ON MISPERCEPTION IN RHOTICISATION AND LAMBDACISATION

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ABSTRACT

Misperception is one of the sources of sound change. This study investigates to what extent misperception can account for rhoticisation of laterals and lambdacisation of rhotics. To this end, laterals and rhotics varying across different acoustic dimensions are embedded in logatomic word forms and presented to native listeners of Greek in a forced choice task. While lateral rhoticisation could be predicted as a function of lateral duration, with shorter laterals undergoing more perceptual confusion with rhotics than longer laterals – especially in intervocalic position–, the lateral's degree of darkness had no effect on participants' responses. Rhotic lambdacisation was high for rhotic approximants; taps and trills, however, were overwhelmingly correctly perceived as rhotics. An additional rhotic variant, a tap lacking the characteristic svarabhakti vocoid, yielded high rates of perceptual elision. The results of the experiment are discussed with respect to documented sound changes.

Keywords: speech perception, rhotics, laterals, sound change

1. INTRODUCTION

Misperception of sounds has been proposed as one of the mechanisms underlying sound change: When two sounds that belong to contrasting categories, such as laterals and rhotics, bear acoustic similarity, listeners might fail to recover the phoneme intended by the speaker, and if such error goes unnoticed, the perceptual confusion might set the seed for long-term sound change ([16]). Sound changes involving laterals becoming rhotics and rhotics becoming laterals occurred, for example, in the historical development of Modern Greek ([15]), Danish ([8]), Old Bearnés (Occitan) ([32]), Alguerese Catalan ([30]), Albanian ([17]), or Atikamek Cree ([18]).

Previous approaches have explained the rhoticisation of laterals, especially to an alveolar tap, as the result of articulatory weakening of the tongue tip which fails to achieve a firm central closure ([25, 6, 27, 29, 28, 20]); conversely, lambdacisation of a rhotic alveolar tap is seen as an instance of strenghtening or stiffening of the tongue tip gesture ([28, 20]). While articulatory changes may be a consequence of or a prerequisite for sound change via misperception ([16]), no account is given of the acoustic characteristics of these lateral and rhotic variants that give rise to perceptual confusion.

One prominent acoustic cue to be investigated in the present study is duration, specifically the duration of the tongue tip constriction or closure period which is marked acoustically by a reduction in intensity of the waveform as compared to vowels ([19]). Müller ([13]) found that laterals shortened to an extent that their duration closely matched that of alveolar tap constriction periods could be misheard as rhotics (lateral rhoticisation), and Romero and Martín ([23]) obtained similar findings when shortening an alveolar fricative (sibilant rhoticisation). Conversely, in Müller's ([13]) study, alveolar rhotics with longer tongue tip constriction duration had a tendency to be confused with laterals.

Another potential cue in perceptual lateral rhoticisation is the degree of darkness of the lateral. Observations from Romance dialects ([11, 5, 7, 26]) suggest that darker varieties of laterals are more prone to rhoticisation. For instance, Provençal-Alpin and Auvernhat varieties of Occitan, in which laterals rhoticised, occur next to varieties with dark laterals ([4]). Similarly, in a women's variety of Southern Kurdish, only the dark lateral, but not the phonemically distinct clear lateral, underwent rhoticisation ([10]). Nevertheless, examples of rhoticisation of clear laterals are attested in loanwords of Standard Italian origin in French and in Italian dialects ([7]) and in loanwords of Standard French origin in Occitan dialects ([24]).

2. EXPERIMENT

2.1. Stimuli

Laterals and rhotics were embedded in disyllabic meaningless words, as shown schematically in Table 1, and recorded in a sound-attenuated booth. All stimuli, except for those in the word-final condition, were stressed on the first syllable (stress placement was found in earlier studies not to contribute to the

perceptual confusion of laterals and rhotics in Greek ([13, 14])). Manipulation of the stimuli was done in praat ([3]) by use of the PSOLA method ([12]).

Table 1: Stimulus template. L = liquid (lateral or rhotic).

CLV	VLC	VLV	#LV	#VL
pLaka	*kaLpa*	*kaLa*	*Laka*	*kataL*
	kaLta			
kLaka	*kaLka*			

2.1.1. Lateral variables: duration and degree of darkness

Laterals were adjusted to two duration values: 60 ms (being the average duration of the lateral in Greek spontaneous speech ([9])), and 30 ms for the shortened variant.

A five-step darkness continuum was created by varying values for F1, F2, and F3 in the laterals. For the darkest lateral, these values were set at F1=5.77 Bark, F2=8.32 Bark, F3=14.16 Bark, and for the clearest lateral, F1=4.53 Bark, F2=10.92 Bark, and F3=14.72 Bark. These values are based on a large cross-linguistic study on lateral formant values conducted by Recasens [22].

2.1.2. Rhotic variable: type

Four different types of rhotic were presented to the listeners: two-closure trills, taps, taps without the svarabhakti vocoid (i.e., constriction period only), and approximant rhotics.

- Trills were all normalised to two closure periods by deleting any additional closure period present in the signal.
- In the taps, closure periods were normalised to a 20 ms duration; the svarabhakti vocoid was not modified.
- A tap without svarabhakti vocoid was created by excising the vocoid from the signal for all syllable positions except intervocalically where no acoustic svarabhakti vocoids occur. See section 4.2 for the reasons for including this rhotic type in the study.
- Approximant rhotics could not be directly recorded in the laboratory setting and were therefore created as follows: The signal of the stimulus /ˈraka/, uttered with a word-initial tap, happened to contain an approximant-like stretch between the closure period for the tap and the full vowel /a/. This stretch was excised, adjusted to a 45-m-duration and inserted in lieu of the tap plus svarabhakti vocoid (or vice versa)-sequences in the stimuli.

The combination of all variables (syllable position, lateral duration, lateral degree of darkness, rhotic type) yielded 111 different stimuli in total.

2.2. Presentation

292 native listeners of Greek participated in the experiment (59 participants at the University of Cyprus, 233 participants at Aristotle University, Thessaloniki, Greece; mean age: 20.9 years (sd: 3.6 years)). They were paid for their participation.

The stimuli were presented to listeners over headphones in a random-order multiple forced-choice test. Only /r/ and /l/-responses will be discussed in the present paper.

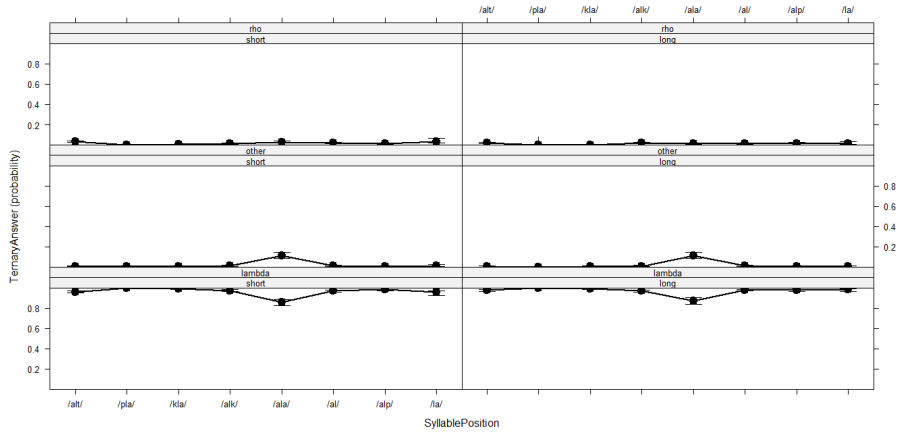
3. RESULTS

Listeners' responses to stimuli containing laterals and stimuli containing rhotics were analysed separately. Their responses were grouped into /r/, /l/, and "other" (since the remaining choices elicited few responses), and multinomial logistic regression models were calculated on the data using the package *nnet* ([31]) in R ([21]).

3.1. Stimuli containing laterals

The predictor variables degree of darkness, lateral duration, and syllable position as well as their interactions were entered into the model. Overall accuracy of the model was good at 96% correct predictions. Contrary to the expectations outlined in the introductory section, degree of darkness in the lateral did not contribute significantly to predicting participants' answers (χ^2[8]=3.97, p=0.86). Duration of the lateral, on the other hand, did show the expected effect (χ^2[2]=14.43, p<0.001), with long laterals being less likely to be perceived as /r/ or as another sound than short laterals, and thus confirmed the results of Müller ([13]). The syllable position in which the lateral was presented was also highly significant (χ^2[14]=855.04, p<0.001). Among the interactions tested, only the interaction between the syllable position and the lateral duration predictor variables was almost significant (χ^2[14]=34.70, p=0.002; see Figure 1), while the other three interactions did not reach significance at all (syllable position $\times$ darkness degree: χ^2[56]=40.54, p=0.94; darkness degree $\times$ lateral duration: χ^2[8]=4.34, p=0.83; syllable position $\times$ darkness degree $\times$ lateral duration: χ^2[56]=36.15, p=0.98).

Figure 1: Predicted probabilities of responses to laterals depending on lateral duration (short, long) and syllable position



3.2. Stimuli containing rhotics

The predictor variables syllable position and rhotic type as well as their interaction were entered into the model. Here, the overall accuracy (83% correct predictions) was lower than in the model for the laterals. Both predictor variables were highly significant (syllable position: $\chi^2[14]=863.6$, $p<0.001$; rhotic type: $\chi^2[6]=6056.7$, $p<0.001$), and so was their interaction (syllable position $\times$ rhotic type: $\chi^2[42]=569.5$, $p<0.001$). As shown in Figure 2, the tap without svarabhakti vocoid is often perceived as neither /r/ nor /l/; the prevalent response of listeners for this rhotic type was perceptual elision (perception of no consonant at all).

4. DISCUSSION

4.1. Misperception of laterals

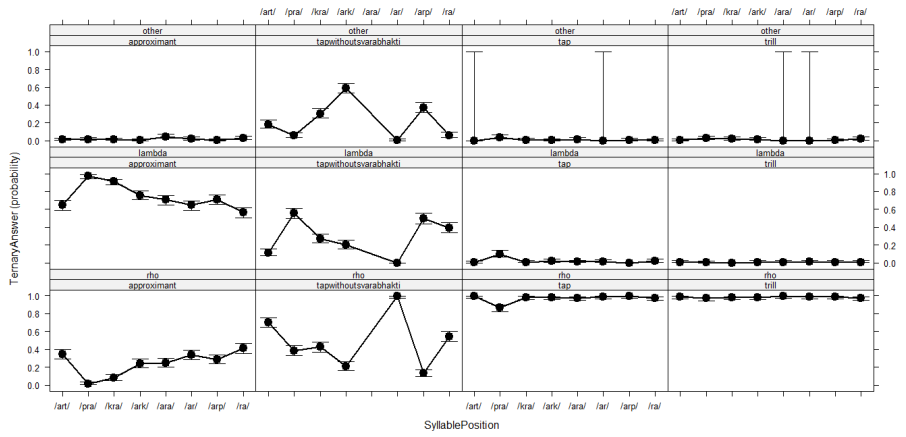
While degree of darkness did not contribute to the correct prediction of lateral misperception, the duration of the lateral (long vs. short) and the syllable position it appeared in had a significant effect in the model. Figure 1 shows that predicted probabilities for perceptual rhoticisation of the lateral were highest in intervocalic position (although the risk of rhoticisation was still low at 0.05 for the short lateral, and 0.02 for the long lateral). These results may be explained by the rhotic tap lacking its characteristic svarabhakti vocoids in intervocalic position; its most prominent acoustic cue in this position is the intensity reduction during tongue tip closure or constriction, and this reduction period is reminiscent of the one found in laterals, especially as the lateral's duration decreases.

4.2. Misperception of rhotics

The rhotics presented in the experiment were categorised according to rhotic type. For trills and taps, no propensity toward misperception was predicted by the model. The tap in the syllable position /pra/, nevertheless, had a higher predicted probability of being identified as a lateral (0.10) than in any other syllable position (see Figure 2). This might be due to the form /plaka/ being meaningful in Greek ('board, tombstone, dial, blackboard, tile, plaque, plate, fun') and could therefore have attracted /l/-responses. The predicted probabilities for /l/-responses is also the highest in /pra/ for the rhotic types tap without svarabhakti vocoid and approximant (0.56 and 0.97, respectively). Similarly, the other meaningful stimulus forms /karta/ ('card') and /katar/ ('Qatar') yielded high predicted probabilities for (correct) /r/-responses relative to predicted probabilities for other syllable positions within the same rhotic type, as illustrated in Figure 2.

The approximant rhotic type was predicted by the model to elicit more /l/-responses than /r/-responses, and this for all syllable positions. The lowest predicted probability for perceptual lambdacisation was the word-initial position (0.56), which is also the syllable position the approximant rhotic was excised from (see section 2.1.2). Two explanations may be advanced for these high rates of perceptual rhotic lambdacisation: First, although approximant rhotics and perhaps more frequently, very reduced taps, exist in Greek casual speech, these do not have the

Figure 2: Predicted probabilities of responses to rhotics depending on rhotic type and syllable position



same consistent approximant pronunciation as English rhotic approximants (in particular, they are never retroflex). The clear speech nature of the stimuli may have biased listeners against the correct perception of a variant strongly associated with casual speech.

Second, the approximant rhotic lacks the characteristic contrast of intensity reduction during tongue tip constriction or closure and the vocoid; instead it presents formant structure, as does the lateral. Moreover, it is generally longer than the tap, and this fact was taken into account in creating the stimuli (see section 2.1.2). Its duration renders it thus similar to the lateral. The main difference to the lateral lies in the rhotic approximant's lacking lateral side channels.

The characteristic shape of the tap as a sequence of a svarabhakti vocoid and an intensity reduction period during tongue tip constriction or closure and the concomitant high predicted probabilities of correct /r/-responses to rhotic taps in the present study is compared to the scenario where the tap lacks this svarabhakti vocoid. The interest of this comparison arises from the observation made by Baltazani ([1, 2]) that 18% to 30% of taps in /rC/-clusters may lack their svarabhakti vocoid in Greek, while it is absent with taps in 0% to 22% of /Cr/-clusters. How is a tap perceived that lacks the svarabhakti vocoid? The model presented here predicts that it is not perceived at all in most cases. Elision of rhotics (the exact variant of which is not always easy to determine from the literature) occurred in the historical development of many languages, e.g., in Albanian ([17]), Latin, Ancient Greek, and Sanskrit ([25]), Faliscan ([25]), and in many Romance languages [32]). Why the svarabhakti vocoid may disappear in the first place cannot be answered by the data elicited in the present investigation.

5. CONCLUSIONS

This study has shown that acoustic factors exist which can account for the mutual confusion of laterals and rhotics through misperception. While lateral degree of darkness could not be shown to play a rôle in lateral rhoticisation, the analysis confirmed previous studies showing that rhoticisation (to a tap) mainly hinges on duration. Rhotic lambdacisation was studied for different types of rhotics, and high rates of lambdacisation were found for the approximant variant, whereas taps and trills were almost invariably perceived as rhotics. When the svarabhakti vocoid was missing in the tap, however, leaving only the closure or constriction period, many participants were not able to perceive the sound at all.

The present investigation was thus able to show that a perceptual confusion of two closely related sound categories or phonemes highly depends on the acoustics characteristics of the sound variant or allophone. In this way it contributes to fostering our understanding of sound change and sound change processes.

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