

Perception and Production of Word-Final Alveolar Stops by Brazilian Portuguese Learners of English

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Abstract

This paper focuses on the perception and production of the English alveolar stops (/t/ and /d/) in syllable coda by Brazilian learners of English. In the production test, the participants read a list of English sentences containing alveolar stops in word-final position. The preceding and following phonological contexts were controlled, so that the effect of context on the production of the alveolar stops could be analyzed. The perception test consisted of an oddity discrimination task where the target obstruents were either unreleased, aspirated, palatalized or produced with a paragodic vowel. The results of the production investigation show that the learners tended to unrelease the obstruents, but several tokens were aspirated, palatalized or produced with a paragodic vowel. As regards the relationship between perception and production of word-final /t/ and /d/, a positive correlation was found between the discrimination and production rates.

Index Terms: L2 perception/production, alveolar stops, coda.

1. Introduction

Several studies have focused on how Brazilian learners of English pronounce consonants in word-final position [1-7]. The interest in final obstruents stems from the fact that in Brazilian Portuguese (BP) only /s/ and /r/ are realized phonetically as syllable-final consonants, differently from English, whose syllable structures are more complex and allow several obstruents in coda position. These studies show that native language (L1) transfer heavily influences the pronunciation of foreign language (L2) consonants. First, in order to simplify the English syllable structure, Brazilian learners of English tend to insert a paragodic vowel to phonetically realize obstruents in syllable-final position, thus turning a CVC syllable into a CV.CV sequence. Secondly, both English final nasals and final /l/ are realized as in BP [6, 7]. In the specific case of alveolar stops, in BP there is variation in their production according to the phonological context, characterizing different dialects, and sometimes, idiolects, so that palatalization of these obstruents is a non-distinctive geographical dialect marker [8, 9]. According to this variation, loanwords such as *Internet* may be pronounced by Brazilians as [internete], [interneti], [internetʃi] or [internet^hi]. Thus, besides vowel paragoge, final alveolars may trigger palatalization or unnatural aspiration.

Bettoni-Techio found that this variation appears in BP speakers' English word-final alveolars as well [2]. In the

case of vowel paragoge, the data revealed that voicing of the target sound affected both rate and type of production: voiced sounds were more susceptible to the addition of a vowel than their voiceless counterparts, corroborating the results found in [1-3].

As regards the relationship between speech perception and production, studies have also shown evidence of transfer in that learners tend to rely on their L1 phonological system to build the L2 system [3, 10-13]. Both Flege's Speech Learning Model (SLM) and Best's Perceptual Assimilation Model (PAM) predict that L1 phonology may act as a filter leading learners to ignore features of the L2 which are irrelevant in their L1, at least at initial stages of acquisition [10, 13].

The relationship between speech sound perception and production has instigated researchers for a few decades already. Some studies have shown that perception tends to precede production [11, 14]. The SLM claims that perception is a condition for production; however, perception is not the motivator of all L2 production errors, since, as acknowledged by Flege, articulatory complexity and linguistic markedness may be important factors contributing to error [15]. Koerich investigated the relationship between perception and production of word-final consonants and found that, at an early stage of second language acquisition, there is some correlation between perception and production: participants who perceived better were also the ones who produced better [3, 13].

Taking into account the results of previous studies which investigated the influence of L1 in L2 production as well as the relationship between speech perception and production, the present study examines the perception and production of English final alveolar stops with the intent of (1) describing the sounds produced by BP learners of English when the target is an English alveolar stop in word-final position, and (2) investigating whether perception and production of final alveolar stops by BP learners of English correlate.

2. Method

2.1. Participants

The participants of the study were nine pre-intermediate students of English, four men and five women with ages ranging from 15 to 21 years. They had had approximately 120 hours of English instruction at an English Course of the Federal University of Santa Catarina. One male American English speaker served as control for the perception test.

2.2. Experiment A: final alveolar stop production

2.2.1. Procedure

The participants' production was elicited by their reading of 240 topically unrelated and randomly ordered short sentences containing monosyllabic words ending in /t/ or /d/ in different preceding and following phonological environment combinations. The preceding environments tested were /i, ε, a/ɔ, aɪ, ʌ, o/, and the following environments tested were the vowels /i, ε, ɔ/, the consonants /p, b, t, d, k, g, f, v, s, z, tʃ, dʒ, h, l, m, n/, and silence. Examples of sentences read by the participants are *My pet eats a lot* (/ɛt#i/) and *The mud goes to the sea* (/ʌd#g/). The participants were recorded for approximately 20 minutes in a quiet room of a language lab with a Sony MZ-NHF800 minidisk recorder and a Sony ECM-MS907 directional microphone.

2.2.2. Analysis

The data were analyzed in Praat. According to the spectrogram, the productions of /t/ and /d/ were classified into four categories: (1) unreleased; (2) palatalized (/tʃ, dʒ/); (3) followed by a paragogic vowel; (4) aspirated; and (5) other misproductions, such as the incorrect reading of a vowel or consonant which formed the phonological context. The tokens whose interval between the target sound and the following environment was greater than 35 ms were discarded [16]. In several English dialects and even idiolects, final aspiration is common. However, except when the target alveolar was followed by silence, aspiration was considered unnatural when produced in the specific environments used in the production test of this study.

2.3. Experiment B: L2 perception

2.3.1. Stimuli

The perception test consisted of a categorical discrimination test (CDT), based on [17]. The test has an oddity format, that is, either every trial contains an odd item or all the items are the same. The participants listened to a total of 56 trials containing one, two, three, or zero tokens where either /t/ or /d/ was mispronounced. Examples of trials to test (a) palatalization: (1) Kade moves, (2) Kade moves, (3) Cage moves; (b) aspiration: Kate moves, (2) Kat^h moves, (3) Kate moves; and (c) vowel paragoge: Katie moves, (2) Kate moves, (3) Kate moves. The stimuli were recorded by 3 native speakers of American English, 2 women and 1 man; thus, in each trial the listener heard 3 different voices.

The results of the control listener, the American English speaker, showed that he discriminated 78% of the trials containing aspirated items and 100% of the trials produced with palatalization and with a paragogic vowel, indicating that the stimuli used in the discrimination test were reliable.

2.3.2. Procedure

The participants were given a sheet of paper with four alternatives for each set and were asked to check alternative (1), (2) or (3) to indicate the odd item, or alternative (4) to indicate that all of the items were the same. Feedback was provided in a practice session before the experiment began. The participants were simultaneously tested in a language lab.

3. Discussion

3.1. Production results

The main types of production errors were vowel paragoge, aspiration, and palatalization. Table 1 shows a summary of the categories and their means taken into account the nine participants.

Table 1. Number of occurrences, mean and median in percentages for each type of alveolar stop production.

Type of production	N	Mean	Median
Unreleased	1039	46.58%	40.91%
Palatalization	418	18.74%	10.81%
Aspiration	346	15.51%	14.18%
Vowel paragoge	164	7.35%	2.87%
Other misproductions	263	11.82%	-
Total	2230	100%	-

The results show that more than 40% of the alveolar stops were unreleased, that is, they were produced in a native-like fashion. As regards the participants' mispronunciation of the target alveolars, palatalization was more frequent than aspiration, which occurred more often than vowel paragoge. The results were in line with those obtained in [2].

3.2. Perception vs. production results

The EFL learners' results show that production of a type of error correlated with misperception of that particular error. The following subsections report the results analyzed according to accuracy in general as well as to palatalization, vowel paragoge, and aspiration individually.

3.2.1. Accuracy

Figure 1 shows the percentage of final obstruents which were unreleased, that is, which were produced in a target-like fashion, and the percentage of discrimination of the tokens in the CDT by each participant.

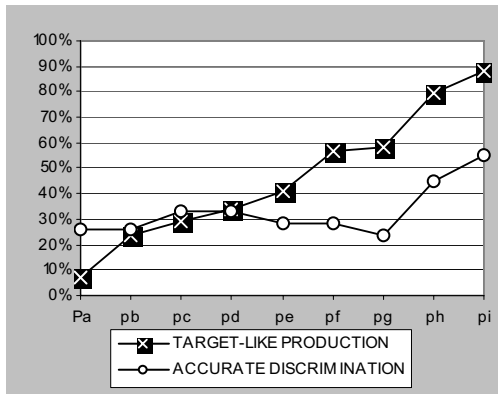


Figure 1: Mean percentage of correct discrimination in the CDT and percentage of target-like production in the reading test by each participant.

A Pearson Product Moment Correlation yielded a positive and significant correlation between accuracy in perception and accuracy in production ($r(9) = .754, p = .019$), as can be seen in Figure 2. Thus, considering overall error, the participants who perceived the target alveolars better were also the ones who produced them in a more native-like fashion.

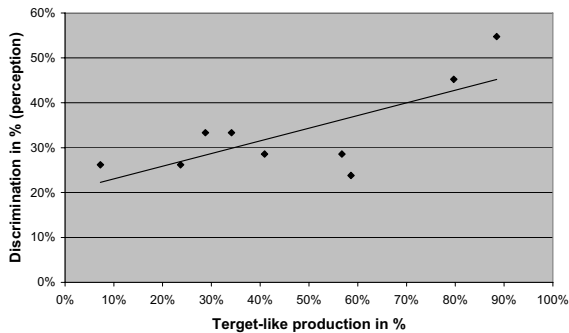


Figure 2: Correlation results between the perception and production tests.

Concerning voicing of the target sound, Figures 3 and 4 show rate of discrimination and frequency of production, respectively. Voicing, as found in previous studies, plays a role for both perception and production concerning palatalization, vowel paragoge, and aspiration. Palatalization was significantly less produced in the context of the voiced alveolar stop ($t(8) = 3.100, p < .016$), but no significant difference was found in the discrimination results between the voiced and voiceless alveolars. Differently, the voiced alveolars were more often produced with a paragodic vowel ($t(8) = -3.253, p < .013$) and were more discriminated in the context of its voiceless counterpart by all participants ($t(8) = 3.468, p < .009$). Finally, aspiration was subtle compared to palatalization and vowel paragoge. The production results show that the voiceless alveolar stop was significantly more frequently aspirated ($t(8) = 4.264, p < .004$) than the voiced one. The perception results revealed no significant

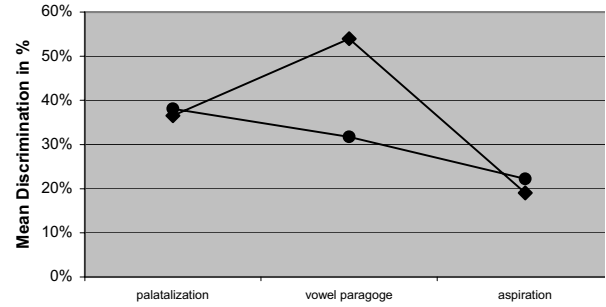


Figure 3: Mean discrimination in % by type of error and target sound (results of /t/ in diamonds and of /d/ in circles).

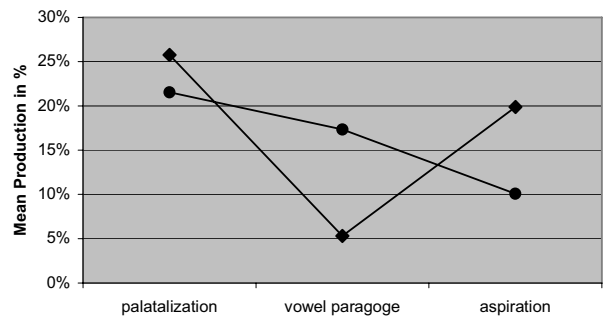


Figure 4: Mean production in % by type of error and target sound (results of /t/ in diamonds and of /d/ in circles).

difference between the discrimination of the voiced and voiceless aspirated items.

4. Conclusions

The main objectives of the present study were to analyze how Brazilian EFL learners produce English alveolar stops in coda position and to investigate whether there is a correlation between perception and production of these obstruents.

As regards production, the learners tended to produce the final alveolar stops in a native-like fashion, but many tokens were also aspirated, palatalized, and produced with a paragodic vowel.

Concerning the relationship between perception and production, being X equal to either word-final /t/ or /d/, the results show that the error which is more produced when the target sound is X may be less perceived when the target sound is X, that is, low perception rates correlated with more frequent misproduction. The voiceless alveolar stop was the most palatalized as well as aspirated sound, and also the least discriminated in perception concerning these two processes. The voiced alveolar stop was the sound to which a paragodic vowel was most frequently added, but items with a paragodic vowel were the least discriminated ones. However, *t*-tests showed that voicing of the alveolar stops did not play a significant role in the perception of aspirated and palatalized items.

Taking Flege's Speech Learning Model into consideration, these results seem to provide evidence that lack of phonological conscience of English final consonants, especially alveolar stops, examined in this study contributes to inaccurate and inconstant production [13].

The combination of markedness of the target sound concerning the variable *voicing* and markedness concerning *syllable structure* was also responsible for the higher frequency of vowel paragoge and for the lower rate of discrimination of CV.CV and CVC in the perception test when the target was the voiced alveolar stop.

More frequent production and poor discrimination of palatalization and aspiration for the voiceless alveolar stop were expected, since voiceless sounds are more susceptible to aspiration and palatalization, taking into account that the most salient difference between aspiration and palatalization is intensity.

Thus, the findings in this study corroborate previous L2 acquisition studies as regards the relationship between speech perception and production: accurate perception is related to accurate production [3], [4], [7], [11], [13], [15], [17].

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