NASALS AND NASALIZATION IN HINDI

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ABSTRACT

We assert that common diachronic phonological variation (sound change) arises from synchronic phonetic variation. To provide support for this view we sought evidence in Modern Hindi for the phonetic "seeds" of two sound changes posited in the history of Hindi and many other Indo-Aryan languages.

The first is the posited introduction of a nasal consonant between a *nasal vowel* and a *following voiced stop* (but *not* a following voiceless stop), e.g., Skt *čandra* "moon" > Old Hindi *čã:da* > Mod. Hindi [čãnd] (but cf. Skt *danta* "tooth" > Old Hindi *dã:ta* > Mod. Hindi [dãt]). Physiological and acoustic recordings of speakers of Hindi and of French showed that when pronouncing a sequence of a distinctively nasal vowel followed by a voiced stop in the next word, the voiced stop was often prenasalized. How such a nasal can be carved out of a voiced stop (but not a voiceless stop) can be explained by phonetic principles.

The second is so-called "spontaneous nasalization", i.e., the emergence of distinctively nasal vowels in words lacking an etymological nasal. E.g., Hindi [sãp] < Skt (Sanskrit) *sarpa*, "snake". Ohala and Amador (1981) hypothesized that high airflow segments such as voiceless fricatives or voiceless aspirated stops require a larger-than-normal glottal opening which may be partially assimilated by adjacent vowels (though still voiced). This slightly open glottis during voicing creates acoustic effects which mimic nasalization (without being physiologically nasal), e.g., increased bandwidth of the first formant. We tested this hypothesis by creating .3 sec long vowels by iterating single periods from the VC junctions in [sas] as well as from the oral vowels in [kat] and [lal] and asking listeners to judge the degree of nasalization. Although [sas] is demonstrably as oral as [lal], listeners judged the vowel made from the period adjacent to [s] to be more nasal than those from [lal].

Thus, phonetically-explainable variation has been shown in these cases to parallel sound change.

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INTRODUCTION

In this paper we pursue phonetic explanations for two somewhat puzzling patterns in the development of Modern Hindi (MH) from Middle Indo-Aryan (MIA). That phonetic explanations are possible is suggested by the fact that similar patterns or tendencies may be found in other completely different languages: in general, the only thing common to diverse languages is the physical apparatus for speech production and perception.

EPENTHETIC NASALS

The first pattern we consider involves apparent epenthetic nasals. MH words such as [dāt][1] "tooth vs [čānd] "moon" present an interesting asymmetry in their phonological history: in their development from MIA to Old Hindi (OH) and then to New IA both were subject to cluster simplification with compensatory lengthening and nasalization of the preceding vowel (Beames 1872, Misra 1967). Thus: Skt *danta* > MIA *danta* > OH *dā:ta* > MH [dāt]; Skt *čandra* > MIA *čanda* > OH *čā:da* > MH [čānd]. In the latter case the nasal consonant present in Sanskrit but then subsequently lost, re-appears in MH. Is it plausible that a nasal be re-introduced only before a voiced stop or should we re-think the historical derivation of such words? The primary evidence that the nasal was indeed lost by the time of OH is the fact of compensatory lengthening of the vowel which in numerous other instances correlates with simplification of medial consonant clusters or geminates, e.g., Skt *hasti* "elephant" > Prakrit *hatt^{h}i* > MH [hat^{h}i]; Skt *sarpa* "snake" > Prakrit *sappa* > MH [sāp]. Our aim is to marshall phonetic evidence in support of the scenario that a nasal consonant (N) could have been re-introduced preferentially between a nasalized vowel (V̄) and a voiced stop (D).

In previous papers (Ohala & Ohala 1991, in press) we attempted to show that a sequence of V̄ + D is often manifested phonetically as the sequence [V̄^{N}D], i.e., with a epenthetic nasal consonant homorganic to the stop. The stop, in other words, is prenasalized. Such an epenthetic nasal either fails to appear or is much shorter in duration in V̄ + T sequences. The evidence for this came primarily from traces of nasal pressure (via a nasal "olive") recorded during cross-word sequences in both MH and French of V̄ + D on the one hand versus V̄ + T sequences on the other. For example, in the French utterance "dit 'saint' bel enfant" the phrase /sā bɛ̃l/ was realized phonetically as [sā^{m}bɛ̃l] with a nasal segment on the order of 70 msec. This contrasts with the utterance "dit

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[1] The transcription of modern words is in IPA with the following exceptions: [a] = IPA [ɑ], [t, d] are dental, [č] = IPA [t$\int$]; [a] in MH is a phonologically long vowel although is not explicitly marked for length. Transcriptions for earlier forms are the conventional transliterations based on orthography.

'saint' pour moi" where the sequence /sã puɓ/ showed an intrusive nasal only 30 msec in duration. In the Hindi utterance /ap jəhã dek^{h}o/ 'you see here', the sequence /ã d/ was realized phonetically as [ã^{n}d] with an epenthetic nasal about 60 msec in duration. In contrast, in the utterance /ap jəhã tako/ 'you glance here', the sequence /ã t/ showed only a 30 msec intrusive nasal.

We argued that since the phonetic manifestations of the constituent words of the crucial sequences in these sentences do not show a nasal consonant, the nasals that do appear must be a purely phonetic event, a transitional element between the $\tilde{V}$ and the following stop. We offered the following reasons as to why a voiced stop but not a voiceless one could tolerate a nasal onset (Ohala & Ohala, in press):

> ... among the auditory cues for a voiced stop there must be a spectral and amplitude discontinuity with respect to neighboring sonorants (if any), low amplitude voicing during its closure, and termination in a burst; these requirements are still met even with velic leakage during the first part of the stop as long as the velic valve is closed just before the release and pressure is allowed to build up behind the closure. However, voiceless stops have less tolerance for such leakage because any nasal sound -- voiced or voiceless -- would undercut either their stop or their voiceless character.

We also cited similar patterns in other languages, both phonetic and phonological, as regards voiced stops' tolerance of a nasal onset (Yanagihara & Hyde 1966; Suen & Beddoes 1974; Roberts & Babcock 1975; Paradis 1988/89; Kawasaki 1981). Since then additional such evidence has come to our attention (Duez 1991, Aguilar Cuevas et al. 1991).

We posit that unintended, non-distinctive contextual phonetic variation can become intended and distinctive if subject to reinterpretation by listeners. This presumably is the mechanism underlying what Jakobson refers to as "phonologization". The plausibility of such a scenario underlying this type of sound change is reinforced by numerous laboratory studies (J. Ohala 1981, 1989).

Some question might remain, however, as to whether the epenthetic nasal that appears in word sandhi might differ from those appearing in internal sandhi in the development of MH words like [čãnd] < OH *čã:da*. In the present study, therefore, we sought to demonstrate that the epenthetic nasal could appear within a word.

Method

To show the emergence of a nasal onset to a voiced stop within

a word it is not possible to look for it in existing words where its presence seems rather to have a phonological, i.e., distinctive, function. We therefore looked for it in made-up words. We borrowed a word-blending technique used previously by Treiman (1983, 1986) and Derwing and Nearey (1991). We asked 5 male Hindi speakers to combine the CV of words like [pāč] "five" and the final -C of words like [sud] "proper name" to form the non-existing *[pād]. The subjects, who were non-linguists, were trained in this task by first presenting them with models of word blending which did not involve nasal vowels and then testing them on similar examples. The list of words to be so manipulated was presented orthographically via the traditional Devanagari script. The list was sometimes read twice, time and the subject's patience permitting. A variety of final -C's were included in the corpus, both voiced and voiceless. All but two of the CV-C blends yielded nonsense words with the exception of two of the blends involving final voiceless -C's.

We were interested in determining whether there was any acoustic evidence of an epenthetic nasal, i.e., a nasal onset to the voiced stop. Naturally, this would be a relatively brief phonetic event with potentially tenuous acoustic correlates. We therefore adopted the following criteria for the identification of such intrusive nasals. First, in order to say that a nasal consonant was present there should (a) be visual evidence in a spectrographic display of the utterance of the usual acoustic correlates of a nasal: a discontinuity in the amplitude and the spectrum of the signal (vis-a-vis the preceding vowel), and (b) be auditory evidence of the nasal consonant when the utterance is heard with the final stop release gated out. It is important to listen to a gated portion of the utterance since even phonetically trained ears have been known to "add" or subtract details to the percept of the speech signal by integrating elements from larger contexts. Second, in order to say that the nasal was intrusive and not phonological, it should be brief, i.e., shorter than a phonologically distinctive nasal consonant. Using the same speakers, we recorded instances of full nasals in words like [čānd] and found that such full (phonological) nasals typically had durations on the order of 90 - 100 msec (cf. also M. Ohala 1983).

Results

As mentioned, the acoustic speech signal is often ambiguous regarding presence or absence of a nasal onset to a voiced stop, especially as the transition between nasal to oral state is a gradual, not abrupt, one. Thus for many of the tokens recorded and analyzed we could not say definitively whether a nasal onset occurred or not. Also in some other tokens we found what would seem to be a full nasal by virtue of their relatively long duration (c. 100 msec). These almost invariably were found on the second reading of the list. Such a full nasal could arise either due to a phonological rule, i.e., a regular process operating on an