

A Perceptual Study of Tenselessness. Some Acoustic Cues Identifying Tense Vs Non-Tense Contrast in Berber

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ABSTRACT

In Berber, tenseness is a phonological feature - not to be equated with voicing or gemination - which can be added to all consonants in any word position and context. This study investigates the perceptual parameter(s) cueing tense consonants (*/C*/*) vs their non-tense counterparts (*/C:/*) in initial, medial and final position. We want to find out whether tenseness is cued by VOT or closure duration for stops, and by the duration or the intensity of the frication period for fricatives.

The test perception results show that, in the case of */t/ vs /t*/*, the closure duration is the only cue that differentiates phonemically tense from non-tense consonant in medial and final position. But in initial position the information is involved in VOT combined with the following vowel intensity. For fricatives, the perceptual phonemic cue is the duration of the consonantal frication independently of its position and context.

1. INTRODUCTION

The consonant system of Berber contrasts two types of consonant; tenses *vs* non-tenses. Tenselessness is a phonological rule that can be added to any kind of consonant, regardless of its context, place and mode of articulation. The tense *vs* non-tense contrast in Berber should not be confused with voiced *vs* voiceless or geminated *vs* non-geminated. In our previous studies [1], we have shown the temporal and spectral properties that differentiate geminate from non-geminate consonants as well as the tense from their non-tense correlates. For tense stops, for instance, we reported that the closure duration of tenses is twice longer than that of their non-tense counterparts. On the contrary, the VOT of the tense */t*/* is twice shorter than that of the non-tense */t/* (the only case can be found in the Tashlhit Berber variety, because of the frication or approximant characteristics of the other non-tense stops). We have also reported that the vowels preceding tense consonants are significantly shorter than the vowels preceding the non-tense ones. Regarding the duration of the vowels following tense and non-tense consonants, we have not found any statistically significant difference. However, the intensity of the vowels following the tenses is significantly higher [2].

We also previously tried to know which cue or cues differentiate perceptually the phonemic tense *vs* non-tense

distinction in Berber. But as we were not able at that time to find a sufficient number (we selected only five) of native Tashlhit Berber listeners, we have considered the previous perception test just as a pilot one.

The purpose of the present research is, then, to investigate which cue(s) plays a role in tense *vs* non-tense identification in speech perception. We expected, for example, that the VOT would provide a perceptually salient cue to identify initial stop contrast, like */t/ vs /t*/*; and the duration for fricatives, like, */s/ vs /s*/*.

Following the traditional phonetic transcription used for tenses in Korean researches, we are used to transcribing the Berber tenses with an asterisk after the consonant */C*/*, because the transcription */C:/* used in phonetic literature to represent both geminate and tense consonants, seems, in our view, valid for gemination but not at all for tenseness in Berber. So these two phonological characteristics have to be necessarily differentiated by notation. We believe that IPA should provide an alternative means, instead of */C:/*, to symbolise tenseness and, therefore, distinguish it from gemination.

2. EXPERIMENT

We have chosen some minimal pairs composed of meaningful isolated words that present the tense *vs* non-tense contrast in initial, medial and final position. As we are particularly curious to know whether the VOT could differentiate the opposition */t/ vs /t*/* in initial position, where there is no way to acoustically delimit the silent interval, we have prepared three minimal pairs. Finally and before the test perception, we have left out two of them because their quality was degraded by the splicing technique, and we kept just the perfect one. The quality of the rest of the stimuli was nearly perfect. The minimal pairs chosen are the following (the target sounds are in bold):

For stops: */t/ vs /t*/*

tutas (she hit one of his) *vs* **t***utas (you forgot to do him)
urtut (she did not hit) *vs* **u**rt*ut (you did not forget)
isrut (he threshed) *vs* **i**srut* (he threshed it)

For fricatives : */s/ vs /s*/*

su (drink) *vs* **s***u (give a drink)
iswa (he drank) *vs* **i**s*wa (he gave a drink)
ifis (hyena) *vs* **i**fis* (he is quiet)

The target words were produced, in a natural speaking rate, by a native speaker of Tashelhit Berber; recorded, digitised and edited on spectrogram displays using CSL speech analysis software in the Phonetics Laboratory of the Central University of Barcelona.

For the target stops, the experiment consists in cross-splicing the VOT of non-tense /t/ in the first word of the pair with the VOT of its correspondent tense /t*/ in the second word of the pair. For the target fricatives, the original non-tense consonant is replaced by an equally long segmental portion, preferably with greater darkness, excised from its tense counterpart. This latter, in turn, is replaced by successive portions of its corresponding non-tense that sum up the same duration as that of the original tense sound.

Furthermore, we wanted to find out if there is any other acoustic secondary element that can play a relevant role in the perceptual identification of the opposition /t/ vs /t*/ in initial position. For this goal, we have also cross-spliced the vowel following the tense consonant with the vowel following its respective non-tense, keeping intact others components, including the original VOT. The vowel intensities have also been measured.

The natural and edited stimuli have been recorded and submitted to 58 native Southern Morocco Tashelhit Berber students at the University of Agadir for perceptual identification. Some of them are students from the Spanish Department and have an advanced background in phonetics and phonology; the others are students from the Arabic Department. The listeners, divided in shifts of three groups, were asked to listen attentively to the test words on a tape recorder and immediately mark, on a paper previously prepared with two response options written in both Spanish and Arabic, just one of the two boxes corresponding to the meaning they think they are hearing. The stimuli items, represented by numbers in order, were randomised in the response paper, in the same random in which they were appearing, with an interval of five seconds, in the recording. Prior to the test, all instructions and explanations about the meaning of the natural test word were given. To ensure that the listeners were familiarised with the items recorded and really knew what to do and how to proceed, we played the recording twice before they gave a response. The subjects' responses were scored according to the meaning of each stimulus word.

3. RESULTS

Table 1 and Table 2 indicate that almost the totality of listeners understood correctly the meaning of all the natural stimuli, for stops as well as for fricatives.

For the manipulated opposition /t/ vs /t*/ in initial position as in the pair “*tutas*” (she hit one of his) vs “*t*utas*” (you forgot to do him), the score of responses represented in Table 1, Figure 1 and Figure 2, indicates that, after cross-splicing the VOT between /t/ and /t*/ , the listeners also tend to cross the original meaning of the pair. More concretely, if the meaning of the natural word “*tutas*” is

/t/ vs /t*/ is perceived as	In natural pairs		In manipulated pairs	
	Tense	No-tense	Tense	No-tense
Initial (n=58)				
<i>tutas</i>	2	56	38	20
<i>t*utas</i>	55	3	18	40
Medial (n=58)				
<i>urtut</i>	0	58	2	56
<i>urt*ut</i>	57	1	54	4
Final (n=58)				
<i>isrut</i>	0	58	0	58
<i>isrut*</i>	58	0	57	1
Initial (n=58)	With cross-spliced /u/			
<i>tutas</i>	2	56	35	23
<i>t*utas</i>	55	3	20	38

Table. 1 Shows the total responses of 58 listeners to the natural and manipulated stops stimuli. In the lower part, there are responses to the pair with the cross-spliced vowels following the tense /t*/ and no-tense; /t/.

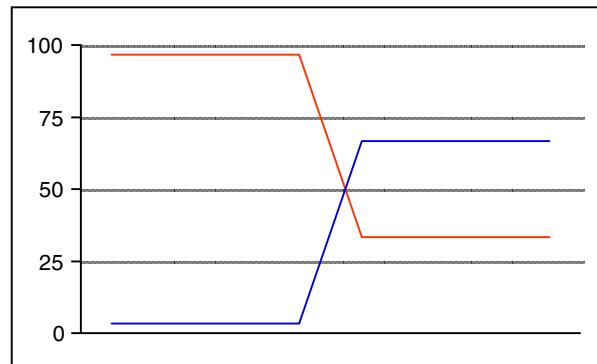


Figure 1 Shows the percentage of the test perception responses to the non-tense /t/ in initial position in the word “*tutas*”. On the left, the perception of the natural word, and on the right, the perception after cross-splicing the VOT .

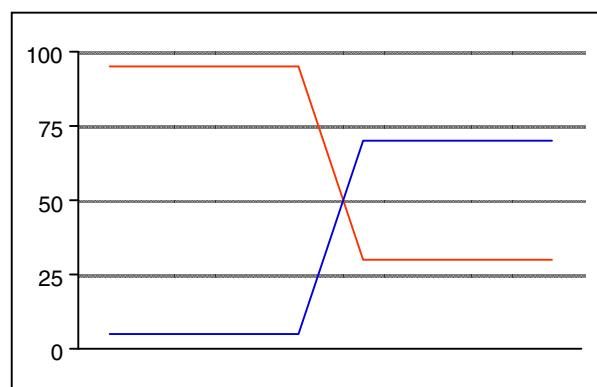


Figure 2 Shows the percentage of the test perception responses to the tense /t*/ in initial position in the word “*t*utas*”. On the left, the perception of the natural word, and on the right, the perception after cross-splicing the VOT .

correctly understood in 97% of the cases as “she hit one of his”, this same word, after cross-splicing the VOT, was understood in 66% as “t*utas” (you forgot to do him). The same thing is observed for “t*utas”. The natural word “t*utas” (you forgot to do him) was correctly understood by 95% of the subjects, in its original meaning, but after its manipulation, it was understood by 69% as “utas” (she hit one of his).

According to these results, we can say that the cross-spliced VOT of the opposition /t/ vs /t*/ in initial position affects the identification of the word in its original meaning. However, in spite of this predominant tendency of listeners to perceive, after the cross-splicing VOT, the tense consonant as a non-tense one and vice versa, we are not able to confirm that the VOT, alone, is a sufficient cue that can distinguish phonemically the Berber tense stop, /t*/ from its counterpart non-tense, /t/, in initial position. Figure 3 shows the representative spectrograms illustrating the cross-spliced VOT.

Concerning following vowels, the intensity value of the vowel following tense consonant is about 12 dB higher than that of the vowel following the non-tense. The data, in the lower part of Table 1, show that the listeners are also sensitive to the difference that emerges when the following vowels are cross-spliced (see Figure 4). The responses of the perception test show that, after cross-splicing the following vowels, /u/, “utas” was perceived in 66% of the cases with the meaning of the other member of the pair, “t*utas”; and, in turn, “t*utas” was perceived in 60% with the meaning of “utas”. This indicates that the following vowel, especially in terms of intensity (because there is no significant difference in their duration), also has a slight effect in the identification of the opposition, /t*/ vs /t/ in initial position. But this effect produced by the cross-spliced vowel, cannot be considered, in itself, as a relevant cue in the identification of this opposition. Figure 4 shows the representative spectrogram illustrating the cross-splicing of the following vowel.

In the Korean language, M. R. Kim et al. [3] reported that the stop identification contrast between tense and lax consonant, /C*/ vs /C/, in initial word, was strongly determined by the cross-spliced vowel following the consonants rather than by the consonant burst release. They justified their affirmation by the difference in *fo* between the vowel following tense vs lax; as being higher for the former and lower for the latter. But at the same time, they reported the VOT as a salient cue distinguishing the tense vs aspirated contrast.

However, Kim et al.’s. results should not be compared with ours, because their target words were embedded in the carrier sentence and the target initial-word stops were intervocalic within the carrier sentence.

For the Berber /t*/ vs /t/ contrast in medial and final position, the listeners are not, on the contrary, sensitive at all to the difference of the VOT. The stimuli responses, in Table 1, indicate that almost all the listeners are still perceiving the manipulated items in the same meaning as for the natural items.

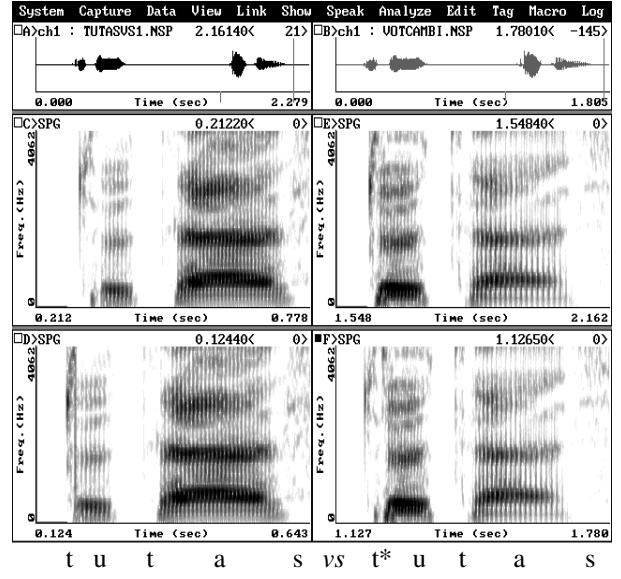


Figure 3. Spectrogram display shows both natural and manipulated pairs of “utas” vs “t*utas”. The lower part shows the words with cross-spliced VOT between /t/ and /t*/ in initial position.

/s/ vs /s*/ is perceived as	In natural pairs		In manipulated pairs	
	Tense	No-tense	Tense	No-tense
Initial (n=58)				
su	0	58	1	57
s*u	58	0	56	2
Medial (n=58)				
iswa	0	58	0	58
is*wa	58	0	58	0
Final (n=58)				
ifis	0	58	1	57
ifis*	57	1	57	1

Table 2. Shows the total responses of 58 listeners to the natural and manipulated fricatives stimuli. /s*/ = tense; /s/ = non-tense.

This evidences that the VOT does not play any role in the identification of the opposition /t/ vs /t*/ in medial and final position. The phonemic information is then carried only and exclusively in the closure duration. These results are consistent with those reported by J. Hankamer et al. [3], in Turkish and Bengali languages.

For the Berber fricatives, Table 2 illustrates that the listeners still perceive, at least in 97% of the cases, the manipulated items in the same way as in their respective natural items. This means that the duration difference of the frication period, regardless of its position or of other secondary cues, such as the higher intensity of the following context or the shorter duration of the preceding context (if it is the case), is a sufficient cue that differentiates phonemically the tense fricative from its non-tense counterpart.

4. CONCLUSIONS

This experiment tested the perceptual cues that could distinguish phonemically, in Tashlit Berber variety, the stop and fricative voiceless tense consonant from its non-tense counterpart in initial, medial and final position. The results show that for the perceptual identification of the opposition tense, /t*/ (which we transcribe with an asterisk in absence of an IPA diacritic) vs non tense, /t/, in initial position, that is, where there is no possibility to delimit acoustically the closure phase, the majority of listeners tend to base their decision on information encoded in the VOT as well as on the following vowel, and specially its intensity.

However, the information provided by the VOT alone appears slightly more important than that provided by the following vowel. But as the listeners' judgements involve a slight ambiguity, evident in the score of responses, we think that neither VOT, nor the following vowel could be separately sufficient to be significant perceptual cues to identify phonologically the voiceless tense, /t*/, from its non-tense counterpart, /t/, in initial position. We suppose, then, that the perception of the initial voiceless tense stop depends on the combination of both cues, the VOT as well as the following vowel intensity.

In contrast, for the opposition in medial and final position, the VOT does not play any significant role in the perceptual identification at all. So, in this case, we can confirm that the difference of the closure duration, being twice longer for tenses, is the only cue able to strongly distinguish the tense /t*/ from its correlate non-tense /t/. In other words, when the closure phase is delimited by an acoustic element, even by VOT in itself as in final position, the closure duration is a sufficient cue to perceive the phonemic difference between tense and non-tense voiceless stops. The other elements, such as the intensity of the following vowel or the shorter duration of the preceding sound, be it vocalic or consonantal (which is possible in Berber), are the negligible factors in the perception of this kind of opposition.

Concerning fricative consonants, the test perception data show that the intrinsic duration of the sound frication, being twice longer for tenses, is the only perceptual cue able by itself to differentiate phonologically the tense vs non-tense fricative opposition, regardless of its position or its context. Neither the intensity of the frication nor any other secondary factor, such as the higher intensity of the following vowel or the shorter duration of the preceding vowel (if it is the case) causes change of the natural meaning word in any significant manner.

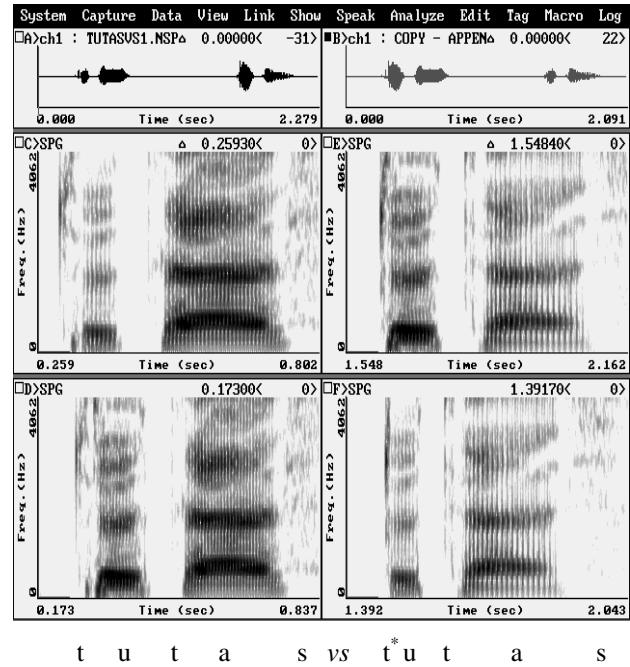


Figure 4. Spectrogram display shows both natural and manipulated pairs of “tutas” vs “t*utas”. The lower part shows the words with cross-spliced vowel /u/ following /t/ and /t*/ in initial position.

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5. REFERENCES

- [3] J. Hankamer et al. “Perception of consonant length: voiceless stops in Turkish and Bengali”, *Journal of Phonetics*, **17**, pp.283-298, 1989.
- [3] M. R. Kim et al. “The contribution of consonantal and vocalic information to the perception of Koeran initial stops”, *Journal of Phonetics*, **30** pp.77-100, 2002.
- [1] O. Ouakrim, “An acoustic parameter distinguishing tenseness from gemination in Berber”, *Proceedings of The XVth International Congress of Linguists*, Québec, Canada, pp. 67-70, 1992.
- [2] O. Ouakrim, *Fonética y fonología del bereber*, Universidad Autónoma de Barcelona, Servei de Publicacions (Ciència y tècnica; 3). Barcelona; España. 1995.