

THE PERCEPTION OF /pt/ AND /kt/ IN EUROPEAN AND BRAZILIAN PORTUGUESE

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ABSTRACT

This study is concerned with consonant clusters in two varieties of Portuguese, Brazilian (BP) and European (EP) and more specifically with whether the two varieties differ in the way that consonants are synchronized with each other. Two further aims were to test whether the synchronization was influenced by place of articulation and whether perceptual responses to a cluster were influenced by the listener's variety. Twenty-one L1 EP and 16 L1 BP speakers participated in a forced choice perception experiment in which they judged whether medial /C₁t/ clusters (C₁ = /p, t/) excised from real words produced by one EP, and one BP speaker had been reduced to a singleton /t/ or not. Listeners were more inclined to perceive a singleton /t/ in EP clusters which is consistent with the idea of a tighter temporal synchrony between the consonants in EP than for BP. They were also more inclined to perceive a singleton /t/ in /kt/ than in /pt/ clusters but there were no differences between Brazilian and Portuguese listeners' responses to the same stimuli. Taken together, the results show that there is a greater asynchrony between the consonant of a cluster for medial labials than for medial velars and between BP than EP clusters.

Keywords: Perception, phrasing, timing, back-to-front cluster, front-to-back Cluster.

1. INTRODUCTION

Auditory studies have suggested that there is a greater tendency in Brazilian (BP) than in European Portuguese (EP) for a vowel to intervene between two consonants of a cluster [1,4,5,6,7,8, 11,12]. Thus BP and EP differ in the production of *captar* ('to catch') which is sometimes transcribed as /kaptar/ in BP but /kaptar/ in EP. One possibility is that an intervening category of a schwa-like vowel forms part of the BP word's lexical representation. But another equally

plausible way of representing such differences may be in terms of timing differences which in a model of articulatory phonology [2,3] could be expressed by phase differences between the consonants: thus in BP C₂ is timed to occur later than C₁ in a /C₁C₂/ cluster and this gives rise to the perception of an intervening short vowel without one actually being included in the word's lexical representation. If consonants of a cluster are timed to occur closer together in EP than in BP then listeners should also be more inclined to (mis)perceive a cluster as a singleton consonant in EP. This is because if the phasing between the consonants is inherently less in EP, then the same reduction in phasing differences in the two varieties should more readily result in C₁ being covered up or hidden by C₂ than for BP clusters. One of the aims of this study was to test whether this is so, i.e. whether there is indeed a greater likelihood of perceiving a cluster as a singleton consonant in EP than in BP.

Beyond the specifics of these variety differences, another aim was to assess whether the place-order of articulation would have any influence on cluster reduction, given that other research for Georgian [2] has shown this to be a contributory factor in the extent to which there is overlap between places of articulation. More specifically, their study showed consistently more overlap in the front-to-back direction than in the other way round [4,10], possibly because the places of articulation are perceptually more easily recoverable in front-to-back than in back-to-front clusters [2]. The question of whether there is a similar tendency was also considered in this study.

A third aim of this study was to investigate whether the listener's variety also plays a role in the perception of these consonant clusters. Here we predicted that clusters should be more readily perceived as singleton consonants by BP than EP listeners, if perception matches production: that is, if BP requires a wider phasing between consonants of a cluster in *production*, then BP listeners might also require a relatively wide phasing between

consonants for them to hear a cluster rather than a singleton stop in *perception*. In particular, BP listeners should hear the majority of the tightly timed clusters in European Portuguese as singleton consonants.

2. METHOD

2.1. Acoustic Stimuli

The stimuli consisted of the real words in Table I containing stop clusters in unstressed syllables in word medial position. The clusters were obtained from the same set of words in both varieties and they include /kt/ in words like *factura*, and *facto*, and /pt/ in e.g. *captar* and *capto*. The analysis included for /kt/ 5 words \times 2 contexts \times 2 speakers = 20 stimuli and for /pt/ 3 words \times 2 contexts \times 2 speakers = 12 stimuli.

Table I: Target words: relevant consonants are underlined.

/kt/	/pt/
fact <u>u</u> ra	cap <u>t</u> ar
fact <u>u</u> rar	cap <u>t</u> ador
fact <u>o</u>	cap <u>t</u> o
espectá <u>c</u> ulo	-
espect <u>a</u> dor	-

Each target word was embedded in the following carrier sentence: *O Pedro leu ___mal* 'Peter read ___wrong'. In this sentence, the target word was produced in one prosodically accented and one prosodically deaccented context, displayed on a notebook screen and repeated in randomized order 3-4 times. These were produced by two female first language speakers of European and Brazilian Portuguese aged between 25 and 28 years of age and both students in their home countries. We recorded simultaneous movement data using a 5D-EMA system although this will not be analyzed in the present experiment.

2.2. Perception Experiment

The target clusters were excised between their acoustic onset and offset from the words in Table I and presented in randomized order in an online forced choice experiment. The participants listened to each stimulus separately and carried out an identification task in which they responded to each front-to-back token with one of <t>, <pt>, <pet>, <put> and to each back-to-front token with one of <t>, <kt>, <ket>, <kut>. Since the main research question in this study is whether subjects hear one

or two consonants (irrespective of whether the perceived an intervening lax vowel), responses from the last three choices were pooled. Henceforth, /t/ is used to denote that listeners responded to the stimulus with /t/; and /Ct/ that they responded with one of the other three alternatives that included the preceding consonant.

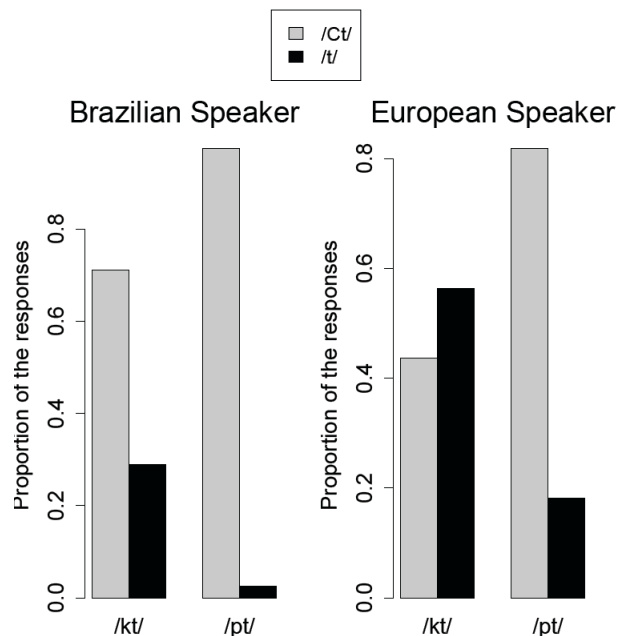
The experiment took place at the subjects' homes and they used a headset SENNHEISER PC 165 USB. Twenty-one native speakers of European Portuguese (from Porto and aged between 24-36 years) and sixteen native speakers of Brazilian Portuguese (from Campinas, and aged between 22-35 years) participated in the perception experiment. None of the subjects reported any hearing or reading problems.

The responses were analyzed with a generalized linear mixed model (GLMM) in R with the listener as a random factor and with cluster, speaker variety, and listener variety as fixed factors.

3. RESULTS

The results in which listeners were asked to judge each perceived stimulus as /t/ or as /Ct/ are shown in Fig. 1 by speaker group and cluster type.

Figure 1: Proportion of the responses of all participants to the Brazilian acoustic stimuli (on the left) and to the Portuguese stimuli (on the right).



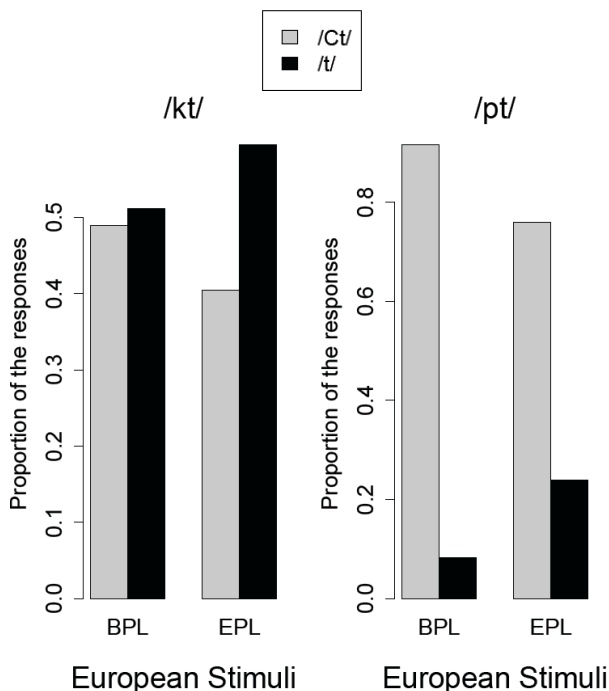
Consistently with our first prediction, Fig. 1 shows clearly that the stimuli from the EP speaker were more readily perceived as a singleton /t/ than were

the BP stimuli. The results of a GLMM test with speaker variety as a fixed factor showed that the proportion of stimuli perceived as /t/ as opposed to /Ct/ was significantly greater for the EP than for the BP speaker ($z = 8.6, p < 0.001$).

Consistently with the second hypothesis, Fig. 1 also showed that the back-to-front cluster /kt/ were more prone to be perceived as /t/ than was the front-to-back cluster /pt/. Overall, this difference was shown to be significant ($z = 10.0, p < 0.001$). The results were significant for both varieties: thus listeners were significantly more likely to perceive a singleton /t/ in /kt/ than in /pt/ clusters in the production data of both the Brazilian ($z = 8.5, p < 0.001$) and the European ($z = 5.3, p < 0.001$) speakers.

Consistently with these findings, Figs 2-3 shows that there are no variation above listeners groups; both Brazilian and European listeners perceived more singleton consonants in velar /kt/ than in the labial /pt/-clusters in both stimuli sets.

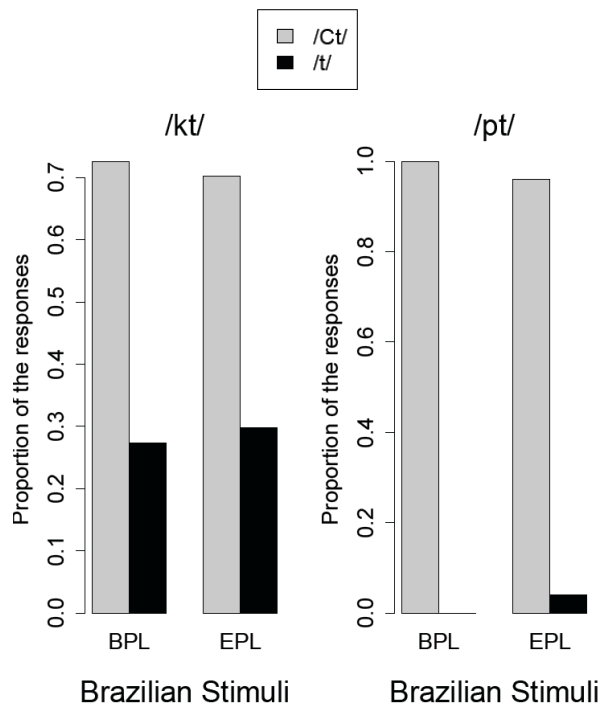
Figure 2: Proportion of the responses to the EP-Stimuli from both listener groups for back-to-front cluster (on the left) and to front-to-back cluster (on the right).



Concerning the third hypothesis, in the EP data presented in Fig 2, EP listeners, and not BP listeners as predicted, were more inclined to perceive singleton consonants than were BP listeners. However, this difference was not significant.

As far as Brazilian data is concerned (Fig.3), BP listeners were no more inclined to perceive clusters than singleton consonants than were EP listeners.

Figure 3: Proportion of the responses to the BP-Stimuli from both listener groups for back-to-front cluster (on the left) and to front-to-back cluster (on the right).



4. DISCUSSION

The first result showed that listeners were more likely to hear a cluster in Brazilian than in European Portuguese. We interpret this result to show that these varieties differ in their phasing between the consonants with BP showing a wider phasing than EP (leading often to the percept of an intervening vowel). The EMA data is currently being analyzed to investigate whether this is so; in addition, a future experiment may need to include a more spontaneous speaking style.

Secondly, listeners were more inclined to hear a singleton consonant in the back-to-front cluster /kt/ than in the front-to-back /pt/ cluster. These results are consistent with the idea that front-to-back clusters may be more stable because they are more recoverable perceptibly [4,10]. The presence of perceptual cues associated with the bilabial release of /p/ that are more audible than the velar release of /k/ preceding /t/ release could provide another explanation for these findings.

Finally, Brazilian listeners did not show a stronger tendency to hear a singleton /t/ than the listeners of European Portuguese. This may suggest that both groups of listeners are equally sensitive to the relevant perceptual cues and that the crucial difference lies in the production and not in the perception of clusters in BP vs. EP. Alternatively, the laboratory-style speech of the two speakers from which the extent of cluster reduction was insufficient for such differences to emerge. These production-perception relationships are currently being investigated with a larger number of speakers and with EMA data in order to analyze the way the timing differences between these two varieties in cluster production.

5. REFERENCES

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