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THE INTERPLAY BETWEEN LANGUAGE PROFICIENCY AND PHONOLOGICAL DEVELOPMENT: A STUDY ON ENGLISH CODAS PRODUCED BY BRAZILIAN LEARNERS

A RELAÇÃO ENTRE PROFICIÊNCIA E DESENVOLVIMENTO FONOLÓGICO: UM ESTUDO SOBRE A PRODUÇÃO DE CODAS DO INGLÊS POR APRENDIZES BRASILEIROS

LA RELACIÓN ENTRE COMPETENCIA Y DESARROLLO FONOLÓGICO: UN ESTUDIO SOBRE LA PRODUCCIÓN DE CODAS EN INGLÉS POR ESTUDIANTES BRASILEÑOS

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RESUMO: O presente estudo investigou a relação entre a proficiência e o desenvolvimento fonético-fonológico da língua estrangeira (L2) sob uma perspectiva longitudinal. Cinco aprendizes brasileiros de inglês participaram de duas coletas de dados com um intervalo de sete meses entre elas. Os participantes leram um parágrafo com ocorrências de duas consoantes nasais e um rótico em posição de coda final, /m n ɹ/. Proficiência oral foi medida através de uma tarefa de descrição de imagem avaliada por professores experientes de inglês. Os resultados revelam transferências linguísticas na produção das codas sendo /ɹ/ o segmento em que mais se observou ganhos de pronúncia entre as coletas. Análises estatísticas revelaram uma correlação forte e significativa entre proficiência e acurácia na produção dos fonemas na coleta inicial. Contudo, esta correlação não foi significativa na última coleta, indicando que o desenvolvimento das categorias fonológicas se deu independentemente do desenvolvimento da proficiência oral.
PALAVRAS-CHAVE: Desenvolvimento fonológico. Codas. Proficiência em L2. Produção

RESUMEN: Este estudio investigó la relación entre la competencia y el desarrollo fonético-fonológico de la lengua extranjera (L2) desde una perspectiva longitudinal. Cinco estudiantes brasileños de inglés participaron en dos recolecciones de datos con un intervalo de siete meses entre ellos. Los informantes leyeron un párrafo con apariciones de dos consonantes nasales y una rótica en la posición de coda final, /m n ɹ/. La competencia oral se midió mediante una tarea de descripción de imágenes. Los resultados revelan transferencias lingüísticas en la producción de codas, siendo /ɹ/ el segmento en el que se observaron las ganancias de pronunciación más pronunciadas entre las recolecciones. Los análisis estadísticos revelaron una correlación furte y significativa entre el nivel de inglés y la precisión en la producción de fonemas en la recolección inicial. Esta correlación no fue significativa en la última colección, lo que indica que el desarrollo de categorías fonológicas ocurrió independientemente del desarrollo de la competencia oral.
PALABRAS CLAVE: Desarrollo fonológico. Codas. Competencia en L2. Producción.

ABSTRACT: The present study investigated the correlation between second-language (L2) proficiency and phonological development within a longitudinal frame. Five Brazilian learners of English participated in two data collection sessions with a seven-month interval. Participants completed a paragraph reading task containing several instances of two nasals and a rhotic coda in word-final position, namely, /m n ɹ/. Proficiency was measured via experienced English teachers' ratings of an image description task. Results revealed cross-linguistic influences on coda production with vowel nasalization and deletion of the nasal codas, as well as frication and deletion of the rhotic coda. /ɹ/ was the segment that displayed considerable improvement over time. Statistical analyses unveiled a strong, significant relationship between proficiency and accuracy scores, but this relationship was not significant in the final data collection. The development of the phonological categories at issue seems to have occurred independently of participants' oral proficiency.
KEYWORDS: Phonological development. Consonant codas. L2 proficiency. Production.

1 INTRODUCTION

Second language (L2) speech development has a limited number of studies to date that adopt a longitudinal perspective, which is necessary to better understand how pronunciation develops as L2 proficiency progresses. This study adopts a theoretical perspective that sees language development as a "complex, dynamic, non-linear, self-organizing, open, emergent, sometimes chaotic, and adaptive" phenomenon (LARSEN-FREEMAN; CAMERON, 2008, p. 4). Consequently, it is expected that the sound systems of the first language (L1) and the L2 are constantly subject to changes based on cognitive resources and diverse linguistic and social experiences obtained throughout life (LARSEN-FREEMAN, 2014). This information allows each individual to build a unique L2 development pattern, which explains why individual differences are constant in the developing system since each learner has their own repertoire of resources and experiences and traces a distinctive learning path (BARBOZA, 2013).

Examining proficiency is also paramount to better understand L2 development in the framework adopted, as language experience is believed to reflect in the development of language proficiency. In this paper, language proficiency is operationalized according to Hulstijn's (2015) understanding. The author submits that proficiency can be understood, just like language cognition and ability, as knowledge of the language and as the ability to access, retrieve and use that knowledge in listening, speaking, reading, or writing (HULSTIJN, 2015, p. 21). Accordingly, the author states that knowledge of linguistic elements and the ability to use them form the heart of language proficiency. It is relevant to point out that proficiency explicitly regards language use, thus acknowledging the underlying role that empirical experience plays in language development. This is directly connected to the longitudinal endeavor of the present investigation.

Experience with language is, therefore, at the core of learning a new sound inventory, which will entail learning new contrasts (including both acoustic and articulatory information and their mappings), new restrictions on where these sounds occur, and a new prosodic system (BROSELOW; KANG, 2013; VAN LEUSSEN; ESCUDERO, 2015). At least initially, L2 development is shaped in resemblance to the L1 environment. Van Leussen and Escudero (2015) postulate that the initial state of L2 learning mirrors the result of L1 acquisition when L2 sounds will be perceived in the same fashion that these categories are produced in their L1. The development will be shaped by the acoustical differences and similarities between the phonemes of two languages in contact (VAN LEUSSEN; ESCUDERO, 2015). Framing this process into a dynamic agenda, the L1 sound system will act as an attractor that can make the learner process L2 sound information as being equivalent to L1 data, which ends up leading the learner to perceive and/or produce L2 sounds based on L1 sounds (DE BOT; LOWIE; VERSPOOR, 2007; LIMA JR, 2013; ZIMMER; ALVES, 2012).

Several studies have highlighted the fact that both the perception and the production of L2 sounds and syllable patterns improve as L2 proficiency progresses (examples for the case of Brazilian English learners in Zimmer (2004) and Silveira (2011)). However, these studies have adopted a cross-sectional design, which generally implies a single data collection session from a group of learners with different L2 proficiency levels. Cross-sectional data is insufficient to understand how proficiency influences the development of the L2 sound system, or the role played by other factors in the construction of the phonological grammar (e.g., formal learning experiences; L2 use; age; L1 variety).

The importance of adopting a longitudinal perspective lies in the fact that, in the development of an L2 system, progress and regression coexist since the learning of new structures can temporarily affect structures that were already present in the learners' system. Therefore, learners will have to find a space for both structures in their systems. This is a necessary path in the L2 development process (DE BOT; LARSEN-FREEMAN, 2011) and, as already discussed, is part of the set of predictions and implications of adopting a dynamic view of language development.

The central objective of this paper is to investigate how a group of Brazilian learners produces, at different learning stages, three types of consonants in word-final position. The English consonant codas selected for analysis are [m n ɹ]. These codas were selected due to results of previous studies reporting that they are subject to the transfer of L1 phenomena by Brazilian learners (KLUGE, 2004; OSBORNE, 2010; SCHADECH, 2013; SILVEIRA; GONÇALVES, 2017; ZIMMER, 2004) Moreover, these three types of syllable coda have at least orthographic representation in Brazilian Portuguese (BP), as illustrated by the examples *cem*, "hundred"; *hífen*, "hyphen"; *mar*, "sea". Furthermore, previous studies have shown that these codas continue to trigger the transfer of L1 phenomena even in data from informants with advanced proficiency level (CRISTÓFARO SILVA; CAMARGOS, 2016; SILVEIRA, 2012; SILVEIRA; GONÇALVES, 2017; ZIMMER, 2004).

Word-final nasals have different realizations in English and BP. In English, the nasal consonants are produced "by blocking the sound from coming out of the mouth, while allowing it to come out through the nose" (LADEFOGED, 2001, p. 53). English has three nasal codas, /m n ŋ/, and they are phonetically and phonologically distinct in word-final position, as demonstrated by the examples "clam" [klæm], "clan" [klæn], and "clang" [klæŋ].

Brazilian Portuguese has two nasal consonants, namely /m n/[1], both realized with the consonant gesture (*mala; novo)* in onset position only (CRISTÓFARO SILVA, 2002; SEARA; NUNES; LAZZAROTTO-VOLCÃO, 2015). It is important to emphasize, however, that word-final nasal consonants are not produced with blockage of the air in BP. Instead, the preceding vowel assimilates

[1] BP also has another consonant nasal /ɲ/, which is restricted to onset and appears in mid-word position only (e.g., *unha* [ũɲa], "nail"), but this consonant will not be discussed here given that our focus in on nasals in word-final position.

the nasal quality and the consonant loses its consonantal gesture[2] (KLUGE, 2009; MONAHAN, 2001), as demonstrated by the examples *som* "sound" [sõ] and *pólen* "pollen" [ˈpɔlẽj]. Consequently, in BP, differently from English, there is no contrast between nasal consonants in syllable-final position.

Turning to the rhotic sound, the most common realization of <r> in North-American varieties of English is the retroflex approximant [ɹ]. This phone "is produced with the tip of the tongue curled back toward the hard palate" (YAVAŞ, 2011, p. 69). The retroflex pronunciation of the orthographic <r> in General American English is found in all positions within a word: "road" [ɹowd], "car" [kaɹ]. Conversely, in the so-called non-rhotic varieties of English (e.g., British English) there is the deletion of the postvocalic <r> (e.g., "car" [ka:]) (COLLINS; MEES, 2013).

In Brazilian Portuguese, rhotics are often classified as "strong R" and "weak r" (CRISTÓFARO SILVA, 2010). The latter refers to the tap, which is represented by the phoneme /ɾ/, and appears in onset position. The former appears in onset in all word positions (e.g., *rua*, "street"). The production of the "strong R" is subject to dialectal variation and is conditioned by the phonological context; nevertheless, in word-final position, it is mostly realized as a velar fricative [x], a glottal fricative [h], or as a trill [r]. Moreover, in word-final position, rhotics may also be deleted (CRISTÓFARO SILVA, 2002). Thus, a word such as *mar* ("sea") may be pronounced in different ways (e.g., [mah, max, maɾ, maɹ, ma]).

Previous studies have pointed out that the English nasal and rhotic codas may pose difficulty to Brazilian learners (e.g., CRISTÓFARO SILVA; CAMARGOS, 2016; SILVEIRA; GONÇALVES, 2017). Yet, the literature lacks studies adopting a longitudinal design to investigate how the production of these word-final consonants develop as learners' proficiency level increases. Therefore, the present study aims at answering two research questions:

1) How do Brazilians produce English nasal and rhotic codas across time?
Hypothesis 1: Given that experience with language promotes L2 development, participants will display new categories for all types of codas across time.

2) What is the relationship between participants' proficiency level and how accurately they produce nasal and rhotic codas?
Hypothesis 2: The more proficient the participant is, the more accurately they produce the target codas.

In the section below, studies that investigate how Brazilians produce English nasal and rhotic consonants in word-final position are reviewed. Next, the method of the present study is presented, followed by a discussion of the results. Finally, some concluding remarks are presented.

2 LITERATURE REVIEW

In this section, we begin with studies that focus on the nasal codas and then review studies on the rhotic coda. Baptista and Silva Filho (2006) recorded six Brazilian learners at different proficiency levels reading a set of sentences containing CVC monosyllabic words ending in different types of English codas, including the three nasal consonants. The authors found that when the nasal consonants were not produced in a target-like fashion, they were vocalized 7.6% of the time, while 4.3% of the time the nasal consonants were fully produced, but followed by a paragogic vowel (e.g., *name* [ˈnejmi]).

Kluge (2004) also investigated the production of English word-final /m/ and /n/ by twenty Brazilians who were pre-intermediate learners of English. The results of her sentence-reading test showed a strong tendency of learners to nasalize the preceding vowel

[2] There is still an ongoing debate among researchers about the status of the nasal coda in Brazilian Portuguese. Some researchers follow Câmara's (1977) proposal of using the archiphoneme /N/ to transcribe these codas, based on the assumption that BP has seven oral vowels, and that nasal vowels are actually biphonemic and should be represented by the nasal vowel followed by /N/ (e.g., BISOL, 2001; CRISTÓFARO SILVA, 2002; MEDEIROS, 2012). We side with the second position, which defends that BP has 12 vowels, seven oral vowels and five nasal vowels (PONTES, 1972), as demonstrated by minimal pairs such as *lã* 'wool' [lɐ̃] and *lá* 'there' [la]. In this view, we dispense with the use of the nasal archiphoneme.

and delete the final nasal. The number of inaccurate productions reached 38.66%; 91.96% of them were the result of the deletion of the nasal consonant with vowel nasalization, 8.75% showed deletion of the nasal consonant, with no nasalization, and less than 1% resulted from producing the nasal coda followed by a paragogic vowel. The author points out that the alveolar nasal (73.25% of accurate responses) was more often produced in a target-like manner than the bilabial nasal (48.44% of accurate responses), possibly because the participants are more likely to transfer the L1 process to words ending in the most common spelling pattern for the nasal coda in BP, which is the <m> grapheme. In this study, the rate of vocalization is considerably high among pre-intermediate learners of English.

Zimmer (2004) investigated the production of a number of word-final consonants by 156 Brazilian learners of English at four different proficiency levels. Her focus was on the occurrence of phonological processes transferred from the participants' L1 into the L2. Concerning the English nasal codas, Zimmer (2004) reports that nasal vocalization was among the least frequent processes (12%), and clearly more recurrent in the data of the less proficient informants (levels 1 and 2).

The three studies reviewed in the previous paragraphs report on data from Brazilian learners of English residing in Brazil and whose language learning experiences are mostly classroom-based. Silveira and Gonçalves (2017) examined data from 24 Brazilians residing in the United States (mean time of residence: 9.19 years, mean age: 38.1, mean years of formal education: 12.9). Participants recorded a set of meaningful sentences (e.g., 'There is no room here.' / 'Let's play a game.'). The target words were all monosyllabic and C(C)VC. Each of the two target consonants was tested with words ending with a consonant grapheme (e.g., 'sun', 'room'), and with a consonant followed by a silent –e grapheme (e.g., 'pine', 'time'). Results showed 16% of vocalization of the consonants ending with the consonant grapheme and 5.6% of vowel paragoge for the target words spelled with a silent –e grapheme. The authors correlated the vocalization and paragoge rates with the participants' English proficiency measure and obtained weak-to-moderate, significant negative correlations. In other words, the more proficient the participants were, the more accurately the participants produced the nasal codas.

Turning to previous studies on the production of English rhotics, Osborne (2010) investigated the production of English rhotics by three Brazilians, all residing in the United States (length of residence: 45 days to 6 years). Two participants were originally from the state of Minas Gerais and one was from the state of Bahia. The author collected extemporaneous speech data and examined the rhotic production in onset and coda positions. The results showed that in word-final position, the English rhotic was deleted by the participants 52.5% of the time. When the rhotic was not deleted, it was produced as a retroflex (27.5%) or a fricative (20%).

Cristófaro Silva and Camargos (2016) investigated the production of the English rhotic by two groups of speakers from the state of Minas Gerais (from the cities of Belo Horizonte and Lavras), Brazil. These speakers represent varieties of Brazilian Portuguese that differ in the way the rhotic is produced in word-final position: In Lavras, the rhotic is produced as a retroflex, and in Belo Horizonte, as a fricative. Sixteen participants had basic English proficiency level, and sixteen were advanced users. Results showed that the students from the retroflex variety obtained nearly 100% of productions with the retroflex in the English words, while the participants from the fricative variety reached 87% of productions with the retroflex. The authors also present the results splitting the participants from the non-rhotic variety according to their proficiency level. In summary, English retroflex posed more difficulties to beginners (74.3% of target productions) than to advanced learners (98.7% of target production).

Overall, the studies reviewed in this section provide evidence that the production of nasal consonants by Brazilians vary according to proficiency level, being relatively challenging for low-proficiency learners. The production of nasal codas is often influenced by experience with the learners' L1 (VAN LEUSSEN; ESCUDERO, 2015). Among the phonological processes that influence nasal coda production, studies have documented vocalization (BAPTISTA; SILVA FILHO, 2006; KLUGE, 2004; SILVEIRA; GONÇALVES, 2017; ZIMMER, 2004), deletion (KLUGE, 2004), and insertion of a paragogic vowel (BAPTISTA; SILVA FILHO, 2006; KLUGE, 2004; SILVEIRA; GONÇALVES, 2017). Kluge (2004) and Zimmer (2004) also acknowledge that the difficulty in producing these segments might have been related to participants' low proficiency level in the L2.

Concerning the rhotic category, deletion (OSBORNE, 2010) and the substitution of the target sound with a fricative (CRISTÓFARO SILVA; CAMARGOS, 2016; OSBORNE, 2010) are the two processes that influenced production in the L2. Again, difficulties in production are linked to participants' proficiency in the L2, and also with the L1 variety spoken by the participant (CRISTÓFARO SILVA; CAMARGOS, 2016). Having discussed how these L2 codas are generally learned by Brazilians, we move on to the method of this study.

3 METHOD

The data presented here is part of a research project that was approved by the Ethics in Research Board at the Federal University of Santa Catarina. We begin this section by describing the speakers who provided data for the study. Then, we explain the research instruments used to collect data from the speakers and to assess their proficiency level and experiences as English learners. Next, we provide information about the procedures used for data collection and analysis.

3.1 PARTICIPANTS

Five Brazilians attending English classes provided data for the study. These participants were recruited from two undergraduate programs at a university located in the State of Santa Catarina. Initially, eleven participants volunteered to be part of the study, but only five of them were present in two data collection sessions. As shown in Table 1, four of the five participants were enrolled in the Executive Secretariat (ES) program (3 females and 1 male), and one of them was a student at the English Language and Literature (ELL) program (female). Their ages ranged from 18 to 32 (mean = 22.8). Four participants were from cities located in the South (Florianópolis and Ampére) and one was from a city in the North of Brazil (Santarém). Participants' rhotic variety in BP is displayed in Table 1.

Table 1: Speakers' background

Participant	Major	Age	Sex	Rhotic variety
P1	ES	18	F	Fricative in onset and coda
P2	ELL	18	F	Fricative in onset and retroflex in coda
P3	ES	21	M	Fricative in onset and coda
P4	ES	25	F	Fricative in onset and coda
P5	ES	32	F	Fricative in onset and retroflex in coda

Source: Authors

Considering the variation of rhotics in Brazilian Portuguese, it is important to highlight that we examined speech samples produced by the participants when reading sentences in BP. Three of the participants (P1, P3, and P4) produced /r/ as fricatives in all syllable positions, and two of them (P2 and P5) produced /r/ as a fricative in onset position, but as a retroflex in syllable coda or word-final position.

3.2 INSTRUMENTS AND PROCEDURES TO COLLECT SPEECH SAMPLES

Speech data were obtained with the help of a Paragraph Reading Test (Appendix 1). The test contained 47 target words: Thirteen words ending in a bilabial nasal consonant (e.g., "some", "seem"), 12 words ending in an alveolar nasal consonant (e.g., "known", "one"), and 22 words ending in a rhotic consonant (e.g., "member"). Each participant was recorded reading the text twice, first in Time 1 and then in Time 2, thus yielding 470 tokens to be analyzed (47 words; two data collection sessions; 5 participants).

To assess participants' oral proficiency level, an Image Description Test, adapted from Silveira (2011, 2012) was used. The test consisted of five slides with unrelated images, which participants were asked to describe orally. Their descriptions were recorded and rated by experienced English teachers (details in SILVEIRA; MARTINS, 2020).

Participants also answered a questionnaire where they provided details about their experiences as English language learners. The questionnaire gathered information about participants' age, gender, city of origin, educational level, foreign language knowledge, learning experiences, and L2 use.

Participants were tested individually. The recording sessions took place at the Applied Phonetics Laboratory (FONAPLI), which is equipped with an acoustic booth, a *C 520 L* professional head-worn condenser microphone connected to a hybrid audio interface *MOTU Ultra Lite mk3,* and an audio editor software (*Ocean Audio*) mono connected to an iMac computer to record the speech data. The first data collection session started with participants signing the consent form and completing the background questionnaire. The next step was to have the participants record the Image Description Test. Finally, participants recorded four production tests (two in Portuguese and two in English). In the present paper, we report on data from one of these tests, the second test to be recorded, that is, the Paragraph Reading Test. Participants were instructed to read the paragraphs silently and, when feeling ready, inform the research assistant who initiated the recording. Participants took about 60 minutes to complete the first data collection session.

About 7 to 8 months later, participants were tested again. This data collection session comprised the Image Description Test (for proficiency measure purposes) and the production tests. Participants followed the same instructions as in Time 1. Participants took about 40 minutes to complete this data collection session.

3.3 DATA ANALYSIS

The word containing the target sound together with the following phonetic context were segmented using Praat (BOERSMA; WEENINK, 2019) and phonetically transcribed by one of the authors and a research assistant. The transcriptions were checked by another author. Complete agreement was obtained. The transcription relied greatly on auditory perception, but acoustic information provided by Praat (BOERSMA; WEENINK, 2019) also assisted in the transcriptions. Based on the transcriptions, the number of accurate productions for each type of coda was calculated and the types of non-target productions were identified.

The proficiency level of the five Brazilian students was estimated by three experienced teachers (mean language teaching experience: 16.6 years), two Brazilians pursuing a Doctoral degree in English Applied Linguistics, and an Australian holding a BA in English Teaching. The initial 30-second speech sample of each informant performing the Image Description Test was selected to be rated. The audio files were edited using the Audacity® to remove low-frequency noise and to normalize the samples to the same peak level. Samples from the two data collection sessions and speech samples from other speakers (English native speakers and Brazilians with high English proficiency levels) were presented to the raters in a randomized order.

The raters were instructed to use a Proficiency Assessment Form to rate the speech samples using an adapted version of the Overall Speech Production Scale provided by the CEFR (2001, p. 58), and four rating scales to assess the speakers' pronunciation, vocabulary, grammar and fluency (SILVEIRA; MARTINS, 2020). This paper will focus on the holistic scores based on the CEFR scale with the objective of minimizing possible influences of participants' segmental pronunciation on the overall oral proficiency score. The Overall Speech Production Scale included seven descriptors that placed participants in one of the CEFR levels: C2, C1, B2, B1, A2, A1, and a descriptor that indicates lack of proficiency. Each descriptor was converted into numbers to allow statistical analysis, using a scale that ranged from 1 (lack of proficiency) to 7 (C2 level). The average proficiency rate for each participant was calculated for Time 1 and Time 2 using the ratings assigned by the raters. Cronbach alfa was calculated to check for interrater reliability, which showed a high-reliability rate for both data collection times (Time 1: Cronbach $\alpha = .92$; Time 2: Cronbach $\alpha = .89$), exceeding the benchmark value of .70–.80 (LARSON-HALL, 2010).

The questionnaire data were tabulated to understand the kinds of experiences participants have had as language learners. Later on, these results will be examined in order to discuss the findings of the coda production and proficiency development.

In order to answer the first research question and test its accompanying hypothesis, we calculated the vowel production accuracy scores for each data collection session (Time 1 and Time 2), combining the scores for the three consonants tested. Descriptive statistics (mean, standard deviation, minimum and maximum scores) and gain scores were calculated. Then, the mean scores for Time 1 and Time 2 were compared using a non-parametric t-test (Wilcoxon signed-ranks test). Next, we repeated the same procedures, but this time we obtained separate accuracy scores for each of the three codas and we ran three Wilcoxon tests to compare the means from Time 1 and Time 2 for each type of coda.

To answer the second research question, the coda accuracy scores with all codas combined were correlated with the proficiency rates obtained by the participant. Two-by-two non-parametric correlations (Spearman) were run with the data from Time 1 and from Time 2. The software SPSS 20.0 was used for all statistical procedures and alpha was set at .05.

4 RESULTS AND DISCUSSION

This study aimed at investigating the development of English nasal and rhotic codas by Brazilian learners at different proficiency levels. In order to answer the first research question ("How do Brazilians produce English nasal and rhotic codas across time?"), we tested the hypothesis that the participants would display new categories for all types of codas across time. Table 2 shows the number of accurate productions for the three codas combined, for Time 1 and Time 2, in addition to the gain score (Time 2 minus Time 1) for each participant.

Table 2: Total accuracy production for Time 1, Time 2, and gain score (all codas)

Participant	Accuracy Scores—Time 1	Accuracy Scores—Time 2	Gain
P1	42 (89.36%)	45 (95.74%)	3
P2	42 (89.36%	44 (93.61%)	2
P3	40 (85.10%)	43 (91.48%)	3
P4	36 (76.59%)	38 (80.85)	2
P5	39 (82.97%)	44 (93.61%)	5
Mean	39,8	42,8	
SD	2,48	2,77	

Maximum score possible = 47

Source: Authors

As can be seen in Table 2, all codas combined show high rates of accurate productions in both Time 1 and Time 2, with slightly higher percentages and a higher mean for Time 2 (42,8) when compared to Time 1 (39,8). The gain scores confirm that in a period of 7-8 months after the first data collection, participants displayed improvement in the way they produced the nasal and rhotic codas. P5 was the participant who displayed the most improvement (gain score = 5).

In order to check whether the change in performance across time was significant, a Wilcoxon test was run to compare Time 1 and Time 2 results. The test confirmed that the change in performance across time was not due to chance, but because something else (possibly gains in proficiency) triggered this change ($Z = -2.04$, $p = .04$).

Figure 1 allows us to look into the results per participant more clearly across time. P1 and P2 obtained the highest accuracy scores in Time 1, and P2 and P3 obtained very similar scores in Time 1, in contrast with P4, who obtained the lowest score. In Time 2, P1 and P3 improved their performance slightly and obtained similar scores, while P2 displayed little improvement in Time 2. However, P4 still remained with the lowest score, displaying little change across time, contrary to P5, who managed to improve performance and obtained the highest score for Time 2. Such results interestingly shed light on the understanding that learning paths are non-linear and vary as participants trace distinctive trajectories with the language (BARBOZA, 2013).

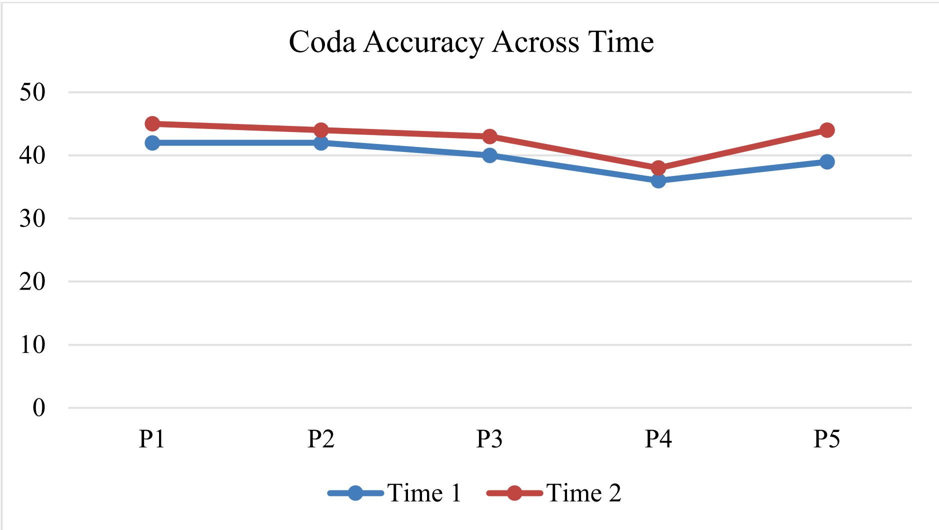


Figure 1: Participants' accuracy scores across time
Source: Authors

Considering the overall results, it is interesting to examine whether the participants improved with all types of codas. Table 3 shows the descriptive statistics for each nasal coda and for the rhotic coda across time, while Table 4 shows the gain scores for each participant. The non-target productions of the codas occurred when the participants nasalized the vowels and deleted the consonants for the nasal codas, or when they produced the rhotic as a fricative or deleted it, thus echoing previous research (BAPTISTA; SILVA FILHO, 2006; KLUGE, 2004; OSBORNE, 2010; SILVEIRA; GONÇALVES, 2017; ZIMMER, 2004).

Table 3: Accuracy scores for each type of coda in Time 1 and Time 2

	/m/ Time 1	/m/ Time 2	/n/ Time 1	/n/ Time 2	/ɹ/ Time 1	/ɹ/ Time 2
Mean	12.60	12.40	8.0	9.2	18.40	20.20
SD	0.54	0.89	0.70	1.48	1.94	1.30
Min-max	12-13	11-13	7-9	7-11	15-20	19-22
N	13	13	12	12	22	22

Source: Authors

Table 4 : Gain scores for each type of coda

Participant	/m/	/n/	/ɹ/
P1	0	1	2
P2	-1	1	2
P3	0	1	1
P4	-1	-1	4
P5	1	4	0

Source: Authors

The results show that the bilabial coda is the one that poses less difficulty, with participants displaying means over 12 points out of 13. There was little room for improvement for the bilabial nasal coda, as all participants obtained very high accuracy scores in Time 1, and yet Time 2 results show slightly worse performance due to P2 and P5 decreasing one score point in Time 2 (Table 4). The alveolar nasal coda posed more difficulty to the participants, with the means ranging from 8 (Time 1) to 9.2 (Time 2), out of a maximum of 12 points possible. There is a considerable increase in the mean for Time 2, triggered by the improved performance of four participants—but notably of P5, who managed to improve performance in four points. Finally, participants produced 22 tokens of the rhotic coda, which posed some difficulty to all the participants in Time 1 (mean = 18.40). Nevertheless, there was an improvement in Time 2 (mean = 20.20). As shown in Table 4, four participants improved their performance with the rhotic coda in Time 2, but P4 was the one who improved the most (four score points).

As the number of tokens for each type of coda was different, conducting statistical tests to compare them was not deemed appropriate. Hence, participants' performance for each coda across time was compared to investigate possible changes in segmental pronunciation. Wilcoxon tests were used to compare Time 1 and Time 2 scores for each type of coda. Results showed no significant improvement for the bilabial nasal coda (Z = - .57, p = .56), nor for the alveolar nasal coda (Z = -1.41, p = .15). However, for the rhotic coda, the test approached significance (Z = -1.84, p = .06), thus suggesting that this type of coda displayed considerable improvement across time.

To investigate pronunciation development, Figure 2 displays participants' performance across time for all consonants combined (Figure 2a) and for each consonant separately (Figure 2b-d). As noted, each type of consonant shows different performance patterns, which demonstrates different learning paths for each participant in consonance with the theoretical framework adopted, depending on the type of coda being analyzed.

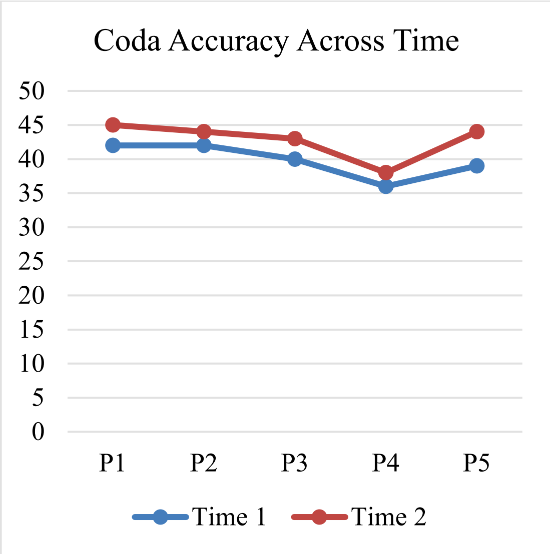


Figure 2a: Participants' accuracy scores across time for all consonants
Source: Authors

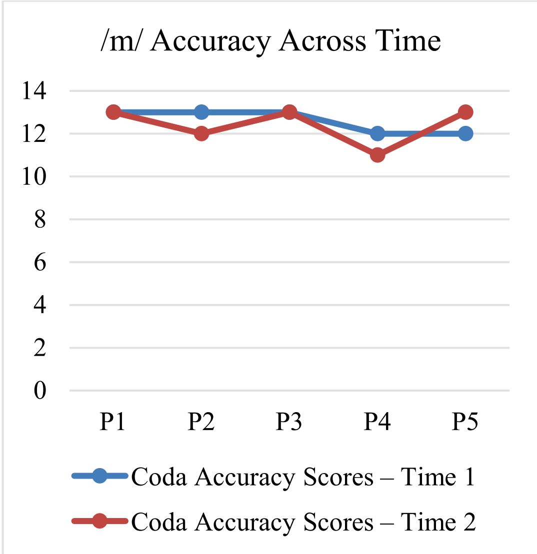


Figure 2b: Participants' accuracy scores across time for /m/
Source: Authors

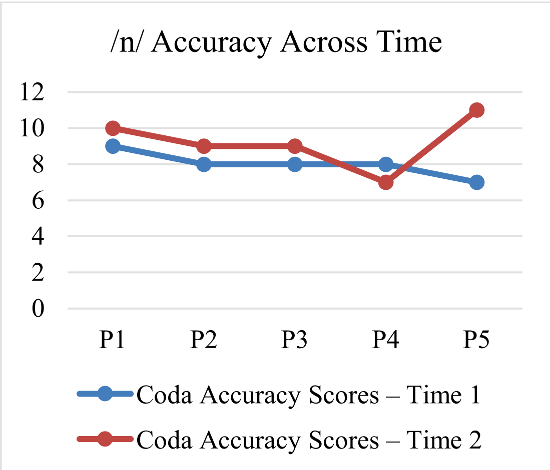


Figure 2c: Participants' accuracy scores across time for /n/
Source: Authors

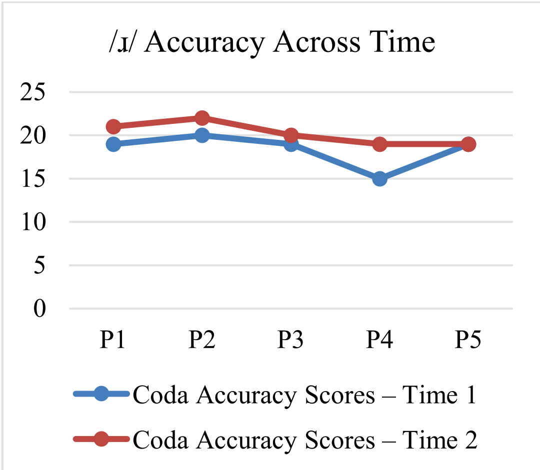


Figure 2d: Participants' accuracy scores across time for /ɹ/
Source: Authors

For the bilabial nasal (Figure 2b), each participant produced 13 tokens and very high accuracy scores were achieved (range = 11-13). Although Time 1 data tends to mirror the results of all codas combined (Figure 2a), with P1, P2, and P3 displaying the highest scores, and P4 and P5 with the lowest scores, Time 2 data shows a very different scenario. While P1 and P3 continued to perform equally well, P2 and P4 worsened their performance, and P5 improved performance.

Figure 2c shows the results for the alveolar nasal. Twelve tokens of /n/ were produced by each participant, and this nasal coda yielded lower accuracy scores than the bilabial nasal (range = 7-11). P1 continued to be the participant with the best performance in Time 1, but P2, P3, and P4 displayed the same performance, and P5 was the participant with the lowest scores. For Time 2, all participants except P4 showed improvement, but P5's performance was strikingly better, reaching an increase of four score points.

Figure 2d shows the results for the 22 tokens of rhotic codas produced by each participant. Here we can see that the rhotic coda yielded high accuracy for all participants (range: 15-22), except for P4 in Time 1. P1 and P2 displayed the best performances in Time 1 and Time 2, while P3 and P5 displayed little or no change in scores. P4, however, managed to improve performance the most in Time 2, with a gain score of four points.

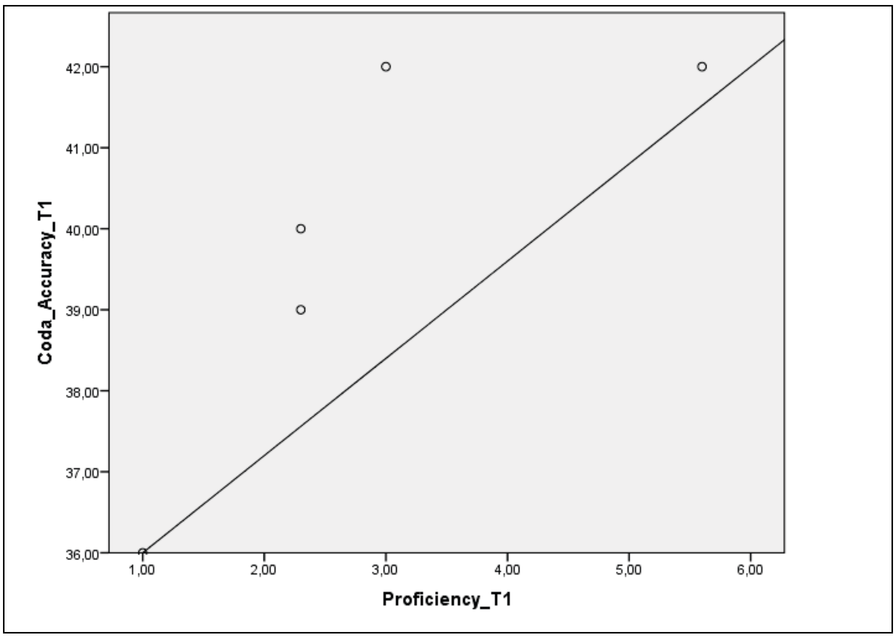
Turning to the second research question, we correlated participants' coda accuracy with their proficiency ratings across time. Table 5 displays the results for proficiency and coda accuracy scores across time, as well as means and standard deviations. As discussed before, participants showed significant improvement for the coda accuracy scores across time, as demonstrated by a Wilcoxon test. In Table 5, we observe that participants' proficiency level also improved across time. A Wilcoxon test confirmed that the difference was significant ($Z = -2.03$, $p = .04$).

Table 5: Participants' proficiency rates and coda accuracy scores across time

Participant	Proficiency T1	Proficiency T2	Accuracy T1	Accuracy T2
P1	3.0	4.0	42	45
P2	5.6	6.0	42	44
P3	2.3	3.3	40	43
P4	1.0	1.3	36	38
P5	2.3	2.6	39	44
Max. score possible	7	7	47	47
Mean	5.0	6.0	39.8	42.8
SD	2.8	3.4	2.4	2.7

Source: Authors

In order to answer the second research question, the performance patterns of each participant in both the proficiency measure and in the coda accuracy measure had to be analyzed. P2 starts with the highest proficiency rates and P4 displays the lowest rates, while P1, P2, and P3 had similar rates. The accuracy scores present slightly different performances, with P1 holding the highest scores and P4 the lowest ones. The scatterplots in Figure 3 illustrate the positive relationship found between proficiency development and accuracy scores across time.



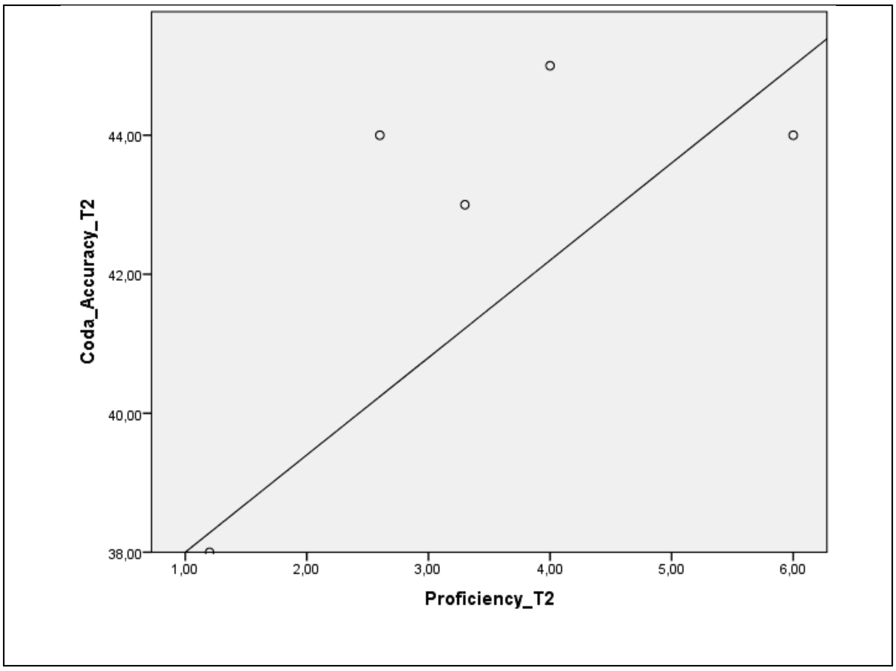


Figure 3: Scatterplots displaying the relation between proficiency and coda accuracy scores for Time 1 and Time 2

Source: Authors

Spearman correlation tests were conducted to check the relationship between proficiency and segmental accuracy. Results for Time 1 yielded a strong, positive, significant correlation (rho = .94, p = .01) according to field-specific guidelines (PLONSKY; OSWALD, 2014). For Time 2, the correlation coefficient was positive, strong, but reached no significance (rho = .66, p = .21). Thus, hypothesis 2 is partially confirmed, since even though we can observe a strong, significant relationship between proficiency rates and accuracy scores, it is no longer significant in the posttest. This result in Time 2 is probably due to the fact that P5 presents a striking improvement for the coda accuracy score (second-highest score), but not for the proficiency variable (second-lowest score) in Time 2, which may have an important impact on the coefficient considering the small sample size.

In summary, the codas selected for the present study presented little-to-medium difficulty to the Brazilian learners of English tested. Furthermore, as proficiency advanced, participants' production of the target codas tended to improve. One participant, in particular, P5, exhibited great improvement (5 score points) compared to the others, who increased two or three points in their accuracy scores for Time 2. All these participants were university students attending formal English classes four or five times a week and their experiences as English learners and users were very similar, as reported by them in the biographical questionnaire. P5 reported fewer years studying English (2 years in elementary school) than the others, who reported having studied English in in elementary school, high school, and in private English courses. This might suggest that P5's pronunciation is being boosted by the intense contact with the L2 in formal classes, yet his proficiency level is developing slowly. Turning to the results for each type of coda, P4, who is the participant with the lowest proficiency level, also managed to improve considerably the production of the rhotic coda, but her proficiency level showed little improvement. Further studies need to have a closer look at the participants' experience in order to understand how it relates to the development of L2 codas.

5 FINAL CONSIDERATIONS

The present study investigated the production of English nasal and rhotic codas by Brazilian learners within a seven or eight-month interval. Results indicated that these phonetic categories present little-to-medium difficulty to the learners as participants demonstrated high levels of segmental accuracy at both Time 1 and Time 2. Moreover, results demonstrate that as participants' proficiency advanced, accuracy in the production of the codas tended to improve. The bilabial coda was the one that posed less difficulty overall when compared to the alveolar nasal coda and the rhotic coda. The latter posed some difficulty to all the participants in the beginning, and it was the category in which four (out of five) participants improved their performance. Considering participants' individual trajectories, P5 exhibited great improvement (5 score points) if compared to others, who increased two or three points in their coda accuracy scores for Time 2. This finding suggests that P5's pronunciation was boosted by the contact with the language in formal classes, yet his proficiency level was developing slowly.

Further studies in this agenda need to include a larger sample of participants in order to obtain more robust and generalizable results. Furthermore, statistical models might factor in participants' L1 dialect, considering the influence that regional variation of the rhotic coda in Brazilian Portuguese may pose to learning English phonological inventory. Additionally, other testing sessions might be included to gather insights on the role of experience in phonological categories development.

As a final word, this paper showed that phonological knowledge and overall gains in oral proficiency tend to develop in tandem, but are independent and do not always display correlated results. This calls for the need of pedagogically-driven efforts that lead learners' attentional resources to focus on specific categories of the L2 phonological inventory. Techniques such as perception training and explicit pronunciation instruction (addressing, for example, sound-spelling correspondence in the L2) might be beneficial in shaping learners' experience with the target language, especially when included along with communicative practices that are meaningful to learners in the classroom.

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REFERENCES

BAPTISTA, B. O.; SILVA FILHO, J. L. A. The influence of voicing and sonority relationships on the production of English final consonants. *In*: BAPTISTA, B. O.; WATKINS, M. A. (org.). *English with a Latin beat: Studies in Portuguese/Spanish-English interphonology*. Amsterdam/Philadelphia: John Benjamins Publishing Company, 2006. p. 73-89.

BARBOZA, C. L. F. *Efeitos da palatização das oclusivas alveolares do português brasileiro no percurso de construção da fonologia do inglês língua estrangeira*. 2013. Tese (Doutorado em Linguística) – Programa de Pós-Graduação em Linguística, Centro de Humanidades, Universidade Federal do Ceará, Fortaleza, 2013. Disponível em: http://www.repositorio.ufc.br/handle/riufc/8225. Acesso em: 20 set. 2020.

BISOL, L. *Introdução a estudos de fonologia do Português Brasileiro*. 3. ed. Porto Alegre: EDIPUCRS, 2001.

BOERSMA, P.; WEENINK, D. *Praat:* Doing phonetics by computer. Versão 6.0.46. *[S. l.]*, 2019.

BROSELOW, E.; KANG, Y.. Second language phonology and speech. In: HERSCHENSOHN, J.; YOUNG-SCHOLTEN, M. (org.). *The Cambridge handbook of second language acquisition*. Cambridge: Cambridge University Press, 2013. p. 529–554.

CÂMARA, J. M. *Para o estudo da fonêmica portuguesa*. 2. ed. Rio de Janeiro: Padrão, 1977.

COLLINS, B. S.; MEES, I. M.. *Practical phonetics and phonology*. 3. ed. Londres: Routledge, 2013.

CRISTÓFARO SILVA, T.. Branching onsets in Brazilian Portuguese. *Revista de Estudos da Linguagem*, [S.l.], v. 10, n. 1, p. 91-107,

2002. Disponível em: http://dx.doi.org/10.17851/2237-2083.10.1.91-107. Acesso em: 20 set. 2020.

CRISTÓFARO SILVA, T.. *Fonética e fonologia do português:* roteiro de estudos e guia de exercícios. 10. ed. São Paulo: Contexto, 2010.

CRISTÓFARO SILVA, T.; CAMARGOS, M. A.. Conhecimento fonológico e apropriação de róticos em inglês L2 por falantes nativos de português brasileiro. *Ilha do Desterro*, Florianópolis, v. 69, n. 1, p. 049, 2016. Disponível em: http://dx.doi.org/10.5007/2175-8026.2016v69n1p49. Acesso em: 20 set. 2020.

DE BOT, K.; LARSEN-FREEMAN, D.. *A dynamic approach to second language development*. Amsterdam: John Benjamins Publishing Company, 2011.

BOT, K.; LOWIE, W.; VERSPOOR, M.. A Dynamic Systems Theory approach to second language acquisition. *Bilingualism*: Language and Cognition, [S.l.], v. 10, n. 01, p. 7, 2007. Disponível em: http://dx.doi.org/10.1017/s1366728906002732. Acesso em: 20 set. 2020.

HULSTIJN, J. H. *Language proficiency in native and non-native speakers*. Amsterdam: John Benjamins Publishing Company, 2015.

KLUGE, D. C.. *Perception and production of English syllable-final nasals by Brazilian learners*. 2004. Dissertação (Mestrado em Inglês e Literatura Correspondente) – Programa de Pós-Graduação em Letras-Inglês e Literatura Correspondente, Centro de Comunicação e Expressão, Universidade Federal de Santa Catarina, Florianópolis, 2004.

KLUGE, D. C.. *Brazilian EFL learners' identification of word-final /m-n/: native/nonnative realizations and effect of visual cues.* 2009. Tese (Doutorado em Inglês e Literatura Correspondente) - Programa de Pós-Graduação em Letras-Inglês e Literatura Correspondente, Centro de Comunicação e Expressão, Universidade Federal de Santa Catarina, Florianópolis, 2009.

LADEFOGED, P. *A course in phonetics*. 4. ed. Boston: Houghton Mifflin Harcourt, 2001.

LARSEN-FREEMAN, D. Saying what we mean: Making a case for "language acquisition" to become "language development". *Language Teaching*, [S.l.], v. 48, n. 4, p. 491-505, 2014. Disponível em: http://dx.doi.org/10.1017/s0261444814000019. Acesso em: 20 set. 2020.

LARSEN-FREEMAN, D.; CAMERON, L. *Complex systems and applied linguistics*. Oxford: Oxford University Press, 2008.

LARSON-HALL, J. A guide to doing statistics in second language research using SPSS. Nova Iorque: Routledge, 2010.

LIMA JR, R. M. Complexity in second language phonology acquisition. R*evista Brasileira de Linguística Aplicada*, [S.l.], v. 13, n. 2, p. 549-576, 2013. Disponível em: http://dx.doi.org/10.1590/s1984-63982013005000006. Acesso em: 20 set. 2020.

MEDEIROS, B. R. Uma proposta sobre a coda do português brasileiro a partir da fonologia gestual, com foco especial na nasal. *Revista da ABRALIN, [S. l.],* v. 11, n. 1, 2012.

MONAHAN, P. J. *Evidence of transference and emergence in the interlanguage* (DOC 444-0701). Rutgerss Center of Cognitive Science, 2001.

OSBORNE, D. M. The production of rhotic sounds by Brazilian speakers of English. *Arizona Working Papers in SLA & Teaching, [S. l.],* v. 17, p. 1–25, 2010.

PLONSKY, L.; OSWALD, F. L. How big is “big”? Interpreting effect sizes in L2 research. *Language Learning*, [S.l.], v. 64, n. 4, p. 878-912, 2014. Disponível em: http://dx.doi.org/10.1111/lang.12079. Acesso em: 20 set. 2020.

PONTES, E. *Estrutura do verbo no português coloquial*. 1. ed. Rio de Janeiro: Vozes, 1972.

SCHADECH, T. S. *The production of word-initial /ɹ/ by Brazilian learners of English and the issues of comprehensibility and intelligibility*. 2013. Dissertação (Mestrado em Inglês e Literatura Correspondente) – Programa de Pós-Graduação em Letras-Inglês e Literatura Correspondente, Centro de Comunicação e Expressão, Universidade Federal de Santa Catarina, Florianópolis, 2013.

SEARA, I. C.; NUNES, V. G.; LAZZAROTTO-VOLCÃO, C. *Para fonética e fonologia do português brasileiro*. São Paulo: Contexto, 2015.

SILVEIRA, R. Pronunciation instruction and syllabic-pattern discrimination. *DELTA*: Documentação de Estudos em Linguística Teórica e Aplicada, [S.l.], v. 27, n. 1, p. 21-36, 2011. Disponível em: http://dx.doi.org/10.1590/s0102-44502011000100002. Acesso em: 20 set. 2020.

SILVEIRA, R. PL2 production of english word-final consonants: The role of orthography and learner profile variables. *Trabalhos em Linguística Aplicada*, [S.l.], v. 51, n. 1, p. 13-34, 2012. Disponível em: http://dx.doi.org/10.1590/s0103-18132012000100002. Acesso em: 20 set. 2020.

SILVEIRA, R.; GONÇALVES, A. R. English sonorant codas in a Brazilian Portuguese-English bilingual context. *In*: YAVAS, M.; KEHOE, M; CARDOSO, W. (org.). *Romance-Germanic bilingual phonology*. Sheffield: Equinox, 2017. p. 244-262.

SILVEIRA, R.; MARTINS, T. S. Assessing second language oral proficiency development with holistic and analytic scales. *Ilha do Desterro*, [S.l.], v. 73, n. 3, p. 227-250, 2020. Disponível em: http://dx.doi.org/10.5007/2175-8026.2020v73n3p227. Acesso em: 20 set. 2020.

VAN LEUSSEN, J.-W.; ESCUDERO, P. Learning to perceive and recognize a second language: The L2LP model revised. Fr*ontiers in Psychology*, [S.l.], v. 1000, n. 6, p. 1-12, 4 ago. 2015. Disponível em: http://dx.doi.org/10.3389/fpsyg.2015.01000. Acesso em: 20 set. 2020.

YAVAŞ, M. *Applied English phonology*. 2. ed. Oxford: Wiley-Blackwell, 2011.

ZIMMER, M. C. *A transferência do conhecimento fonético-fonológico do português brasileiro (L1) para o inglês (L2) na recodificação leitora:* uma abordagem conexionista. 2004. Tese (Doutorado em Letras) - Programa de Pós-Graduação em Letras, Faculdade de Letras, Potifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, 2004.

ZIMMER, M. C.; ALVES, U. K. Uma visão dinâmica da produção da fala em L2: o caso da dessonorização terminal. *Revista da ABRALIN*, *[S.l.]*, v. 11, n. 1, p. 221–272, 2012.

APPENDIX A – PARAGRAPH READING TEST

Some friends come into our lives for just a short time. Others come and stay forever. Think about your closest friends. How long have you known each other? Some people say that their spouse or family member is their best friend. Others say they have known their closest friends for many years. And some great friends haven't known each other all that long, but knew right away that there was a connection, or bond, between them. Could it be that there is a twin spirit out there for each of us?

What turns a stranger or acquaintance into a friend? Do you know right away if you are going to like someone? Some people think that any stranger can become a friend if they spend enough time together. That may be true for some people. But one thing most of us agree on is that true friendships seem to happen when people have something in common. Perhaps we see a part of ourselves in our friends. Maybe seeing the good in them helps us to see the good in us as well.

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