POST-NASAL DEVOICING IN TSWANA

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ABSTRACT

Tswana is traditionally described as having a process of post-nasal stop devoicing (/mba/ → [mpa]). If this description is accurate, then Tswana poses a challenge to views that neutralization processes should be articulatorily grounded. Airflow leakage through the nasal cavity should promote, not inhibit, voicing post-nasally. Zsiga *et al*. [1] performed an acoustic study of the speech of 6 Tswana speakers, and found no evidence of post-nasal devoicing. They conclude that, counter to the traditional descriptions, Tswana does not have post-nasal devoicing. In an independent study, we collected speech samples from 12 Tswana speakers. Four of our speakers showed clear and consistent post-nasal devoicing. In this paper, we present the data for these 4 speakers to show that at least some speakers of Tswana do have an active process of post-nasal devoicing. We also consider possible explanations for this process, arguing that it is motivated by perceptual rather than articulatory considerations.

Keywords: Post-nasal devoicing, Tswana.

1. INTRODUCTION

Tswana is traditionally described as having a process of post-nasal stop devoicing: [re botsa] 'ask us' vs. [m potsa] 'ask me' [2]. This description is aerodynamically problematic – in [nasal+stop]-sequences, complete velic closure is not achieved before stop articulation has started, and nasal airflow leakage during stop articulation should promote, not inhibit, voicing. This led Pater [3] to propose that there is a constraint against [nasal+voiceless stop]-sequences (*NC̥), but not against [nasal+voiced stop]-sequences (*ND). Of course, if Tswana does have post-nasal devoicing, the claimed non-existence of *ND is a problem: What motivates the devoicing if not *ND? For this reason, Hyman [4] argues that *ND does exist. Zsiga *et al*. [1] suggest a different solution. They acoustically analyzed speech from 6 Tswana speakers, and found no evidence of post-nasal devoicing. They conclude that the descriptions of Tswana as having post-nasal devoicing are inaccurate, and that *ND is not necessary after all.

In an independent study, we collected speech from 12 Tswana speakers. Like Zsiga *et al*., we found a fair amount of variation. Most of our speakers show no evidence of devoicing, and have voiced stops both post-nasally and inter-vocalically. Other speakers have voiced stops post-nasally, which they lenite to fricatives inter-vocalically. However, unlike Zsiga *et al*., we have 4 speakers with clear, and consistent post-nasal stop devoicing.

	'ask us'	'ask me'
Voiced everywhere:	[re botsa]	[m botsa]
Leniters:	[re βotsa]	[m botsa]
Devoicers:	[re botsa]	[m potsa]

Zsiga *et al*.'s conclusion that Tswana lacks post-nasal devoicing might be premature. Their speaker sample might have accidentally excluded devoicers, or the dialect that they studied lacks this process. In the rest of this paper, we report on the 4 speakers from our study with post-nasal devoicing. We present the acoustic evidence, and consider possible explanations for this process, suggesting a perceptual rather than articulatory motivation.

2. BACKGROUND ON TSWANA

Tswana has phonemically voiced stops only at the labial place, and we therefore focus on the labials here. Tswana has a number of prefixes that end with a nasal. Since Tswana does not allow codas, these nasals are realized syllabically when the prefixes attach to consonant-initial stems. The relevant prefixes mark Class 9 and 10 nouns, and the 1st SG OBJ agreement marker attached to verbs.

Class 9 noun:	[m̩.pa]	'stomach'
Class 10 noun:	[di.m̩.pa]	'stomachs'
1st SG OBJ marker:	[m̩.po.tsa]	'ask me'

When any of these prefixes attaches to a noun or verb stem that start with a voiced stop, the stop devoices according to traditional descriptions of Tswana grammar. The devoicing is clear when comparing a verb with a first person plural as opposed to first person singular object prefix.

1st PL OBJ marker:	[re.bo.tsa]	'ask us'
1st SG OBJ marker:	[m̩.po.tsa]	'ask me'

3. DESIGN OF EXPERIMENT

3.1. Token selection

We selected 5 Tswana verbs that start with /p/ and /b/, respectively. Each of these verbs was embedded in a sentence with a 1st SG OBJ marker, and in an identical sentence with a PL OBJ marker.

SG:	Bana	ba a	m	pitsa
	children	they are	1st SG-OBJ	call
	'The children are calling me.'			
PL:	Bana	ba a	re	bitsa
	children	they are	1st PL-OBJ	call
	'The children are calling us.'			

We also selected 10 /p/ and 10 /b/ initial non-words, and embedded them in similar sentences.

3.2. Procedure

Stimuli consisted of two sentences. Sentence A contained either a SG or PL OBJ marker. Sentence B was identical to A, except that the OBJ marker and the verb were left blank. Subjects had to read A as it was written, and then read B with the same verb but with the opposite OBJ number as A.

A. Bana ba a rebitsa.
B. Bana ba a _____.

In this example, subjects would first read A: *Bana ba a rebitsa*. Since A had the PL OBJ marker, subjects then read B with the SG OBJ marker: *Bana ba a mpitsa*. This design controls for the influence of orthography. Tswana marks devoicing in its spelling. If this sentence was written with a SG OBJ, it would be written with a *p*: *Bana ba a mpitsa*. By requiring subjects to form, rather than just read, the verb with the SG OBJ marker, we control for the possibility that subjects pronounce a voiceless stop simply since that corresponds to the spelling. (See §4.1.2 for more.)

Each token was inserted in two sentence pairs – with the SG OBJ in the A and B position, respectively, and presented in a semi-random order.

3.3. Subjects

Subjects were adult L1 Tswana speakers, affiliated with the North-West University, Potchefstroom, South Africa. We collected data from 12 subjects, but we report here only on the 4 subjects that showed clear evidence of post-nasal devoicing.

3.4. Analysis

Stimuli were analyzed in *Praat*. For each token, we determined whether it has a release burst. If not, the token was classified as [β], and excluded from analysis. Only 1 token was excluded for this reason. For the remaining tokens, we measured the duration of the following intervals: (i) consonant closure, (ii) initial voicing (voicing bleed from the preceding nasal/vowel into closure), (iii) final voicing (voicing before closure release, usually equal to initial voicing in [b]), (iv) VOT. Following Hayes and Stivers [5], we assume that a stop will be perceived as voiced if more than half of its closure is voiced. Tokens with more than 50% closure voicing were thus classified as [b], even if the period just before the release was voiceless, and VOT hence positive. We therefore employ a stricter than usual definition of a voiceless stop, so that we use a very conservative test of the claim that post-nasal devoicing is observed in the speech of our subjects. Figures 1 and 2 give examples of tokens that were classified as [b] and [p] respectively, and also show the different measurements that we made (cf. audio file 1 and 2 for corresponding recordings.)

Figure 1: Spectrogram of [rebi]

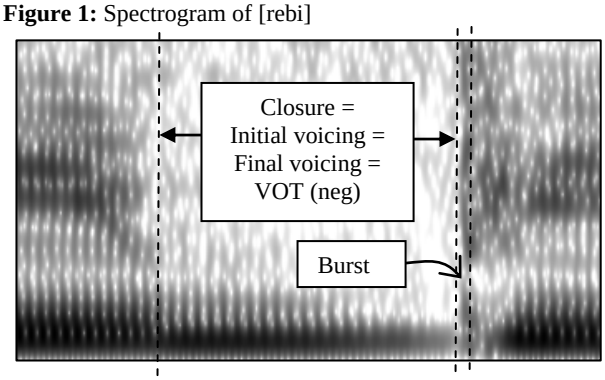
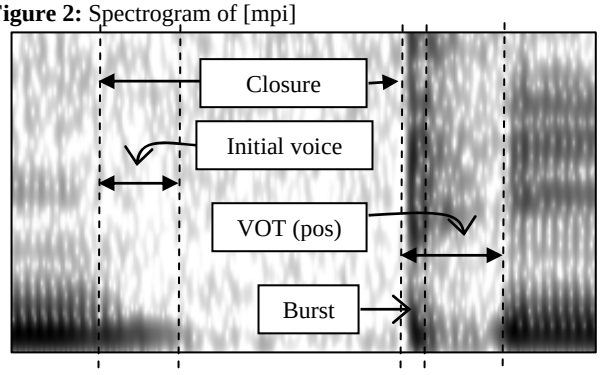


Figure 2: Spectrogram of [mpi]



4. RESULTS

4.1. Words

4.1.1. Basic results

Table 1 gives mean values calculated over all four subjects for the real word stimuli. The first column

shows the underlying form and the second column the output predicted by traditional descriptions of Tswana grammar. The final column shows the percent tokens classified as [b] according to the guidelines explained in §3.4 above.

Table 1: Results for real words (ms)

		Closure	Initial Voi	% Voi	VOT	% [b]
/re+bV/	[re.bV]	87	82	94	-82	97
/m+bV/	[m.pV]	87	27	31	22	1
/re+pV/	[re.pV]	120	44	37	10	16
/m+pV/	[m.pV]	88	26	33	18	3

Except for the closure duration, /m+bV/-tokens pattern like voiceless rather than voiced stops. In fact, the contrast between /m+bV/ and /re+bV/ is significant in % voicing ($t(8) = 28.9$, $p < .001$) and VOT ($t(8) = 17.0$, $p < .001$) (all statistics are two-tailed, and by item). On the other hand, /m+bV/ does not differ significantly from /re+pV/ on % voicing ($t(8) = 1.2$, $p = .28$). /m+bV/ does differ from /re+pV/ on VOT ($t(8) = 2.4$, $p < .05$), but /m+bV/ has a higher VOT than /re+pV/, and is hence less voiced if anything than /re+pV/. It is clear that these four Tswana speakers do devoice voiced stops in post-nasal position.

4.1.2. Influence of orthography

As explained earlier, devoicing is indicated in Tswana spelling. With the 1st PL OBJ marker, the verb *botsa* 'to ask' is written as *rebotsa*, but with the 1st SG OBJ marker, it is written as *mpotsa*. It is hence possible that our subjects do not have a phonological rule of post-nasal devoicing, but rather that they simply read accurately – i.e. they pronounce [p] whenever they see the letter *p*. Our stimulus design allows us to test for this possibility. Stimulus presentation was done in sentence pairs, with only Sentence A fully specified. Sentence B lacked the OBJ marker and verb. Subjects read A as written, and then read B, supplying the OBJ marker and verb. The verb had to be the same verb as in A, but the OBJ marker had to be of the opposite number – i.e. SG if A had the PL and *vice versa*. For each subject, there are then recordings of *mpotsa* in two contexts – one where *mpotsa* was used in Sentence A and was actually seen by the subjects, and one where *mpotsa* was in the B position so that subjects did not see the form written. If the devoicing that we observed is the result of orthography, then it should be less likely when *mpotsa* occurred in Sentence B. Table 2 gives the mean values of /m+bV/-tokens, divided into A and B occurrences. For comparison, we also include the results for the other token types. Table 2 shows that the A and B recordings of /m+bV/ differed equally from /re+bV/, and both were quite similar to /re+pV/. Statistical analyses show that the A and B utterances of /m+bV/ do not differ in initial voicing ($t(8) = 1.6$, $p = .15$), or VOT ($t(8) = 0.6$, $p = .55$). They do differ on % closure voicing ($t(8) = 3.8$, $p < .01$), but the A recordings had more voicing than the B recordings. So, if anything the subjects devoiced less when they actually saw *mpotsa*. Devoicing cannot simply be the result of the orthography of Tswana.

Table 2: Results (ms) for /m+bV/ real words, divided into Sentence A and Sentence B tokens

	Sentence	Closure	Initial Voi	% Voi	VOT	% [b]
/m+bV/	A	83	28	35	21	0
/m+bV/	B	91	25	28	24	3
/re+bV/	A and B	87	82	94	-82	97
/m+pV/	A and B	88	26	33	18	3
/re+pV/	A and B	120	44	37	10	16

4.2. Non-words

Section §4.1 provides clear evidence that /b/-initial verbs are pronounced with a [p] after the 1st SG OBJ marker. However, the results do not show that post-nasal devoicing is a productive phonological process for the 4 speakers in our study. It is possible that these speakers have learned these verbs as exceptions, and that they store the [m+p]-versions as such in their mental lexicons – similar to exceptional plurals like *mice* in English. To show that the phonological grammars of these speakers contain a rule of post-nasal devoicing, we must show that such a rule applies to non-learned forms. With this in mind, we also used non-words that begin on /b/ in our experiment. Specifically, our stimulus list contained sentence pairs where Sentence A had the PL OBJ marker followed by a non-word written with the letter *b*. As before, the OBJ marker and verb was left out of Sentence B, and subjects had to provide these. In these sentence pairs, they therefore had to change the PL OBJ marker to the SG marker, and then use the non-word from Sentence A as verb. If their phonological grammars contain a productive rule of post-nasal devoicing, they should pronounce the non-words in Sentence B with a voiceless stop.

Table 3 contains the results for the Sentence B utterances of these tokens. For comparison, it also includes the real word data for /m+bV/ and

/re+bV/. The non-word /m+bV/-tokens show more voicing bleed, more closure voicing, and shorter VOT than the real word /m+bV/-tokens. However, the non-word /m+bV/-tokens are clearly still overwhelmingly voiceless, and different from /re+bV/. In fact, the non-word /m+bV/-tokens differ from the /re+bV/-tokens on voicing bleed ($t(13) = 14.1$, $p < .001$), % closure voicing ($t(13) = 11.8$, $p < .001$), and VOT ($t(13) = 12.0$, $p < .001$).

Table 3: Results (ms) for /m+bV/ non-words

	Word?	Closure	Initial Voi	% Voi	VOT	% [b]
/m+bV/	Non	91	34	41	11	16
/m+bV/	Word	87	27	31	22	1
/re+bV/	Word	87	82	94	-82	97

5. SUMMARY AND CONCLUSION

Unlike Zsiga *et al*., we found clear evidence of post-nasal devoicing for one third of our subjects. We also found that this process applies when subjects are not led to the voiceless pronunciation by orthography, and even to non-words. We therefore have to conclude that at least some Tswana speakers do have a productive process of post-nasal devoicing. There are at least two reasons for the difference between our results and those of Zsiga *et al*. It is clear that not all Tswana speakers have this process. Since Zsiga *et al*. collected data from only 6 speakers their sample might have accidentally excluded devoicers. The difference might also reflect dialectal differences. They collected data in central Botswana from the northern Tswana dialect region. Our data was collected in Potchefstroom, South Africa, and represent mostly the southern dialect region.

Having established that post-nasal devoicing is part of the phonological grammar of our 4 Tswana speakers, we need to consider the implications that this has for phonological theory in general. As explained in the introduction, voicing rather than devoicing is expected in post-nasal position. In terms of articulation, post-nasal devoicing is hence not a natural/phonetically grounded process, and it potentially challenges views that phonology should be phonetically grounded. We see at least two possible responses to this: (i) It is possible that not all phonological processes are phonetically grounded, and that Tswana just has an unnatural process. Hyman [4] takes this route, suggesting an historical explanation for this unnatural process in Tswana. (ii) It is also possible that Tswana post-nasal devoicing is phonetically motivated, but that the motivation is perceptual and not articulatory. In [nasal+voiced stop]-sequences, the stop portion is typically very short [5], and in fact it can be so short as to be virtually absent. Beddor and Onsuwan [6] have shown that listeners can detect the presence of very short post-nasal stop closures. However, they did find a decrease in perceptual accuracy as the stop duration decreased. Post-nasal devoicing with the concomitant stop closure lengthening might therefore be a perceptual enhancement strategy. A [nasal+voiced stop]-sequence is also more likely than a [nasal+voiceless stop]-sequence to be perceived as a prenasalized stop. This might be another motivation for the post-nasal devoicing. There is always a morpheme boundary between the nasal and stop in [nasal+stop]-sequences in Tswana. This morphological boundary is aligned with a corresponding syllable boundary – the nasal is realized as its own syllable. If the [nasal+stop]-sequence were misperceived as a prenasalized stop, this syllabic separation between the morphemes would be lost.

Whatever the motivation for this process, it is clear that post-nasal devoicing does happen in the speech of some Tswana speakers, and that the relationship between articulatory grounding and phonology is hence not a simple one. From the large amount of inter-speaker variation on this phenomenon, it is also clear that it is not a stable process and that it might in fact be on its way out. This might well be because the process is not articulatorily grounded.

6. REFERENCES

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