

On the Nature of Schwa-like Vocalic Elements within some Berber Clusters

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Abstract

In Tashlhiyt Berber, phonetic implementation creates what looks like a schwa vowel but in fact is not, at least of the phonological sort. We present various arguments against the interpretation of these elements as epenthetic segments introduced by the phonological component. In addition to the fact that they do not interact with phonology, our acoustic and articulatory data suggest that these schwa-like elements do not have their own time slot and are not associated with a specific articulatory target. The presence of these vocoids is claimed to be related to the amount of overlap and the voicing specifications of adjacent consonants.

1 Introduction

Tashlhiyt Berber has three vowels at the underlying level /a, i, u/, and particularly long consonantal sequences. At the phonetic level, a schwa-like vocoid may sometimes surface within some consonantal clusters. This is the case, for instance, of the underlying form /t-gnu/ “she sewed”, which may surface as [t@g@nu] as shown in figure 1 (hereafter the schwa-like element is transcribed [@]).

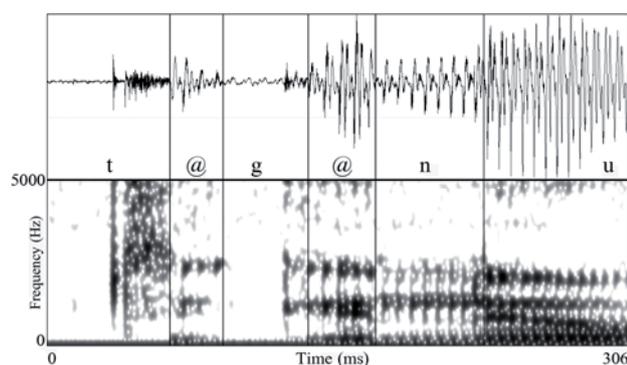


Figure 1: Realization of /t-gnu/ “she sewed” as [t@g@nu]

Where do these schwa-like elements come from? Do they result from a vowel epenthesis process, or do they derive acoustically from a specific coordination

between adjacent consonants? The first interpretation is advocated by [1], who argues that these are epenthetic schwa vowels introduced by phonological component to repair the syllable structure of Tashlhiyt. These schwas are thus claimed to be syllable nuclei. To account for the fact that these ‘epenthetic’ schwas do not always surface, Coleman states that they are sometimes overlapped or “hidden” by the surrounding consonants. The second interpretation posits that these vocalic elements are mere transitional vocoids which do not play any role in syllable structure ([2, 3]). In this view, the schwa-like elements may arise from the coordination of the consonants in the sequences, showing a misalignment between the laryngeal and oral gestures in the sequence and a reduced amount of overlap. Such a proposal has been advocated to explain excrescent schwas occurring in Moroccan Arabic ([4]) or in the production of non-native (illegal) clusters by English speakers ([5]).

Though both “schwas” (resulting from phonological insertion or from coordination) are often labeled ‘epenthetic’, it is important to draw a clear distinction between the two. In our view, a schwa vowel resulting from phonological epenthesis is a vocoid which meets the following conditions (see also [6]):

1. It is a segment which can be manipulated by phonological grammar,
2. It can act as a syllable peak,
3. It has its own temporal specifications and articulatory gesture.

Two arguments are provided in [3] as evidence that the schwa-like elements under study here do not pattern as independent segments in the phonology of Tashlhiyt, and that the syllable structure does not refer to them (see also [2]). The first argument, based on versification, shows that CC sequences (e.g. [ts] in [ts.wit] “you drunk”) are treated in Tashlhiyt poetry as light syllables, in which the second consonant is a nucleus and not a coda. This is true even in CC

sequences containing a vowel-like element in the acoustic record (e.g. [t@r.wit] “you mixed”). The second argument, based on the behaviour of dental stops vis-à-vis the process of assibilation, provides direct evidence that two consonants not separated at the underlying level by one of the full vowels /a, i, u/ are adjacent at the surface. This adjacency is not affected by the occurrence of these schwa-like elements. Moreover, in [7] we have shown that the occurrence of these schwa-like elements was not conditioned by the syllabicity of the following consonant: they do not occur more frequently before syllabic consonants compared to onsets or codas.

In the present paper, we provide additional arguments to show that schwa-like elements which are sometimes visible in the acoustic record are transitional vocoids. They do not have their own temporal specifications and there is no specific articulatory gesture associated with them. These arguments are drawn from acoustic, EPG, and ultrasound data.

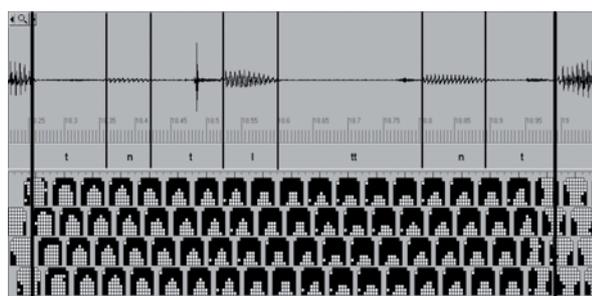


Figure 2: *Acoustic waveform and EPG linguopalatal profiles during the homorganic word [tnltnt] “you hid them (fem.)”. The four lines show the electrodes contacted (i.e. black squares).*

Before presenting the results obtained, it is of interest to specify two conditions where those vocoids never occur. The first context is within voiceless consonant sequences (see [3]). The second context is within a homorganic cluster with unreleased consonants. This finding is obtained based on EPG data recorded by two subjects while producing what one might call ‘homorganic words’, i.e. words composed of coronal consonants only, such as [n.tl] “hide, imp.”, [tn.tl] “she hid”, [tn.tlt] “you hid”, [tn.tlt.tnt] “you hid them (fem.)”. This last form is illustrated in figure 2, and shows that the entire form is produced with one prolonged complete closure. Even

if the consonants in these clusters are coordinated such that they do not overlap, the movement of the tongue from /t/ to /n/ or from /l/ to /t/ will not result in a vocalic element, since the tongue is never pulled away from the alveolar ridge (see a similar discussion in [4] for Moroccan Arabic).

2 Temporal specifications

It is reasonable to hypothesize that if the schwa-like element were a segment, one might expect that it would have a specific time slot, and thus would add some duration to the CC sequence where it is realized. To test this, we examined the acoustic material of an earlier EPG experiment (see [7]). The material consisted of 18 consonant sequences of the shape C1C2C3(V), embedded in the following carrier sentence [innajam ... bahra] “he told you ... a lot”. The consonant C2 was placed in three different positions within the syllable (nucleus, coda, onset) by manipulating the degree of sonority of C1 (/t/ “3rd person feminine singular” and /n/ “1st person plural”) and the presence (or absence) of a vowel after C3. The material was recorded by one native speaker of Tashlhiyt (the second author) and each item was repeated 12 times. Two types of measurements were conducted: duration of C1C2 sequences according to the presence/absence of [a] within the sequence, and duration of [a]. What we counted as schwa-like vocalic element were occurrences showing a portion of the acoustic signal containing voicing and a formant structure at the transition between the flanking consonants (see figure 1).

Out of the 214 C1C2 sequences examined, 73% display a visible vocalic element in the acoustic record, and 25% are consonant-only (note that 2% of the data were excluded from analysis because of the difficulty of determining whether a vocoid was present or not). A logistic regression was used to test whether the occurrence of a schwa-like element could be predicted by the total duration of the cluster (from C1 onset to C2 release). Results show that it was not ($\beta=20,79$ $z=.019$, $p|z|=9$). Indeed, the averaged duration of the C1C2 sequences did not differ according to the presence or not of this vocalic element, with a mean duration of 160 ms ($\sigma=20$ ms) for the tokens realized [C1@C2] and 161 ms ($\sigma=20$ ms) for the tokens realized [C1C2].

Moreover, the duration of the C1C2 sequences was not correlated with the duration of the vocalic element

($r^2=.001$, $p=.6$). This clearly shows that the observed vocalic element does not add duration to the CC sequence as would be expected if it were an epenthesized vowel.

3 A specific articulatory gesture?

Underlying or inserted schwa vowels described in other languages are reported to have their own articulatory target, as opposed to transitional vowel-like elements accounted for by coordination specification between adjacent consonants ([8, 9, 10]). What about the vocalic element appearing in the surface form of CC in Tashlhiyt? Does it have a specific articulatory target associated with it? This question is addressed in a pilot study using ultrasound imaging of the tongue (Mindray DP 600, with head fixed relative to probe) during the production of three types of sequences:

- (a) /tg/ sequences often displaying a vocalic element ([t@g]), in the words /tgra/, /tgri/, /tgnu/
- (b) /tk/ sequences never displaying a vocalic element, in the words /tkra/, /tkti/, /tknu/
- (c) artificially produced CVC sequences containing a full schwa vowel: /təgra/, /təgti/, /təgnu/ produced here in an Arabic carrier sentence.

These sequences were produced 5 to 10 times by the second author. A three-way comparison was conducted between the 3 types of sequences according to the following hypotheses: if the schwa-like element is a transitional element with no specific articulatory target, then the tongue shapes in [t@g] should be more similar to those produced for [tk], than for [təg]. If, on the other, this element is an epenthesized schwa, the tongue shapes in [t@g] should be more similar to those produced for [təg], than for [tk].

For this preliminary study, the successive tongue shapes (processed with Edgetrack and Surface [<http://speech.umaryland.edu/software>]) displayed between the onset of C1 and the release of C2 were analyzed qualitatively according to 3 dimensions: (i) tongue height in /t/ (ii) tongue height in /k/, and (iii) arching of the tongue.

Though some amount of variability is observed between repetitions, some interesting differences are observed between the tongue configurations for [t@g] and [tk] on the one hand, and for [təg] on the other hand. Selected illustrative examples are displayed in figure 3. When looking at the first tongue contour in time (corresponding to the onset of /t/), it appears that

the tongue is higher for [t@g] and [tk] compared to [təg]. When looking at the tongue contours near or at the velar closure, we also observe that [t@g] and [tk] pattern together with a higher tongue body position, compared to [təg] (though all showing a full velar closure). When looking at all the successive tongue shapes, from the first to the last (or close to last) frames, the tongue is more arched (less flat) for [tk] and [t@g] compared to [təg].

The differences observed between [tk] and [təg] could be explained in the following way. In [tk], where the two consonants are adjacent, the second velar consonant could be responsible for the anticipatory raising of the tongue from the onset of /t/. On the other hand, in [təg], the presence of an intervening low lingual target for the schwa between the consonants could explain the lower tongue position during the /t/ and a flatter tongue configuration over the whole sequence. The test sequences produced with a schwa-like element, [t@g], display tongue shape changes which are more similar to those produced for [tk]. Although these observations have to be considered as preliminary, we are tempted to take them as evidence that there is no intervening low vowel target between the alveolar and velar consonants in [t@g] clusters. Interestingly, our observations are consistent with the results obtained by [5] who showed, for English speakers, that excrecent vocoids in the production of foreign clusters do not affect the shape of tongue body the way underlying English schwa does.

4 Discussion & Conclusion

The arguments presented here support the view that the schwa-like elements that are sometimes visible in the acoustic output of some Tashlhiyt clusters should not be considered as segments introduced by phonological component. These results complement the arguments developed in [3] and show that [ə] is a phonetic-level phenomenon of no structural relevance. In [7], we observed the distribution of these vocoids relative to the syllable structure of various consonantal sequences. Our results suggested that rather than being influenced by the syllabicity of the following consonant, the occurrence of this element is conditioned by the voicing of the consonants in the sequence: it occurs when at least one of the consonants in the sequence is voiced; and it almost

always occurs when the two consonants are voiced. An index of overlap between C1-C2 and C2-C3 in forms such as /tgnu/ was also measured in [7], as the overlap between the alveolar and velar linguopalatal contact observed in the EPG recording of one Berber speaker. The results obtained are relevant for the question under discussion here, since the degree of overlap between the successive oral gestures can be analyzed according to the presence or absence of intervening schwa-like elements. This comparison showed that the surfacing of these vocoids is linked to a reduced overlap of the oral gestures (6% vs. 18% of overlap over the CC sequence duration, for cases with and without schwa-like element, respectively). Taken together, these arguments strongly suggest that these schwa-like elements are transitional vocoids surfacing because of the misalignment between oral and laryngeal gestures in consonantal sequences. We are currently analysing a more controlled corpus with additional subjects to further investigate this issue.

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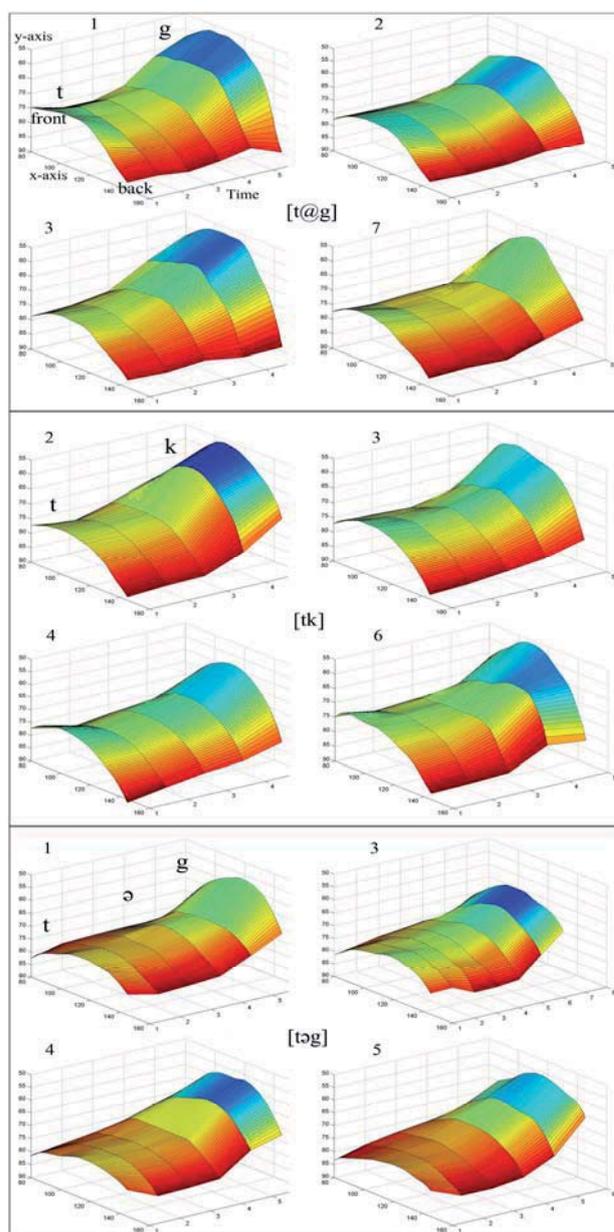


Figure 3: Spatio-temporal displays of the successive tongue shapes over time (derived from kriged contours) for 4 representative tokens of [t@g], [tk], and [t@g].