lake Northern Paiute
B2	1925	Mono Lake Northern Paiute
B3	1932	Mono Lake Northern Paiute
C1	1953	Mono Lake Northern Paiute

Table 1: Subjects. The subjects' initials appear in the Subject column; Date of birth refers to the year the speaker was born; Dialect refers to the dialect of Northern Paiute the subject spoke or speaks.

	Bilabial	Alveolar	Post-alveolar	Velar	Labiovelar	Glottal
Plosive	p bb b	t dd d		k gg g	kw ggw *gw*	‘
Nasal	mm m	nn n		*ŋŋ ŋ*		
Fricative			s			h
Affricate		ts ddz dz				
Glide			j		w	

Table 2: Consonant Inventory of MLNP and CDNP. The sounds are presented in the community orthography. Those consonants in italics are sounds found only in CDNP at the exclusion of MLNP.

Closure duration standard deviations (in milliseconds)	
B1	44
B2	47
B3	36
C1	63

Table 3: Standard deviations of closure duration for speakers in Generations B and C.

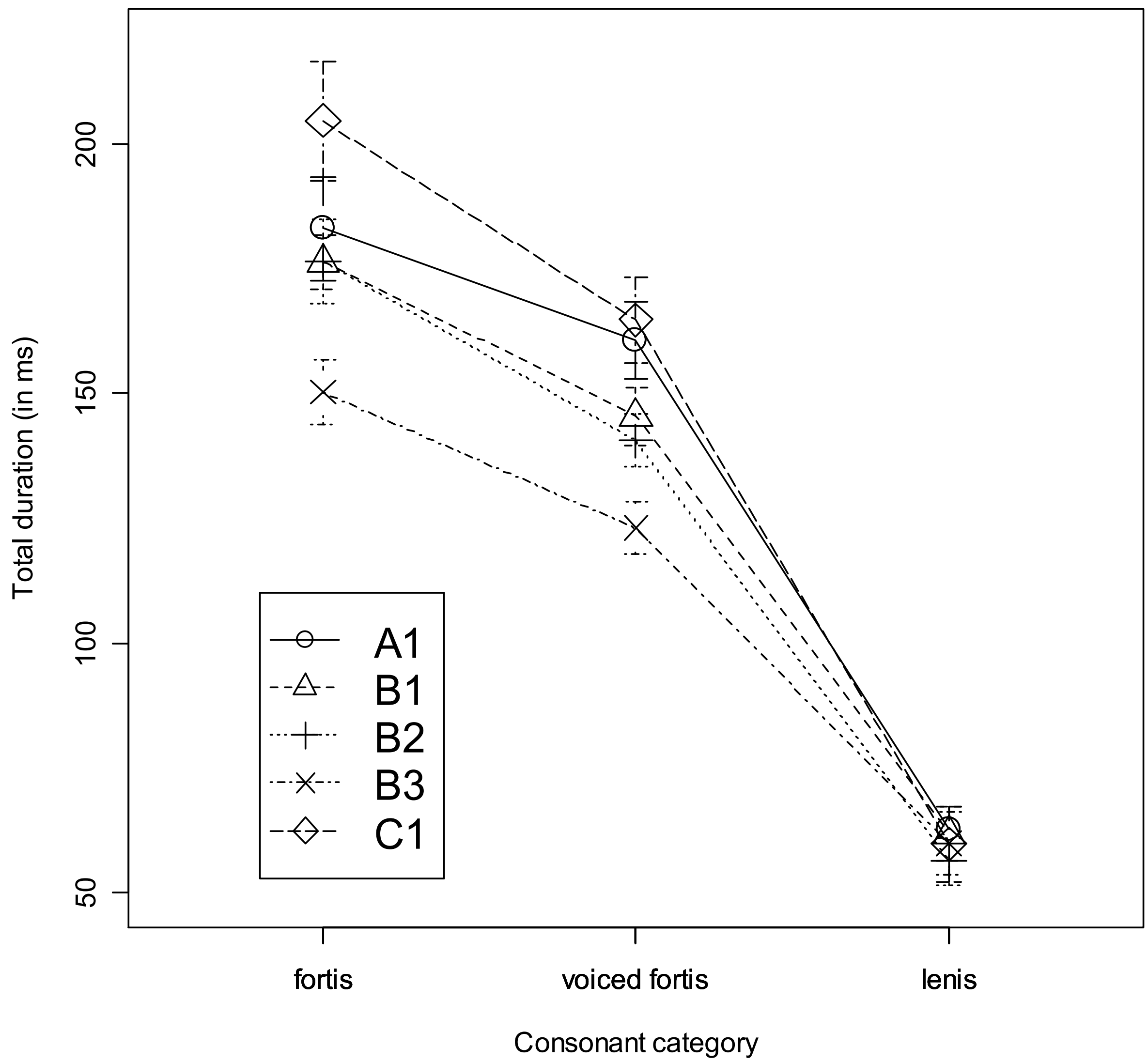

Figure 1: Mean total duration (closure + release) of stop consonants for Generations A, B, and C. The error bars represent a 95% confidence interval.

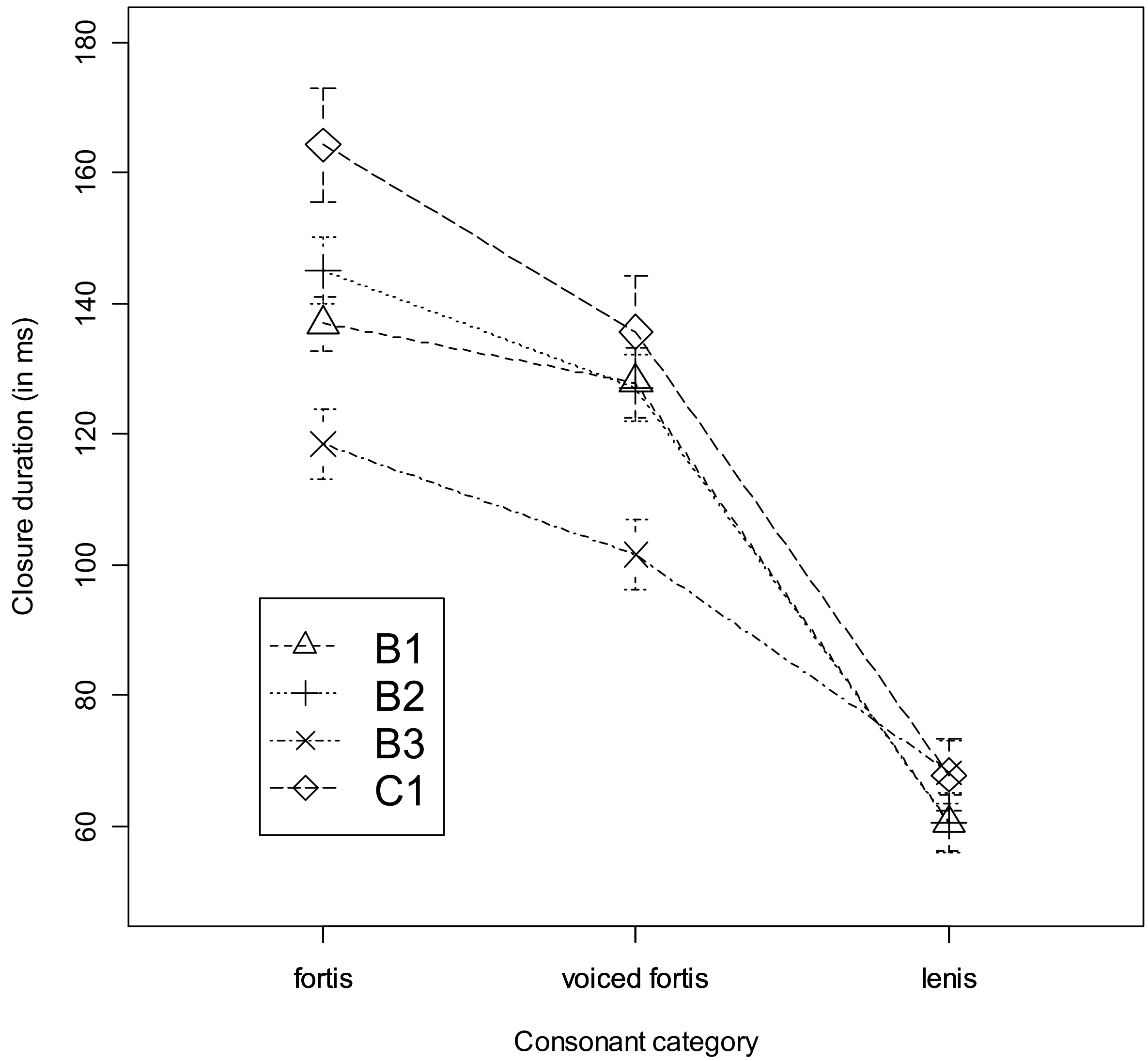

Figure 2: Mean closure duration of stop consonants for Generations B and C. The error bars represent a 95% confidence interval.

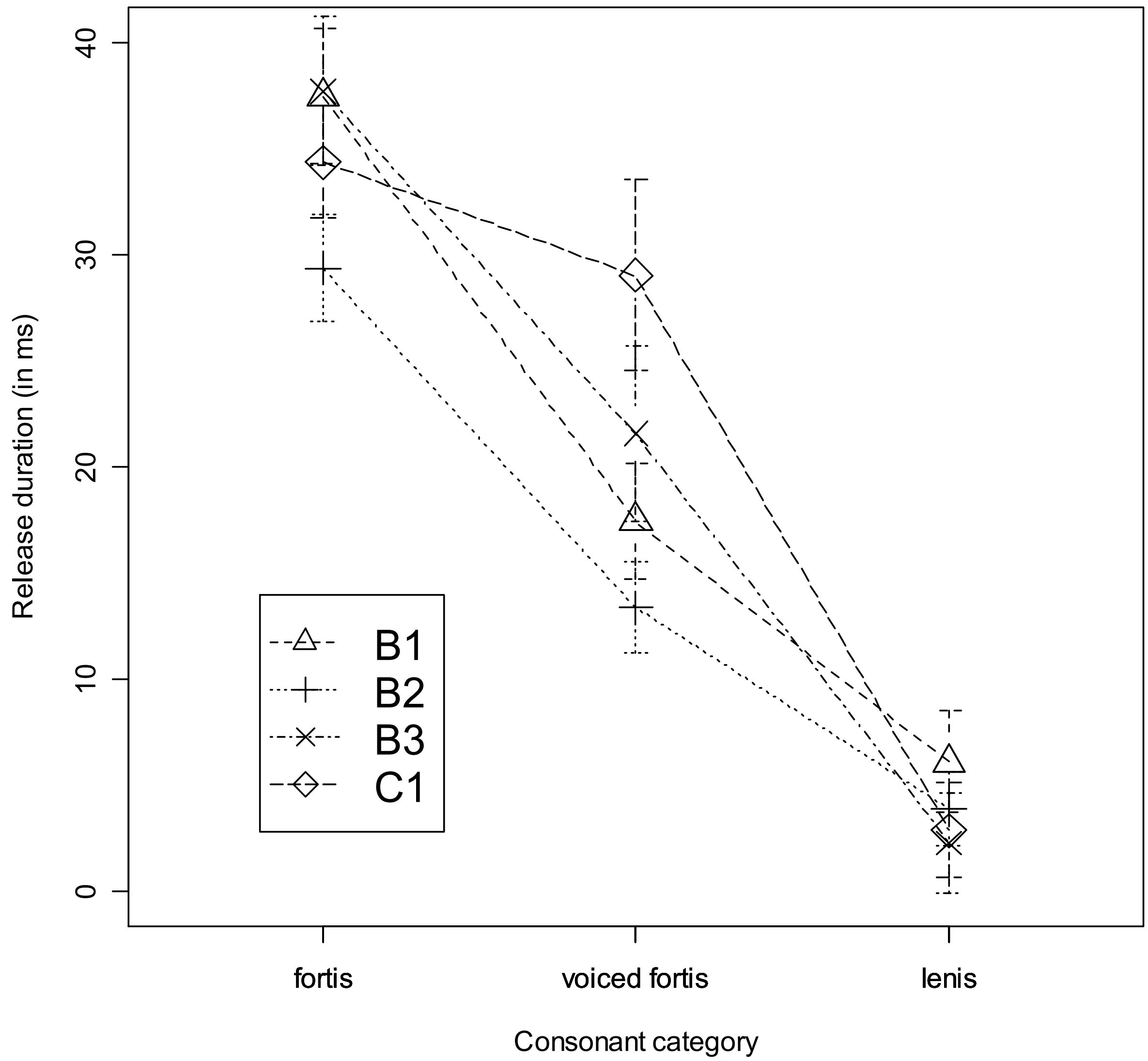

Figure 3: Mean release duration of stop consonants for Generations B and C. The error bars represent a 95% confidence interval.

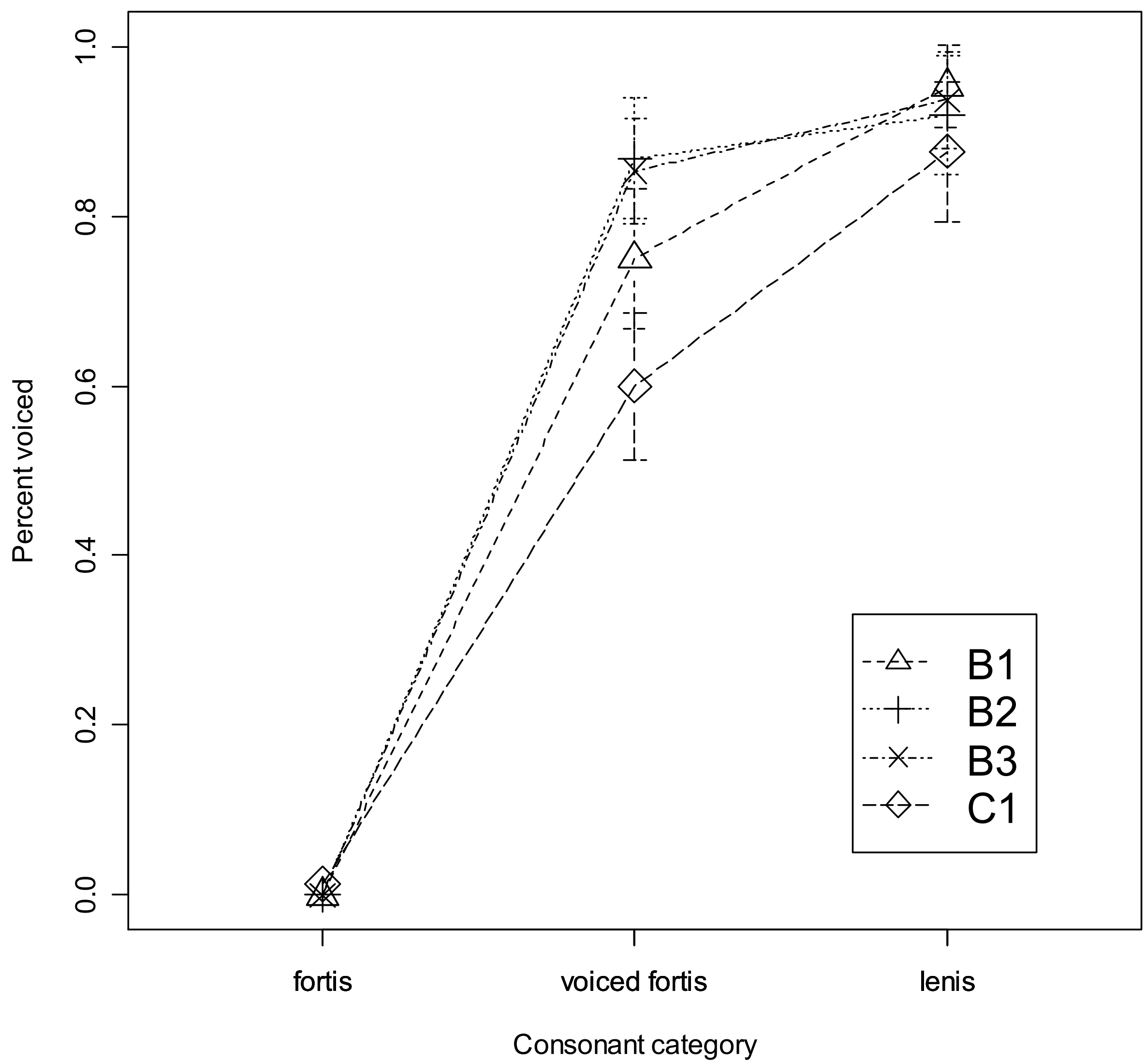

Figure 4: Mean percent voiced value of stop consonants for Generations B and C. The error bars represent a 95% confidence interval.

Figure 5: C1's linguagram for *pisa* (1), *saa* (2), and *sii* (3). The black substance on her tongue shows the part of the tongue that contacted her palate.

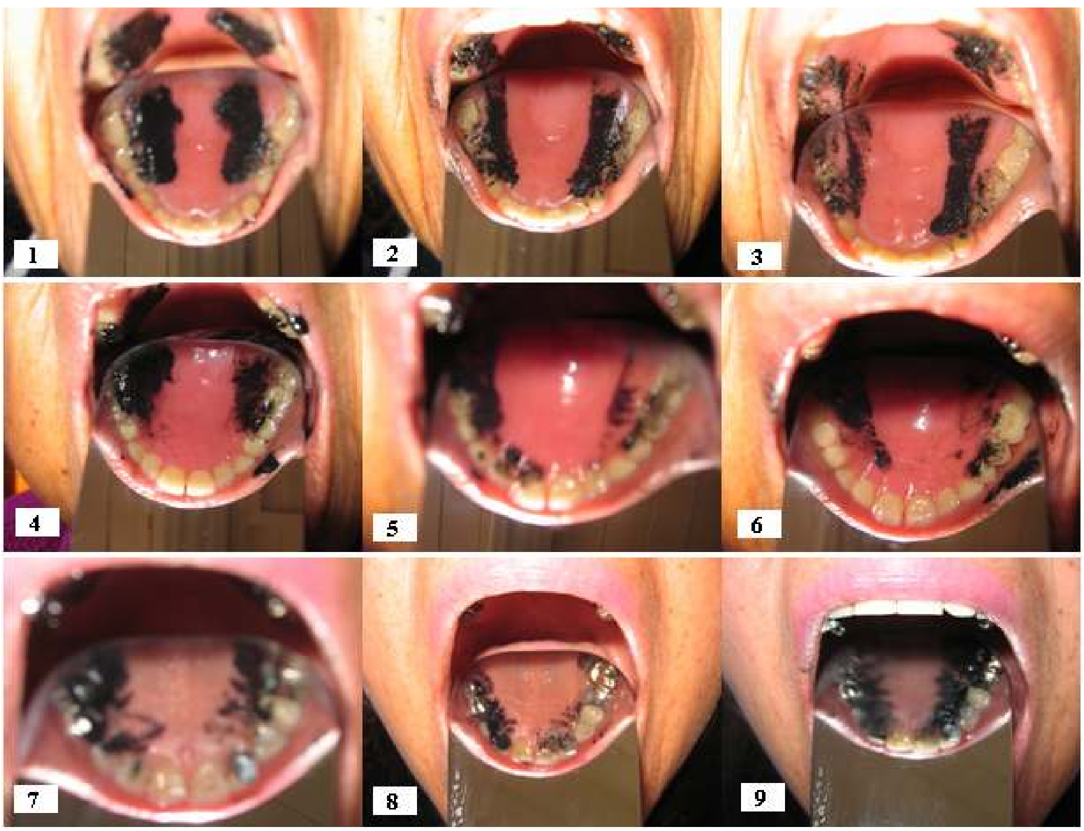

Figure 6: Palatograms. Top row: B2 *pisa* (1), *saa* (2), and *sii* (3); Middle row: B1 *pisa* (4), *saa* (5), and *sii* (6); and, Bottom row: C1 *pisa* (7), *saa* (8), and *sii* (9). The black substance on their palates demonstrates what part was contacted by their tongues.