UNIVERSIDADE FEDERAL DE SANTA CATARINA
CENTRO DE COMUNICAÇÃO E EXPRESSÃO
DEPARTAMENTO DE LÍNGUA E LITERATURA ESTRANGEIRAS
CURSO DE LETRAS INGLÊS

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Second language use and phonological self-awareness as variables in the pronunciation of four English front vowels by Brazilian learners of English

Florianópolis
2024

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Trabalho de Conclusão de Curso submetido ao curso de Letras Inglês do Centro de Comunicação e Expressão da Universidade Federal de Santa Catarina como requisito parcial para a obtenção do título de Bacharel em Letras Inglês.

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Florianópolis

2024

Régis, Gustavo
Second language use and phonological self-awareness as variables in the pronunciation of four English front vowels by Brazilian learners of English / Gustavo Régis ; orientadora, Hanna Kivistö-de Souza, 2023.
58 p.

Trabalho de Conclusão de Curso (graduação) - Universidade Federal de Santa Catarina, Centro de Comunicação e Expressão, Graduação em Letras - Língua Inglesa, Florianópolis, 2023.

Inclui referências.

1. Letras - Língua Inglesa. 2. uso da linguagem. 3. consciência linguística. 4. fala em segunda língua. 5. análise acústica. I. Kivistö-de Souza, Hanna. II. Universidade Federal de Santa Catarina. Graduação em Letras - Língua Inglesa. III. Título.

ACKNOWLEDGMENTS

Firstly, I would like to thank my advisor, Hanna, for the significant assistance throughout the process of writing this work. Your helpful feedback and expertise were crucial for this. I want to thank the time and energy put into improving the study regarding the different delicate steps of acoustic analysis together with the written part. Thank you!

I also would like to thank all my family. Gostaria de agradecer principalmente à minha mãe, ao meu pai e à minha irmã, por todo suporte e por sempre acreditarem em mim. Obrigado por acreditarem nos meus sonhos e nas minhas escolhas. Eu amo vocês mais que tudo. Obrigado Dada por me presentear com os afilhados mais lindos e inteligentes que eu poderia ter. João e Laura, o dindo ama vocês.

And, of course, I would very much like to thank my friends from Letras. I could have never thought I would find such incredible people in the undergraduate course. I want to thank my Bacharelado fellows, Janete, Luiza, Mariana, and Maysa for always supporting me and being there to make me laugh out loud. I love you girls, we did it!

I also want to thank my fellows from Licenciatura, Eduarda, João, and Paula. Thank you so much for these years. Meeting you was incredible. I appreciate the support you gave me at Extra.

I want to thank my friends from childhood, Beatriz and Maria. Thank you for the friendship, it is very important to me. You were there from the beginning, and I hope we can make it to the end. I love you so much.

I also want to express my gratitude to my high school friends, Cecília, Francielle, and Jessica. Thank you for supporting me and being such incredible friends. You are very special to me. I love you!

Finally, I would like to thank UFSC for the opportunity. I also would like to thank the professors, and the people who made this process more enjoyable.

ABSTRACT

The present study aimed to analyze the relationship between second language use and phonological-self-awareness and the pronunciation of the English front vowels /i ɪ ɛ æ/ by Brazilian learners of English. Readings of an elicitation text containing the four target vowels from 18 Brazilian learners were acoustically analyzed regarding spectral quality and quantity (duration, F0, F1, and F2). Learners were divided into high- and low-level groups of the two variables considering the phonological self-awareness and second language use scores (obtained with the help of background questionnaires) so as to compare their values with the values by 5 English native speakers. By looking into vowel plots, it was possible to see that learners' vowels were acoustically distant from the native reference models in relation to spectral quality as nonnative speakers pronounced the English vowel pairs with overlapping regions while native speakers did not. Learners contrasted vowel pairs by means of durations, although still lacking accuracy for the high front vowels /i ɪ/. No relation was observed between either phonological self-awareness or language use and second language pronunciation.

Keywords: language use; language awareness; second language speech; acoustic analysis.

RESUMO

O presente estudo teve como objetivo analisar a relação entre o uso de segunda língua e a autoconsciência fonológica e a pronúncia das vogais anteriores do inglês /i ɪ ɛ æ/ por aprendizes brasileiros de inglês. Leituras de um texto contendo as quatro vogais alvo de 18 aprendizes brasileiros foram analisadas acusticamente quanto à qualidade e quantidade espectral (duração, F0, F1 e F2). Os alunos foram divididos em grupos de alto e baixo nível das duas variáveis considerando os escores de autoconsciência fonológica e de uso de segunda língua (obtidos com a ajuda de questionários) para comparar seus valores com os valores de 5 falantes nativos de inglês. Ao examinar os gráficos, foi possível ver que as vogais dos aprendizes estavam acusticamente distantes dos modelos de referência dos nativos em relação à qualidade espectral, já que os falantes não nativos pronunciaram os pares de vogais do inglês com regiões sobrepostas, enquanto os falantes nativos não o fizeram. Os alunos contrastaram os pares de vogais por meio de duração, embora ainda faltasse precisão para as vogais anteriores fechadas /i ɪ/. Nenhuma relação foi observada entre a autoconsciência fonológica ou o uso da linguagem e a pronúncia de segunda língua.

Palavras-chave: uso da linguagem; consciência linguística; fala em segunda língua; análise acústica.

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LIST OF ABBREVIATIONS

AOL	Age of onset of learning
B	Bark
BP	Brazilian Portuguese
ED	Euclidean Distance
F	Frequency in Hertz
HiPhonA	High phonological self-awareness
HiUse	High second language use
L1	First language
L2	Second language
LoPhonA	Low phonological self-awareness
LoUse	Low second language use
M	Mean score
Min	Minimum
Max	Maximum
N	Number
NS	Native speaker
NNS	Nonnative speaker
SD	Standard deviation

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1 INTRODUCTION

When talking about a second language (L2), speaking is one of the most eminent skills whether in academic fields or in everyday contexts. Language learners usually engage in an L2 course aiming to communicate well with speakers of the given language (Lima Junior, 2015, p. 16). Moreover, mispronunciation, or even heavily foreign-accented L2 speech, can lead to communication breakdowns and place the L2 speaker in a troublesome situation. Therefore, learners may feel frustrated by the incapacity of communicating with native speakers (NSs) even though they possess grammatical and lexical skills in the L2 (Kelly, 2006).

However, pronunciation has not been given the necessary attention in L2 classrooms, and teaching this skill is frequently left to the teacher's own intuition (Derwing; Munro, 2005). While speaking is one prominent goal for learners, many L2 courses overlook it and little or no time is spent on teaching pronunciation. Kelly (2006) argues that pronunciation teaching tends to be neglected as it mostly focuses on a particular issue observed in the classroom instead of a strategically planned class. Additionally, while some teachers successfully address the topic, others may feel insecure in doing that as they also have not received such training regarding phonology (Saito, 2012).

Given the implications of L2 pronunciation, L2 speech acquisition plays an important role in the field of linguistics. To date, various researchers have investigated pronunciation of segmental (vowels and consonants) and suprasegmental features (e.g. intonation and stress) in foreign-accented and nativelike speech (e.g. Lima Junior, 2019; Saito; Trofimovich, Isaacs, 2016; Sereno; Lammers; Jongman, 2016).

Therefore, language awareness (explicit and implicit knowledge about language) has shown to help L2 learners speak more accurately with lower degrees of foreign accent, enhancing comprehensibility. Lima Junior (2017) analyzed the influence of metalinguistic knowledge on the pronunciation of the three English vowel pairs (/i ɪ/, /ɛ æ/, and /u ʊ/) that are not contrasted in Brazilian Portuguese (BP) by Brazilian undergraduate students. Results showed that some learners after receiving metalinguistic instruction on English Segmental Phonology produced contrastive vowel pairs for vowels that they used to pronounce with no contrast, close to the vowel present in BP.

Furthermore, one variable largely addressed in the field of second language acquisition concerning pronunciation is language use. In this respect, the amount of L2 input is taken into account, in other words, exposure to the L2 or the extent to which the speaker

uses the first language (L1) is analyzed to have any relation to L2 speech accuracy. Flege, Frieda and Nozawa (1997), for instance, when examining the effect of L1 usage in the L2 production accuracy by native Italian subjects, found that subjects who seldom used their L1 were considered to have a more accurate L2 pronunciation than subjects with a greater amount of L1 use. Therefore, their study (1997) points to the understanding that language use is one relevant variable in the analysis of L2 pronunciation.

Considering the importance of L2 speech studies and the difficulty observed in the previous work addressing the production of some English vowels by Brazilian learners of English, the present study aims to investigate if differences in *language use* and *phonological self-awareness* by Brazilian learners of English affect the pronunciation of four English front vowels, /i ɪ ɛ æ/. To accomplish that, paragraph readings from 18 learners were acoustically analyzed in regard to spectral quality and quantity (duration, F0, F1, and F2) and the values were compared with values from 5 American English speakers. Moreover, the Brazilian participants were split into high- and low-level groups of the two variables according to their phonological self-awareness and second language use scores (obtained with the help of background questionnaires) so as to examine, by looking into vowel plots, if those participants who had higher levels of the variables produced the target vowels more accurately than those participants with lower levels.

Therefore, by analyzing Brazilian speakers' production of English vowels, the present study can contribute to the field of L2 speech and foreign accent as well as help teachers in the area. As mentioned previously, mispronunciation is associated with frustration and misunderstandings, making the study of L2 speech an important part of the linguistic field. For that reason, identifying the issues in pronunciation may be a way of enhancing comprehensibility and confidence in speech. In addition, having in mind the difficulties faced by learners when pronouncing an L2 make teachers more prepared to approach pronunciation in the classroom through strategically planned material.

Hereby, the present section is followed by a review of literature addressing the topics relevant to the study such as speech accuracy and some variables involved in it, along with content related to the target vowels. After that, we present the method employed to carry out the investigation, along with the results obtained followed by a discussion and a brief conclusion.

2 REVIEW OF LITERATURE

In this section, topics related to the pronunciation of English vowels by Brazilian learners will be addressed. Firstly, some issues of foreign accent and speech accuracy are discussed, followed by two possible significant variables influencing the production of the vowels, phonological self-awareness and language use. Finally, the prevalent non-target pronunciation of English vowels by the Brazilian learners according to the literature and content on vowel acoustic analysis are contemplated.

2.1 THE ISSUE OF FOREIGN ACCENT AND SPEECH ACCURACY

Foreign accent has received considerable attention in nonnative speech research and has been subject to study once it has implications for communication. There are situations in which nonnative speakers (NNSs) might experience communication breakdowns as a result of their non-target pronunciation, for example, the replacement of a vowel by another one resulting in a different word, such as soap /soʊp/ and soup /suːp/ being pronounced as homophones (Kelly, 2006). Along with that, speaking with a foreign accent also may have professional implications as suggested in a study by Derwing and Munro (2009) where comprehensibility and accentedness played important roles in the relationship between NNS and NS interlocutors when investigating Canadians' preferences in the speech of immigrant coworkers in an engineering company. Although accentedness was taken into account by the listeners, comprehensibility was regarded as more important in the workplace.

Nonetheless, the different dimensions of nonnative L2 speech, such as *comprehensibility*, *intelligibility*, and *accentedness* should not be confounded. The first dimension, *comprehensibility*, is defined according to Derwing, Munro and Thompson (2008) as "the ease or difficulty with which a listener understands L2 accented speech." (p. 360). Conversely, *intelligibility* refers to "the extent to which a speaker's message is actually understood by a listener" (Munro; Derwing, 1995, p. 76). In addition, *accentedness* is understood as "the degree to which the pronunciation of an utterance sounds different from an expected production pattern." (Munro; Derwing; Morton, 2006, p. 112).

Although these dimensions may be correlated, one does not predict the other as suggested by Munro and Derwing (1995). In their (1995) study, the authors investigated the interrelationship between the three dimensions in extemporaneous nonnative speech production, assessing intelligibility through speech samples transcribed by NSs who also

performed a listening task to rate perceived comprehensibility and accentedness through a 9-point scale instrument. Speakers were 10 Mandarin and 2 English NSs whereas 18 NSs of English composed the listener participants. Findings indicate a relationship between the dimensions although they appear to be somehow independent. Moreover, the speech samples produced by proficient Mandarin NSs were classified as highly intelligible and rated with high scores of comprehensibility while the skewed distribution of accentedness ratings showed heavily accented speech. In other words, the strength of foreign accent was found to be related to perceived comprehensibility and intelligibility although these dimensions are not necessarily defined by it, once nonnative speech containing strong degrees of foreign accent was highly intelligible.

Hereby, the present study looks into examining the phonetic features of four English front vowels (the easiest and most difficult English vowel pairs by Brazilians to pronounce with contrast distinction) produced by Brazilians given the significance of L2 speech studies in the field of linguistics. Having in mind the concepts of speech dimensions and the implications that pronunciation has in communication, the analyses of the nonnative speech samples made here are part of the study concerning a better understanding of foreign accent and therefore can help develop knowledge in the field of linguistics.

2.2 PHONOLOGICAL SELF-AWARENESS

Many are the variables influencing L2 speech analyzed in the field of phonology, and throughout linguistic study history, different variables have received distinctive prominence. Piske, MacKay and Flege (2001) when reviewing factors affecting the degree of foreign accent, included: age of onset of L2 learning, length of residence, gender, formal instruction, motivation, language aptitude, and language use. Among these variables, age of onset of learning has been extensively addressed in the field by various researchers as well as language use (e.g. Abrahamsson, 2012; Flege; Munro, McKay, 1995). However, other variables apart from the ones already cited emerge in the study of L2 speech. Kivistö-de Souza (2015) mentions in her study the significance of phonological awareness in the production of an L2 and the lack of studies investigating this variable to date. Therefore, the present study examines language use and phonological self-awareness (“awareness about own pronunciation”, Kivistö-de Souza, 2015, p. 04) as variables in the pronunciation of four English front vowels by Brazilian learners of English.

Historically speaking, awareness just entered the scope of language study in the 1980s and its influence on language acquisition is still subject to be analyzed (Kivistö-de Souza, 2015). The definition of *language awareness* and the term itself have varied across different studies, as mentioned by Kivistö-de Souza (2015); thereupon, in her study *language awareness* is understood as "explicit, potentially verbalizable (with or without metalinguistic terminology) knowledge about language, as well as of intuitive awareness of language which cannot be verbalized." (Kivistö-de Souza, 2015, p. 26). Moreover, *L2 phonological awareness* was understood as knowledge about the L2 phonological system, consisting mainly of implicit knowledge and being domain-specific, thus the individual differs in *L2 phonological awareness* among the segmental, suprasegmental, and phonotactic (e.g. sound combination) domains (Kivistö-de Souza, 2015, p. 105). The author mostly based her interpretation of language awareness on Schmidt's postulations on awareness in Second Language Acquisition. Richard Schmidt considered awareness essential in L2 learning (Schmidt, 1990, 1994, 1995) and by the same token, he concluded that *implicit learning* (in the sense of unconscious) is not possible; thus, consciously registering the input (Schmidt, 2010) present in the phonetic features of the target language represents an important part of L2 speech acquisition (Schmidt, 1994, 1995). Therefore, the previously prevalent hypothesis that the L2 can be picked up from exposure to input (Krashen, 1982) has been counteracted by the hypothesis that conscious attention to the linguistic features is necessary for L2 acquisition (e.g., Ellis, 2005, Robinson, 2003, VanPatten, 1996).

Moreover, Alves (2012) argues *language awareness* is the individual's ability to reflect upon and manipulate the different aspects of the linguistic code. In other words, to reflect upon the linguistic code is "to consciously think about language" (Alvez, 2012, p. 32, our translation) by having the language as an object of reflection, for example, when the speaker concentrates on how morphemes are organized in a word. Additionally, manipulating aspects of the linguistic code is related to the speaker's ability to split, delete, add, or replace sounds, for instance, and as a result, create new words and meanings. Therefore, *phonological awareness* refers to these abilities applied to the language phonological system, more especially.

Furthermore, it has been demonstrated that language awareness is related to L2 pronunciation (e.g. Kennedy; Trofimovich, 2010; Ramírez Verdugo, 2006). Kennedy and Trofimovich (2010) when examining L2 learners' language awareness and their L2 pronunciation, found a relationship between them. Its subjects were 10 adult students enrolled in a university-level pronunciation course aimed to raise awareness exclusively of

suprasegmental aspects of English pronunciation. Students were asked to write weekly dialogue journals (reflections about the progress and process of their learning) which were regarded by the researchers as the learners' aspects of language awareness. Students' recordings of a text reading from week 1 and week 10 of the course were assessed by means of accentedness, comprehensibility, and fluency to evaluate L2 pronunciation. Results showed that learners who produced more qualitative language awareness comments (viewing language as carrying meaning in opposition to language as a set of items) were the ones with higher pronunciation ratings.

Additionally, the findings from Kivistö-de Souza (2015) showed a correlation between L2 phonological awareness and L2 pronunciation. The study employed one task for each of the three language domains in order to assess the participants' awareness on each of them. Its subjects were 71 adult BP learners of English and 21 American English speakers who performed the three tasks and answered background questionnaires so as to estimate individual variables. Moreover, during and after the data collection session the BP learners were asked to fill in another questionnaire addressing their phonological self-awareness. Results demonstrated that L2 phonological awareness accounted for 32.8% of the variance in L2 pronunciation while the influence of other individual variables, such as L2 use, remained unsettled. In addition, BP learners demonstrated very low levels of phonological awareness in the segmental and suprasegmental domains whereas phonological self-awareness was related only to the segmental awareness.

Therefore, *phonological self-awareness* can be considered to have some significance in L2 pronunciation. Phonological self-awareness, in turn, is the speaker's meta-awareness of pronunciation. Once one is aware of phonological features, consciously registering the input becomes easier. As a result, the production of those phonological features by the learner can be enhanced to a more native-like level of accuracy as studies in the area have shown a correlation between perception and production in an L2 (Rauber *et al*., 2005). However, there is a marked lack of studies in the area.

2.3 LANGUAGE USE

The other variable analyzed in the present study concerning the pronunciation of the target vowels is *language use*. Although language use has been addressed substantially more often in the field, not many studies have analyzed the influence of this variable in the pronunciation of learners through formal instruction with little or no immersion in the L2,

which is the case of the present study. *Language use*, *Language usage patterns*, or even *Language experience*, refers to the amount of input experienced by the L2 speaker. Input, then, is defined by Flege (2008) as "all L2 vocal utterances the learner has heard and comprehended, including his own, regardless of whether these utterances have been produced correctly by L2 native speakers, or incorrectly by other non-native speakers of the L2" (p. 175). Therefore, higher degrees of L2 language use indicate more exposure to the target language in contrast to lower degrees, which may be a predictor of more accurate L2 speech.

Flege has contributed much to the field of language use and in his studies this variable is usually examined along with age of onset of learning (AOL) and most participants consist of immigrants to L2-speaking countries, such as L1 Italian speakers who arrived in Canada at different times (Flege; Munro, McKay, 1995). Flege, Munro and McKay (1995), analyzed the perceived foreign accent of 240 Italian NSs who arrived in Canada at different ages, ranging from 4 to 22 years old. Participants with earlier AOL reported using English more than Italian while late learners reported the opposite. The authors found that AOL accounted for the most significant variable involved in the production of Italian participants judged by English NSs, composing an average of 59% of the variance in foreign accent ratings, followed by language use which regarded around 15% of the variance. Moreover, language use was found to be a significant predictor even when AOL was partialled out, indicating the relevance of that variable.

However, instructed and naturalistic language learning settings have their particularities, and results from one setting cannot be generalized to the other. Muñoz (2008) points to the differences in both learning contexts. While in an instructed, formal setting, students have access to the foreign language for a limited time in classrooms, where the necessary input is quantitatively and qualitatively poor. In a naturalistic setting, the learner is immersed in the L2 context, and exposed to unlimited input which assists well in the language learning. Therefore, findings from studies analyzing language use in a naturalistic setting, like the one mentioned above, may not replicate in studies having participants learning language in an instructed setting, which is the case of the present study.

2.4 THE BRAZILIAN NON-TARGET PRONUNCIATION OF ENGLISH VOWELS

Brazil as an emerging power in the global scenario is in successive contact with English, making the study of Brazilian Portuguese-English interphonology an important issue worth addressing. Moreover, as English and BP contain dissimilarities both regarding

suprasegmental and mainly segmental features, one can expect some difficulties in the acquisition of English pronunciation by Brazilian learners.

When looking into the charts of American English and BP vowels, one can see that the two languages share a number of vowels, but there are some differences as well. According to Yavas (2011), English has twelve monophthong vowels (/i ɪ e ɛ æ ə ʌ ɑ ɔ o ʊ u/) whereas BP counts only seven oral vowels in stressed position (/i e ɛ ɑ ɔ o u/) (Rauber *et al*., 2005). Therefore, the English /ɪ æ ə ʌ ʊ/ vowels are not present in BP phonology, and this absence of sounds is overcome by Brazilians through the employment of different strategies such as the replacement using sounds present in their L1 (Flege, 2008; Rauber *et al*., 2005)

Rauber *et al.* (2005) analyzed the perception and production of English vowels by highly proficient Brazilian speakers of English. Sixteen masters and doctoral students of English Language and Literature who had all taught English for more than five years participated in two experiments, one regarding production and the other perception of English vowels. In order to assess L1 and L2 production, participants read 66 sentences containing English vowels and 42 sentences containing BP vowels; while perception was assessed using a categorial discrimination test aiming to investigate some English vowel pairs, including /i/ - /ɪ/ and /ɛ/ - /æ/. Production results were obtained comparing F1 and F2 values (these values are related to spectral quality of vowels) of English and PB vowels pronounced by the participants and data from monolingual English NSs based on previous literature. The authors found that the L1 vowel system was used to produce the English vowels substantially. Although participants showed some contrast between L2 vowel pairs, formants were still very different from those by NSs. Moreover, the high front vowels /i/ - /ɪ/ were found to be the most easily contrast distinction by Brazilian speakers while for the results of the /ɛ/ - /æ/ vowels, the opposite was true. For this pair, the authors suggest that the differentiation is based on duration when both production and perception scores were very low. Finally, scores from the two experiments showed a correlation between production and perception skills.

In a larger study acoustically analyzing (spectral quality and quantity) the production of three English vowel pairs (/i ɪ/, /ɛ æ/, and /u ʊ/) by Brazilian undergraduate students, Lima Junior (2016b, 2019) found similar results. The participants, students of English Language Teaching at a federal university, were recorded at the beginning of each semester in order to assess the development of vowel production throughout the course period. The data analysis referring to the first and second semesters (Lima Junior, 2016b) indicated that 6 out of 11 learners were already contrasting the high front vowels /i ɪ/ in the first semester; while just one participant produced distinct vowels for /u ʊ/ in both moments, and two others contrasted

these vowel pairs in the second recording. Moreover, no one contrasted the /ɛ æ/ pair. In the study (Lima Junior, 2019) analyzing the audios from the four first semesters, results found that 7 out of the 10 participants had the high front vowel distinction already established. For the /ɛ æ/ pair, 6 students showed to distinguish it after the third semester, but just 3 students kept this distinction in the last recording whereas 4 students contrasted the /u ʊ/ pair in the last semester. Therefore, the author pointed to the ease and difficulty in the pronunciation of /i ɪ/ and /ɛ æ/ by Brazilian learners of English.

In a study investigating age of onset of learning and the pronunciation of the same three English vowel pairs, Lima Junior (2012) found that Brazilian learners' productions were distant from those of NSs, independently of starting age. Thirty students in the last semester of their English course, differing in age of onset of learning, participated in the study along with 10 English NSs who composed the control group. When acoustically analyzing the vowels (duration, F1, and F2), the author found that the Brazilian learners did not contrast any of the three vowel pairs in both quality and quantity measurements, while NSs did so, and the difficulty to produce separate vowel pairs showed to gradually increase as AOL increased. In the vowel chart, NNSs' vowel pairs overlapped and were positioned in between the NSs' target vowel pairs. Moreover, the /ɛ æ/ pair was found to bear the most difficulty among NNSs who tended to pronounce the two vowels closer to the NSs' /ɛ/.

Thereupon, there seems to be general agreement in studies investigating the pronunciation of English vowels by Brazilian learners of English. The studies included in this section analyzed both spectral quality (F1 and F2) and quantity values of mainly three English vowel pairs. Among these pairs, the authors observed better performance related to the high front vowels /i ɪ/ achieved by Brazilian learners, both in production and perception skills. On the contrary, the /ɛ æ/ pair has shown to be more difficult for Brazilians once they struggled more to pronounce and perceive the differences between the vowels. Hence, these are the two vowel pairs chosen to be further investigated in the present study.

2.5 ACOUSTIC FEATURES OF THE TARGET VOWELS

Vowels, along with consonants, constitute part of the segmental features of languages and are classified with most regard to tongue and lip position in the vocal cavity. Therefore, vowels can be classified as rounded (/u ʊ o ɔ/) and unrounded (e.g. /i ɪ ɛ æ/) according to lip position, as nasal and oral, in relation to whether the air passes through the nasal cavity or not (Silva, 2003), and regarding the position of the tongue in the mouth (height

and frontness). One of the most commonly used classifications of vowels considers the height of the tongue. Accordingly, vowels are classified as high, high-mid, mid, low-mid, and low. In addition, when considering tongue frontness-backness, or "the part of the tongue involved" as suggested by Yavas (2011, p. 11), vowels are classified as front, central, and back. Therefore, English high front vowels, such as /i/ and /ɪ/ (present in the words ‘beat’ /bit/ and ‘bit’ /bɪt/), are the ones in which the tongue is pushed forward in a high position (Yavas, 2001, p. 11).

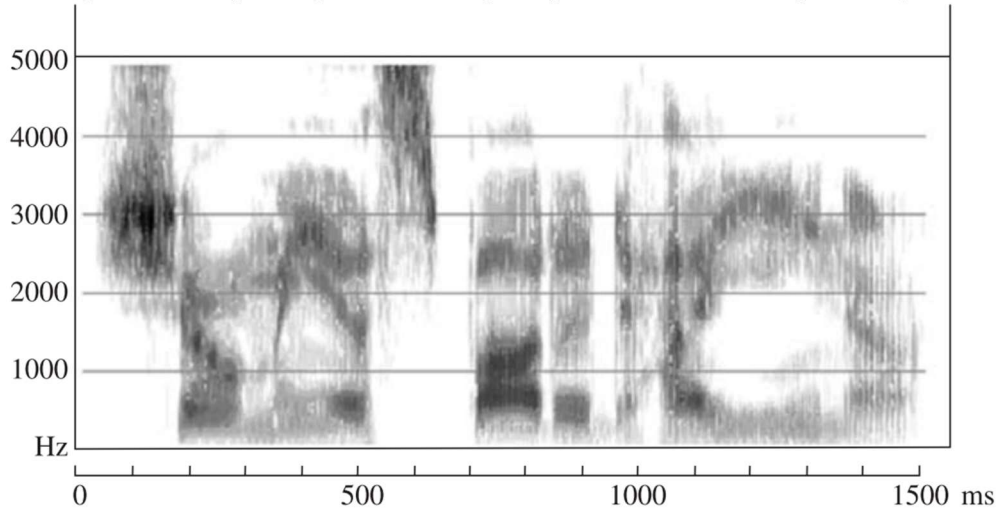
Moreover, in addition to tongue height and frontness-backness, vowels can also be classified regarding tense-lax features (Yavas, 2011). To solve the problem of some vowel classifications that include more than just one vowel (the high front vowels for example), manuals have made use of the tense-lax classification, thus vowel counterparts can be better differentiated using phonetic classifications (Yavas, 2011, p. 79). Hence, Yavas (2011, p. 79) suggests that tense vowels would be higher, longer in duration, and produced with greater muscular effort than their counterpart. However, there is not a complete agreement in the literature on the characteristics of tense-lax features as mentioned by the author (Yavas, 2011, p. 80) once they are not satisfactorily defined.

Additionally, duration also plays an important role in vowel identification, and depending on the phonetic context, the vowel is differentiated by means of time quantity. Lima Junior (2015, p. 23) refers to the Northern Cities Dialect as one example in which the duration of the English vowels /ɛ/ and /æ/ is used to recognize them rather than other vowel phonetic characteristics (Ladefoged, 2001, apud Lima Junior, 2015).

The present research focuses on four American front vowels /i ɪ ɛ æ/. These vowels can be taken basically as two different pairs in which the vowels /i ɪ/ constitute the tense and lax high front vowels, respectively; while /ɛ/ is categorized as a mid, front, lax vowel and /æ/ as the only low front vowel in English phonology that despite being classified as lax, is longer than other tense and lax vowels such as its pair /ɛ/ (Yavas, 2011, p. 106). High front vowels can be seen in pairs of words such as seat - sit (/sit/ - /sɪt/) whereas the mid and low American English vowels are observed in the pair of words bed - bad (/bɛd/ - /bæd/). Previous studies have shown that Brazilian learners of English have difficulty producing and perceiving a difference between each vowel phoneme in the two pairs (Rauber, 2006), and as these are different phonemes in English, the replacement of one vowel by its pair in most cases results in changes of meaning, as exemplified previously, and this replacement can lead to miscommunications.

Vowels are produced with an open vocal tract. The passing of the airflow through the vocal cords and the shape of the vocal tract affect the characteristics of the speech sounds. Speech sounds, then, are discussed in terms of four acoustic properties: fundamental frequency, formant frequency, amplitude, and time (Yavas, 2011, p. 101). The *Fundamental Frequency* is defined by Yavas (2011, p. 101) as "the individual pulsations produced by the vocal cord vibrations for a unit of time", and is perceived by the listener as pitch. *Formant Frequency* relates to the form of the vocal tract, so according to the vocal tract size and to the different tongue and lip positions, the energy resonates differently resulting in different frequency values (F1, F2, F3). *Amplitude*, in turn, "refers to the amount of subglottal (beneath the vocal cords) air pressure." (Yavas, 2011, p. 101), and is perceived as loudness. Finally, *time*, as discussed before, concerns the duration of the sound. These four features can, therefore, be analyzed in a spectrogram or waveform, which are methods to show the speech sound amplitude in the y-axis (measured in Hertz), and frequency throughout a timescale, the x-axis (represented in milliseconds) (see Figure 1).

Figure 1 - A spectrogram showing the phrase *Show me a spotted hyena*

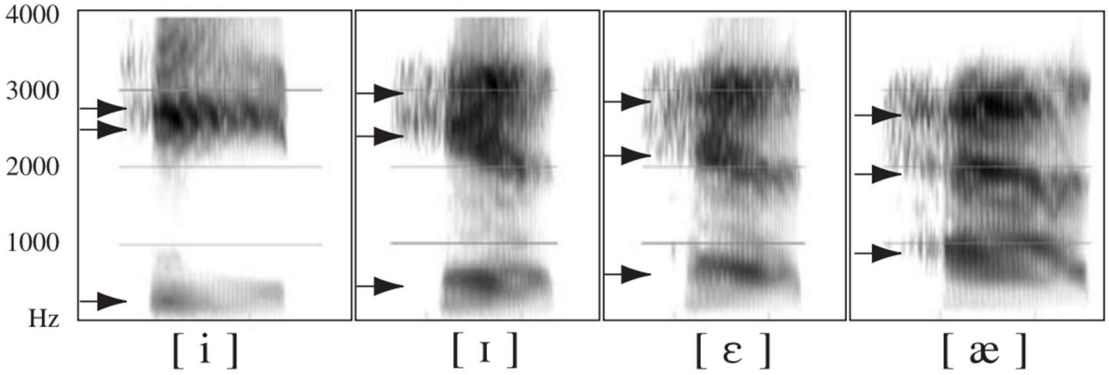


Source: Ladefoged and Johnson (2010, p. 215)

In vowel acoustic analysis, more specifically, we look mainly into the frequency clusters called formants. When the air in the vocal tract vibrates at the production of a vowel, different frequency groups are created simultaneously. These frequency groups are referred to as formants and are shown as linear horizon bands throughout the spectrogram (Yavas, 2011). In general vowel acoustic analysis, the first two or three formants are investigated: these are the ones closer to the bottom of the spectrograph, in other words, with lower Hertz numbers. The first formant (F1) is the most inferior one and is related to the tongue height, the lower

the formant the higher is the tongue positioned. The second formant (F2) comes above F1 and their distance to one another, or the Hertz difference, tells us the frontness-backness of the vowel. The third formant (F3) is related to the rounding of the lips and is more relevant to the English back vowels, which are not regarded here. Thereupon, the present study aims to analyze the first (F1) and second (F2) formants of four English front vowels along with the fundamental frequency (F0) and duration (see Figure 2).

Figure 2 - A spectrogram of the words *heed*, *hid*, *head*, *had*, as spoken by a female speaker



Source: Ladefoged and Johnson (2010, p. 211)

Altogether, the characteristics of the vowels change according to the vocal tract shape and with phonological and social contexts. Despite the standardization of the English vowel positions in the English vowel chart, where a specific point is marked to represent the position of a vowel, inter- and intra-speaker differences have to be considered. As Yavas (2011, p. 104) mentioned, the vocal tract shape influences the frequency of the vowels, thus the same vowel pronounced by a male, a female, or a child speaker will show different frequencies due to differences in vocal tract size. Furthermore, the phonological context (phonemes that precede and follow the vowel) contributes also to the quality and quantity of the vowel (Yavas, 2011). Similarly, vowel quality and quantity differ across different language varieties.

Having in mind the acoustic features of the target vowels, the present study aims to analyze duration, F0, F1, and F2 of the four English front vowels /i ɪ ɛ æ/ pronounced by Brazilian learners of English differing in degrees of phonological self-awareness and L2 use. Therefore, in order to guide the study and achieve the goals, the following two research questions are posed:

RQ1) Do the participants who have higher phonological self-awareness produce the four English front vowels /i ɪ ɛ æ/ more accurately than those participants who have a lower phonological self-awareness?

RQ2) Do the participants who have higher L2 use produce the four English front vowels /i ɪ ɛ æ/ more accurately than those participants who have a lower L2 use?

3 METHOD

In this section, we will present the methods employed to carry out the investigation. Firstly, the participants making part of the study are addressed, followed by the instruments and procedures. Finally, the data analysis is discussed.

3.1 PARTICIPANTS

Brazilian participants were selected from Kivistö-de Souza (2015) with the help of variables scores measured by the author. In the original study, 71 Brazilian learners of English participated and were asked to answer linguistic and demographic background questionnaires used to calculate variables which made possible the selection of participants. Therefore, 18 Brazilian participants differing in degrees of the two variables to be analyzed here were selected to take part in the present study. Only 18 women were regarded as target participants so as to mitigate the acoustic characteristic differences found among men and women in addition to the time constraints posed by the nature of the present study.

Brazilian Portuguese learners of English were 18 graduate (N = 6) and undergraduate (N = 12) students (see Appendix A for individual participants' data). All learners either held a Bachelor's degree in English Language and Literature or were majoring in the field, with the exception of one whose graduate studies were in Translation Studies. They were all female, ranging from 19 to 31 years old (M = 25.06, SD = 3.15), and spoke Brazilian Portuguese as their L1.

Table 1 - Summary of learners' background information (n=18)

Variable	***Mean***	***SD***	***Min***	***Max***
Age	25.06	3.15	19	31
AOL English	10.00	2.91	2	12
Vocabulary Size (0-10.000)	7050.00	1109.91	4250	8800
Native English Experience (in months)	0.25	15.84	0	60
Academic English Experience (in years)	18.00	3.45	16	29

Source: the author
Key: SD = standard deviation, Min = minimum, Max = maximum

Moreover, 5 female English native speakers from Lima Junior (2012) were selected to take part in the study as native reference models (see Appendix B for individual participants' data). Native speakers were all born in the United States and spoke the American English accent, the one Brazilian participants are more familiar with. Yet, as NSs came from different regions of the country they do not hold a singular regional accent, which is suitable for the present study as Brazilian learners of English do not have a specific American accent as the target according to the author (Lima Junior, 2012, p. 72). Additionally, NSs' age at the time of recording varied from 25 to 71 (M = 40.6).

We chose to use Lima Junior's (2012) native reference models in this study since we needed four specific vowel acoustic values (duration, F0, F1, and F2) which could not be found in many studies available in the field. Although a number of relevant research were found addressing the topic of acoustic characteristics of American English vowels, open data was not available for analysis or the values found revealed some lack of reliability.

More information on the Brazilian and American participants can be found in Appendix A and B, respectively. Participants' identities were kept the same from their original studies in case further analysis on the subject is aimed. The letter *p* is used for the Brazilian participants, meaning participant in the original study, while *cM* is used for the NSs which stands for *Controle Mulher* (Control Woman) in the original study, both followed by the number of identification.

3.2 INSTRUMENTS

3.2.1 Vowel Production

The target vowels produced by Brazilian learners to be analyzed here are embedded in a text that Kivistö-de Souza (2015) asked participants to read aloud. This text (see Appendix D) includes words that contain the four English front vowels /i ɪ ɛ æ/, satisfying the analysis proposed in the present study. Although studies of acoustic analysis nature are usually done with the target vowels in CVC words, most of the words selected from the text do not follow this rule as the elicitation techniques used by the author in the original study were not planned with the same purposes of this study. Despite that fact, the target vowels chosen from the text still provide us with reliable results once different types of elicitation are needed to support the outcomes already found in the literature.

Table 2 - Tokens from the elicitation text containing the target vowels pronounced by Brazilian learners

/i/	/ɪ/	/ɛ/	/æ/
feel	still	men	that
feel	it	men	task
keep	rid	says	vast
meal	with	stressed	tasks
seem	will	get	tasks

Source: the author

Therefore, five tokens for each of the target vowels were selected from the elicitation text. All the vowels are inserted in monosyllabic words and appear in the nucleus position (usually in the middle of the syllable), for the exception of one (it - /it/) in which the target vowel initiates the word, once there was not an alternative case present in the text for the target vowel. Each token was pronounced just once for each Brazilian participant in the act of reading the text. Hence, we have 5 tokens for each of the 4 target vowels, resulting in 20 vowels for each Brazilian participant and 360 vowels in total.

As the native speakers' samples came from another study, different elicitation techniques were employed in their vowel production. Three tokens for each target vowel (embedded in CVC words) were pronounced, in which the vowel was preceded and followed by voiceless stop consonants to better isolate acoustic variation. Moreover, for the 4 vowels analyzed in the present study, minimal pairs were found for the 3 tokens as an additional way of controlling the phonological context. Each token was pronounced 4 times inside the sentence "I said *token* this time", already employed by Watkins e Rauber (2010; apud Lima Junior, 2012), resulting in 12 instances for each vowel and 48 for the four of them.

Table 3 - Tokens pronounced by native speakers

/i/	/ɪ/	/ɛ/	/æ/
peak	pick	peck	pack
Pete	Pitt	pet	pat
teak	tick	tech	tack

Source: the author

In opposition to the Brazilian vowel samples that came in the form of audio and were acoustically analyzed in the present study, NSs' acoustic values were directly obtained from the original study. Lima Junior (2012) made available the mean acoustic values for each participant for each target vowel. Among the values were duration in milliseconds and F0, F1, and F2 in Hertz (non-normalized).

3.2.2 Independent Variables

In relation to the Phonological Self-Awareness variable analyzed here, a ***Phonological Self-Awareness Score*** was created in the Kivistö-de Souza (2015) study based on the Phonological Self-Awareness Questionnaire (Appendix B). The score was obtained more specifically with the answers to three questions: *Q5, Q6*, and *Q7*. *Q5* consisted of "awareness on the English pronunciation of EFL [English as a Foreign Language] learners from other language backgrounds" (Kivistö-de Souza, 2015, p. 303) as well as "the ability to distinguish different accents and dialects in the L2" (Kivistö-de Souza, 2015, p. 303); while *Q6* and *Q7* "asked explicitly the participant's ability to notice and to understand aspects of the L2 pronunciation" (Kivistö-de Souza, 2015, p. 303). This score expresses overall the difficulty participants tell to have with different phonological awareness skills: the lower the sum, the harder the participant finds phonological judgments. The mean Phonological Self-Awareness Score was 34.50 (SD = 5.09, min = 25, max = 42).

Moreover, according to the Brazilian learners' linguistic background questionnaire responses, the author measured scores for the variables ***L1 Use Average*** and ***L2 Use Average*** which were the mean percentage of L1 use and L2 use, respectively, in the last five years. Along with that, ***L3 Daily Use*** was regarded as "the number of hours spoken in a foreign language other than English on a daily basis" (Kivistö-de Souza, 2015, p. 298). The mean *L1 Use Average* score was 66.25 (SD = 18.97, min = 15.00, max = 85.00) while the mean *L2 Use* score was 33.75 (SD = 18.46, min =15.00, max = 85), suggesting speakers used their L1 substantially more than the L2, although the highest and lowest values are very much alike. *L3 Daily Use*, on the other hand, was above zero for only 2 participants, *p45* (0.428) and *p46* (0.571), showing the use of another foreign language was not frequent among them.

3.3 PROCEDURES

The elicitation text from Kivistö-de Souza (2015) was recorded during a larger data collection. In the data collection section that lasted approximately 75-90 minutes for each participant, the researcher asked the Brazilian participants to read the elicitation text aloud, which took approximately 2 minutes. The recording session took place in a quiet room. The linguistic and demographic questionnaires were sent to participants prior to the actual data collection by email whereas the phonological self-awareness questionnaires were answered during the data collection section.

The carrier sentences pronounced by NSs in Lima Junior (2012) were also recorded during a larger data collection involving other instruments. During the vowel production, the tokens were randomly presented to participants using a PowerPoint presentation where before each sentence a slide showing 3 words containing the same target vowel took place in order to mitigate the influence of orthography on pronunciation. The author used Praat version 5.2.25 (Boersma; Weenink, 2011 apud Lima Junior, 2012) to acoustically analyze the vowel samples with the help of scripts. Duration was obtained through Arantes (2008a) scripts after marking the onset and offset of each vowel taking into account the stability observed in the spectrogram, as the vowels were meant to be acoustically isolated by voiceless stop consonants. Additionally, Arantes (2008b) scripts were used to extract F0 while F1 and F2 used Arantes (2010; 2011) along with individual examination, and the extraction of formants occurred in the vowel midpoint.

3.4 DATA ANALYSIS

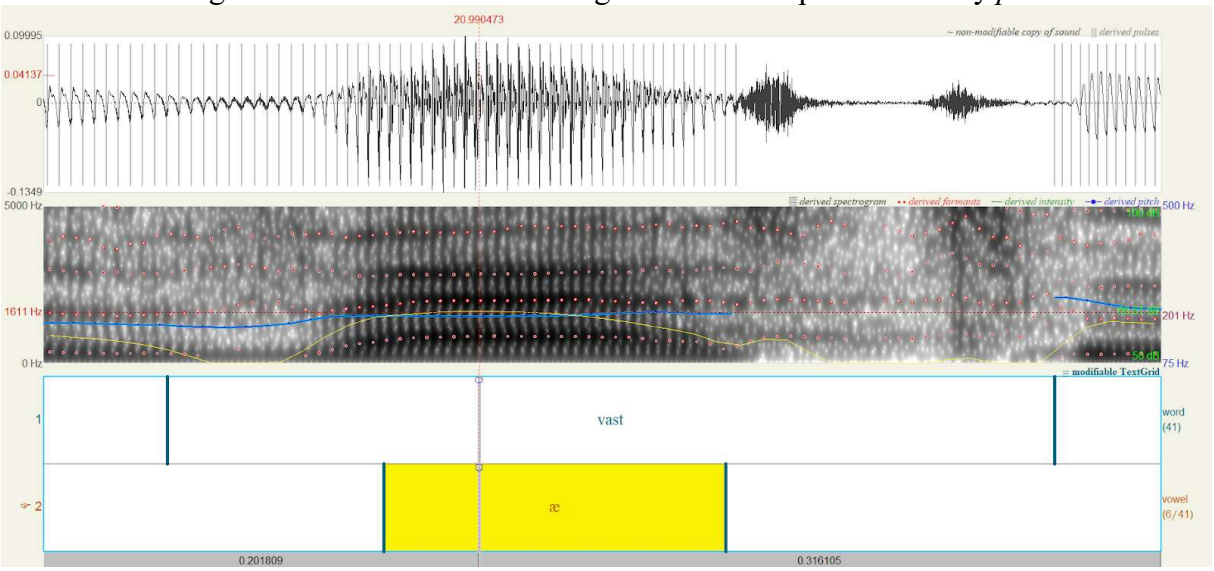
3.4.1 Acoustic Analysis

Brazilian participants' audio files were acoustically analyzed using the free access software for acoustic analysis widely used in the field called Praat, version 6.3.09 (Boersma; Weenink, 2023). The audio files were saved in wav. format and were not acoustically treated as recordings took place in a quiet room and possessed good sound quality. In total, 18 audios composed the data set, one for each Brazilian participant, which were individually analyzed without the use of scripts. Although scripts are largely used in studies like this, vowel measurements still need to be verified to a certain extent as scripts are set by humans and thus can lead to errors. Therefore, the researcher analyzed the text readings one by one, first marking the word and then the target vowel using the Annotation Sound File tool available in Praat (see Figure 3).

Four acoustic values were obtained in the acoustic analysis: duration (in milliseconds), F0, F1, and F2 (in Hertz). Firstly, duration was obtained by marking the onset and offset of the target vowel taking into consideration the stability observed in the spectrogram and waveform as well as the auditory cues. The onset was marked at the start of voicing for those vowels preceded by voiceless consonants or at the abrupt variation in intensity or formant frequency when the vowel was preceded by voiced consonants, similarly to Clopper *et al.* (2005, p. 1663). The offset of the vowel was regarded as the opposite, start

of devoicing when followed by voiceless consonants and a change in intensity or formant frequency in the cases followed by voiced consonants. Exceptionally, for the vowels preceded or followed by nasal or approximant consonants, more careful visual inspections of the spectrum of frequencies were made with the help of auditory cues. Thereupon, duration was calculated as the difference in time between the onset and the offset of the vowel and taken directly from the Praat display (see Figure 3).

Figure 3 - Praat window showing the word *vast* pronounced by *p42*

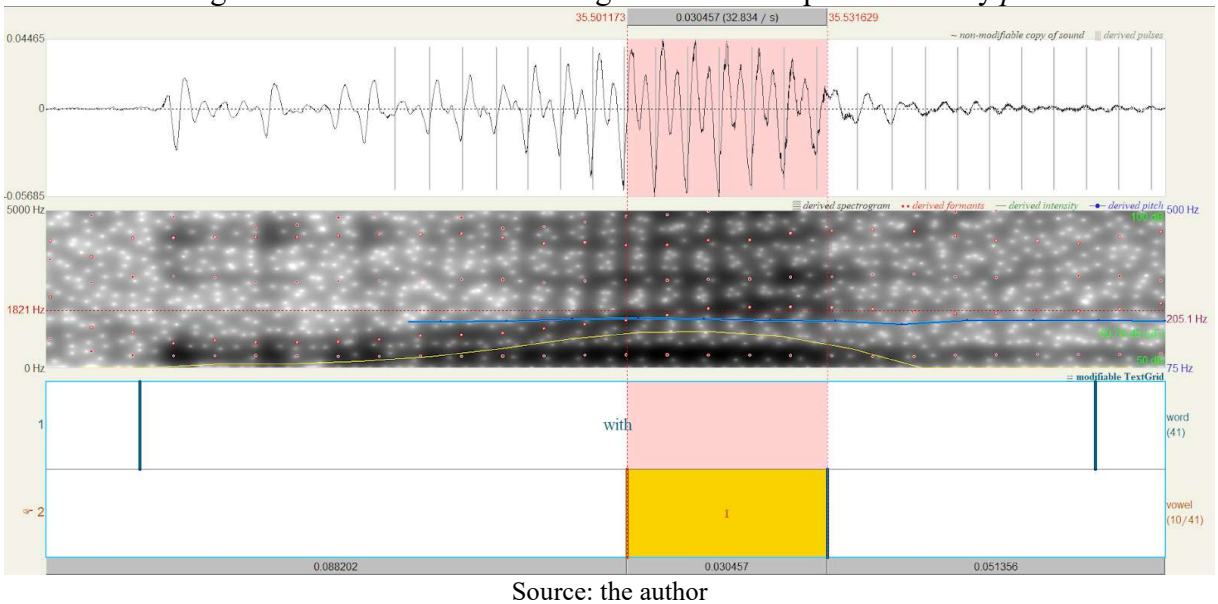


Source: the author

Following that, the fundamental frequency (F0) and frequency of the first two formants (F1 and F2) were extracted from the center of the steady-state portion of the vowel. Praat gives the formant values of the point the cursor is placed, to that end, the cursor was placed in the steady-portion of the vowel identified by means of three acoustic cues: (1) the waveform greatest amplitude, which is frequently in the middle of the vowel; (2) the intensity contour (the yellow line) energy peak; and (3) the first two formants (the red dots) relative stability along a straight line. In the cases when clear acoustic cues were not found or when vowels were very stable, the cursor was placed at the midpoint of the vowel. Moreover, the fundamental frequency (F0) is represented by the pitch contour (the blue line), and at times there is a gap in the line thus the F0 was extracted from the closest beginning or ending point of the line according to the formant extraction point. The formant extraction point of the word *vast*, pronounced by *p42* and exemplified in Figure 3, is thought to be where the cursor (dotted vertical red line) would be placed, and we can see that in this case, it does not coincide with the midpoint of the vowel.

However, some problematic cases were found among the vowel productions as the elicitation technique was not designed for acoustic analysis. In some of the cases when the target vowel was not preceded and followed by voiceless stop consonants, as in *will*, the onset and offset boundaries of the vowel were not clear. Problems were most found when the token did not receive much prominence in the reading of the text and therefore participants tended to quickly pronounce the word or even skip it, which happened very often in the production of the words *it*, *with*, and *will*. These three words are not appropriate tokens for acoustic analysis of vowels as *it* starts with the target vowel, and in *with* and *will* the target vowel is preceded and followed, respectively, by an approximant consonant. These facts together with the words being in an unstressed position in the sentences of the elicitation text caused problems in the acoustic analysis. The word *will* was skipped two times in the readings (*p48* and *p58*) and therefore acoustic values for the vowel /i/ for the two participants included only the other four tokens for the vowel. Moreover, when the aforementioned problems arose in the acoustic analysis, we tried to keep a standard in the measurement of the vowels using the ear to help mark the onset and offset boundaries. Figure 4 shows an example of the production of *with* by participant *p42* where we can visualize the unclear vowel boundaries and how they were marked.

Figure 4 - Praat window showing the word *with* pronounced by *p42*



Source: the author

3.4.2 Normalization Procedures

After the extraction of the four acoustic values from the learners' audio files and from Lima Junior (2012)'s dissertation, the vowel qualities (F0, F1, and F2) were normalized to better compare the findings. Normalization of vowels makes the comparison of vowel productions possible as it mathematically mitigates the physiological differences found among participants such as vocal tract size (Lima Junior, 2012, p. 80). Therefore, the Bark Difference Metric normalization method developed by Syrdal and Gopal (1986) was the one employed in the present study. This method consists of converting the vowel quality measures from frequencies in Hertz (F) into bark scale (B) by using the formula: B= 26.81 / (1+(1960/F)) – 0.53 (Traunmüller, 1997) and then subtracting the B0 value from the B1 value for vowel height, and subtracting the B2 value from B1 value for vowel frontness. Vowel height and frontness mean values for the four target vowels for each participant were then calculated using the normalized bark values. Along with that, duration mean values were calculated using the durations in milliseconds.

3.4.3 Euclidean Distance Calculations

The two bark value differences (B1-B0 and B2-B1) were then employed to measure the Euclidean Distances (ED) of the vowel pairs. Euclidean Distance is a mathematical calculation derived from the Pythagorean theorem used to measure the distance between two points on a cartesian plane (Lima Junior, 2012), in our case, the distance between the vowel pairs (/i ɪ/ and /ɛ æ/) on a vowel graph, and has the following formula:

$$\mathrm{ED} = \sqrt{((\mathrm{B1}-\mathrm{B0})_{\mathrm{X}}-(\mathrm{B1}-\mathrm{B0})_{\mathrm{Y}})^2+((\mathrm{B2}-\mathrm{B1})_{\mathrm{X}}-(\mathrm{B2}-\mathrm{B1})_{\mathrm{Y}})^2}$$

By looking at the ED one can identify if the vowel pairs were acoustically contrasted in the case that the speaker managed to create distinctive phonological categories for each phoneme by showing a substantial distance between the pairs. However, great differences in ED results do not necessarily mean that the vowels were accurate or intelligible and a complementary analysis of vowel plots is necessary.

3.4.4 Plotting

As acoustic values are better interpreted with the help of visual information, different vowel plots were created using the acoustic mean values from NNS and NS participants in Microsoft Excel. For the quality mean values, regarding vowel height (B1-B0) and frontness

(B2-B1), scatter graphs were created according to participants and target vowels. Among the scatter graphs, we also used circles (illustrations) to show the regions occupied in the graph by the same target vowel pronounced by different participants so as to check overlapping regions among different target vowels. For duration values, we employed the box plot as a way to visualize the duration range, mean scores, and outliers in a single graph. All the graphs were created using the spreadsheet editor Microsoft Excel version 2310 (Build 16924.20150) for Windows which enables the creation of graphs in various formats.

3.4.5 Grouping Participants

To answer the research questions in regard to the differing degrees of phonological self-awareness and L2 use, high- and low-level groups for the two variables were created for the NNSs using the *Phonological Self-Awareness Score* and *L2 Use Average Score*, respectively. For each of the variables, the 18 NNSs were divided into two groups of 9 participants in regard to their score for the variable, thus, one group corresponds to the high-level and the other to the low-level. Therefore, four groups in total were created employing the English learners: High Phonological Self-Awareness (HiPhonA), Low Phonological Self-Awareness (LoPhonA), High L2 Use (HiUse), and Low L2 Use (LoUse). The mean score for the HiPhonA group was 37.89 (range: 35-42) while for the LoPhonA group was 29.78 (range: 25-34). Alongside, the mean scores for the HiUse and LoUse groups were 51.67 (range: 35-85) and 21.00 (range: 15-32.5), respectively (see Table 4).

Table 4 - Brazilian participants' mean scores for the two variables

	All (n=18)	**High (n=9)**	**Low (n=9)**
Phonological Self-Awareness	33.83 (25-42)	37.89 (35-42)	29.78 (25-34)
L2 use	35.42 (15-85)	51.67 (35-85)	21.00 (15-32.5)

Source: the author
Key: range between brackets

We chose to have groups of NNSs with the same number of participants to facilitate the comparison between the vowel regions of the groups in the vowel plots. Information on the participants assigned to each group can be found in Appendix E. The vowel quality and quantity will then be analyzed comparing the findings according to the groups and the native reference models based on the vowel graphs plotted with the acoustics values mean scores.

4 RESULTS

In this section, the results from the data analysis will be presented. We will start by comparing the Brazilian Portuguese learners' vowel productions and native models. Then, the results will be presented according to the phonological self-awareness and L2 use variables and the target vowel pairs.

4.1 BRAZILIAN PORTUGUESE LEARNERS AND NATIVE SPEAKERS

Table 5 gives us an overview of the mean values for the vowel characteristics according to participants as a way to compare the findings. By looking at the descriptive statistics, one can see that the learners' mean scores for duration (in milliseconds) regarding the vowels /ɛ/ and /æ/ were close to the native speakers' mean scores. However, nonnative speakers were shown to pronounce shorter high front vowels (/ɪ/ and /i/) than NSs. According to the vowel height (B1-B0), NNSs showed to pronounce the vowel /ɛ/ with mean scores similar to the NSs, but higher /æ/ and /i/ (lower values), and lower /ɪ/ (higher values), than the reference models. Finally, NNSs' vowel frontness (B2-B1) mean scores appear to be more anterior (higher values) for the vowels /ɛ/ and /æ/, and more posterior (lower values) for the tense high front vowel /i/ when compared to the NSs, while its counterpart /ɪ/ demonstrates similar mean scores between NNSs and NSs. Moreover, the vowel characteristics mean scores appear to be very much alike across the groups for phonological self-awareness and L2 use as well as when analyzing all learners together, which suggests the different levels of the variables do not hold a relationship in vowel accuracy production by NNSs in the present study.

Table 5 - Acoustic characteristics from the acoustic analysis

		Learners (n=18)					**Native speakers (n=5)**
		All (n=18)	**Phonological self-awareness**		**L2 use**		
			High (n=9)	**Low (n=9)**	**High (n=9)**	**Low (n=9)**	
ɛ	**Duration (ms)**	116.42 (76-145)	114.13 (86-145)	118.71 (76-144)	122.76 (76-145)	110.07 (86-129)	110.60 (61-179)
	Height (B1-B0)	4.22 (2-5)	4.44 (3-5)	4.01 (2-5)	4.35 (3-5)	4.10 (2-5)	4.75 (4-5)

	Frontness (B2-B1)	7.06 (5-9)	6.87 (6-7)	7.26 (5-9)	7.02 (6-8)	7.11 (5-9)	6.34 (5-6)
æ	**Duration (ms)**	142.06 (109-171)	134.72 (109-171)	149.40 (128-164)	140.69 (109-171)	143.43 (117-164)	140.60 (83-210)
	Height (B1-B0)	5.13 (4-6)	5.11 (4-5)	5.15 (4-6)	5.32 (4-6)	4.94 (4-5)	6.49 (6-6)
	Frontness (B2-B1)	5.63 (4-7)	5.62 (4-7)	5.65 (4-6)	5.37 (4-6)	5.90 (4-7)	4.33 (3-4)
ɪ (Lax)	**Duration (ms)**	58.07 (42-80)	56.51 (43-67)	59.62 (42-80)	58.80 (43-78)	57.33 (42-80)	92.60 (48-147)
	Height (B1-B0)	1.75 (1-2)	1.72 (1-2)	1.77 (1-2)	1.78 (1-2)	1.72 (1-2)	2.63 (2-2)
	Frontness (B2-B1)	8.76 (6-10)	8.71 (7-10)	8.82 (6-9)	8.75 (7-9)	8.77 (6-10)	8.85 (8-9)
i (Tense)	**Duration (ms)**	68.56 (47-91)	66.68 (47-88)	70.44 (60-91)	67.74 (51-80)	69.39 (47-91)	109.60 (58-175)
	Height (B1-B0)	1.59 (0-2)	1.47 (1-2)	1.72 (0-2)	1.58 (1-2)	1.61 (0-2)	1.12 (0-1)
	Frontness (B2-B1)	9.95 (8-11)	9.93 (8-11)	9.96 (8-10)	9.98 (8-11)	9.92 (8-11)	11.84 (11-12)

Source: the author
Key: mean scores, range between brackets, ms = milliseconds, n=number

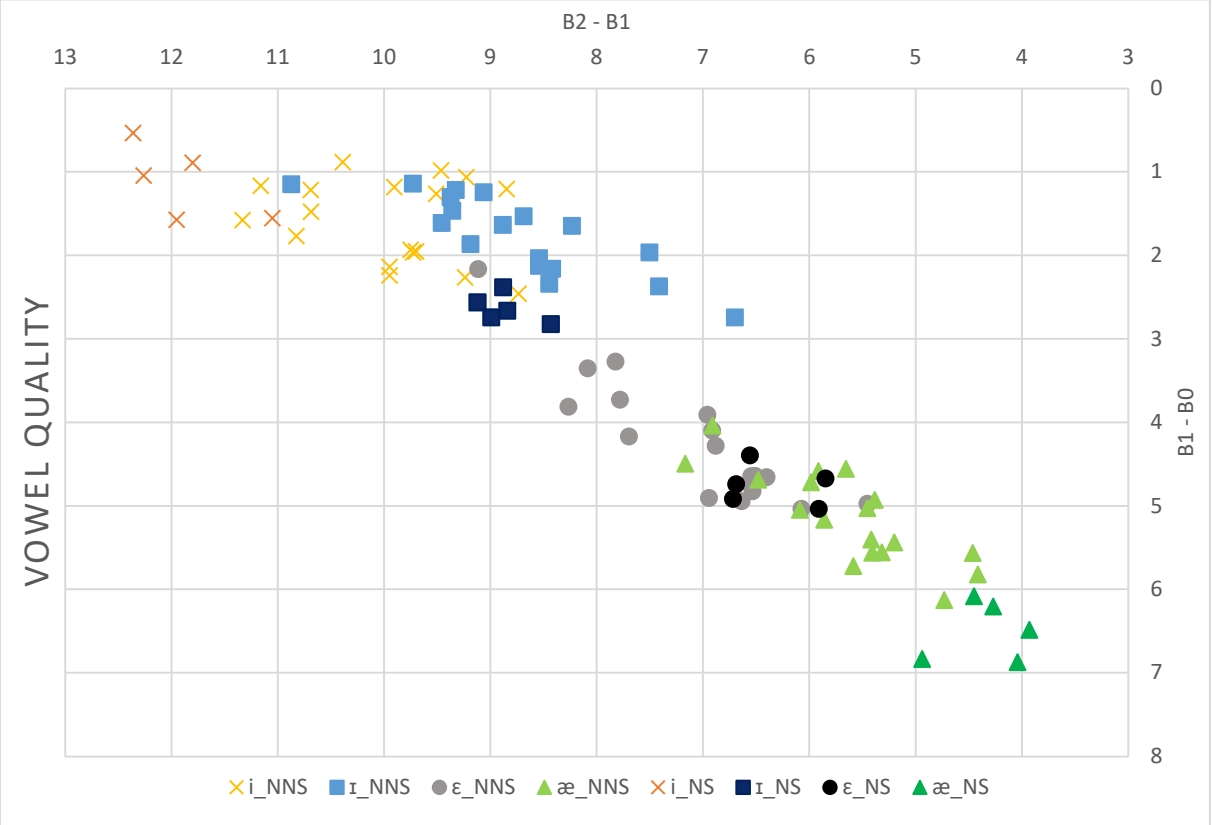
Table 6 displays the Euclidean Distances measured between the target vowel pairs according to participants. By looking at the mean scores one can see that, generally, learners pronounced vowel pairs with shorter distance from each other than native speakers, which is especially true for the high front vowel pair /i ɪ/. While learners' distances among the two vowel pairs ranged from close to zero to slightly more than four, NSs' lowest score was 2.20, pointing to a possible contrast between all the pronounced vowel pairs by NSs but not by NNSs. Additionally, the ED mean scores found among all learners and the high- and low-level groups for the two variables show no apparent differences. However, if looking only at the mean scores, the high-level groups performed slightly better than the low-level groups, with the exception of LoPhonA that pronounced the /ɛ æ/ pair with a mean score of 1.99 whereas the HiPhonA mean score for the same pair was 1.44. Thus, it would seem that the NNSs produced less-target-like vowels, i.e., vowels that are closer to each other, than NSs. However, ED is not able to inform the accuracy of the vowel and ED high numbers do not mean the vowel pair was contrasted. To better examine the vowel characteristics, we will look into the vowel plots.

Table 6 - Euclidean Distance for each vowel pair

	Learners (n=18)					Native speakers (n=5)
	All (n=18)	Phonological self-awareness		L2 use		
		High (n=9)	Low (n=9)	High (n=9)	Low (n=9)	
/ɛ æ/	1.71 (0.50-4.22)	1.44 (0.62-2.68)	1.99 (0.50-4.22)	1.93 (0.80-4.22)	1.50 (0.50-3.33)	2.68 (2.20-3.32)
/i ɪ/	1.34 (0.24-3.30)	1.40 (0.27-2.65)	1.28 (0.24-3.30)	1.40 (0.24-2.65)	1.29 (0.27-3.30)	3.40 (2.47-4.55)

Source: the author
Key: mean scores, range between brackets, n=number

Figure 5 - Vowel height and frontness plotted for all participants (n=23)



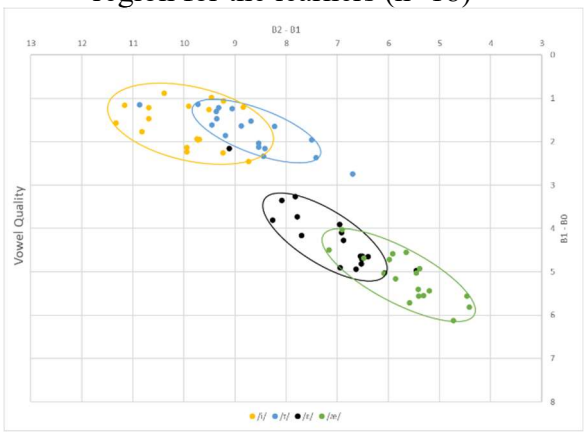
Source: the author
Key: NNS=Nonnative speaker, NS=Native speaker

Figure 5 shows a vowel plot for vowel height (y-axis) and frontness (x-axis) mean values including all participants so as to better interpret the vowel productions. In the graph, the same target vowels are plotted with the same format, but different colors between the productions from learners and NSs. From a first glimpse, one can see that while the NSs' dots are concentrated for each target vowel, the NNSs' productions appear to be spread. Although

some learners pronounced the target vowels close to the ones from the NSs, for example, the vowel /ɛ/, most did not, and their vowel mean values lay somewhere far from the reference models, suggesting a lack of accuracy. Moreover, the NNSs' productions of the tense high front vowel /i/ and the lax low front vowel /æ/ appear to be placed in between the NSs' vowel pairs.

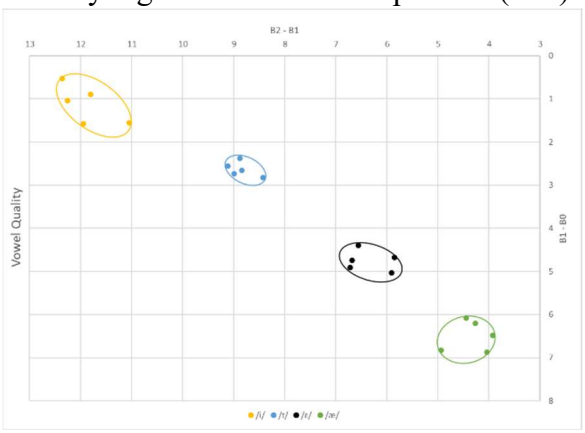
Figures 6 and 7 present the vowel productions by region as a way to interpret if vowel pairs were contrasted or not. Figure 7 refers to the productions by NSs and one can see that they pronounced counterpart vowels in distinctive regions meaning that the vowel pairs were contrasted. On the other hand, figure 6 presenting the mean values for the NNSs' target vowels shows that learners pronounced vowel counterparts in an overlapping manner and with a greater range for each vowel region, in addition to some outlier vowels. Therefore, these vowel plots suggest that NNSs tended to not contrast the vowel pairs while NSs did so. However, it is important to note that only 5 participants constitute the native speakers' group while learners constitute 18 participants, hence, a wider range is expected from the latter.

Figure 6 - Vowel height and frontness by region for the learners (n=18)



Source: the author

Figure 7 - Vowel height and frontness by region for the native speakers (n=5)

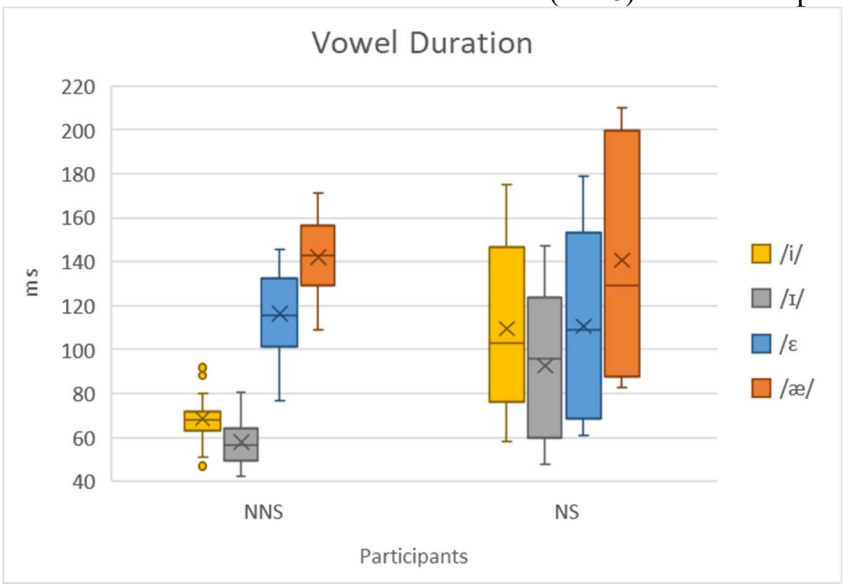


Source: the author

Figure 8 shows the mean duration values for the target vowels. One can see that Brazilian Portuguese learners present similar duration mean values (cross marks) for the /ɛ/ and /æ/ vowels and lower duration mean values for the /i/ and /i/ vowels than the native speakers. Moreover, although NSs (n=5) are in a much lower number of participants than NNSs (n=18), the range of their duration mean values for the target vowel is considerably wider, which suggests NNSs were more consistent in their vowel productions regarding duration. However, this difference may be due to the fact that the acoustic values of the two

groups came from different sources that employed distinctive methods either in the vowel elicitation and also in the vowel acoustic analysis.

Figure 8 - Vowel duration mean scores for learners (n=18) and native speakers (n=5)



Source: the author

Key: ms=milliseconds, NNS=nonnative speaker, NS=native speaker. Line within the boxplot indicates the median value. Cross mark indicates the mean value. Whiskers indicate standard deviation

In this subsection, we carried out some preliminary analyzes to compare the productions by Brazilian Portuguese learners and English native speakers in general. In the next two subsections, results will be displayed according to the phonological self-awareness and L2 use variables in order to answer the two research questions.

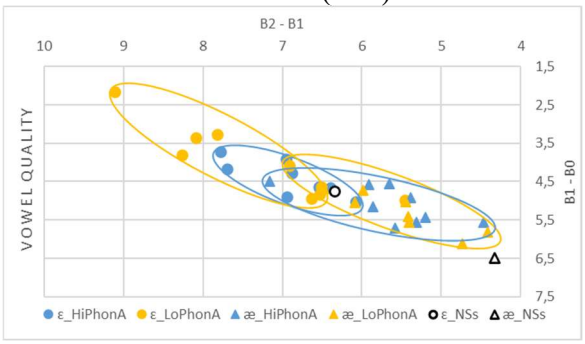
4.2 PHONOLOGICAL SELF-AWARENESS

Research Question 1 asks if the participants who have higher phonological self-awareness produce the four English front vowels /i ɪ ɛ æ/ more accurately than those participants who have a lower phonological self-awareness, and to answer that we will look into the production of the target vowels by the Brazilian Portuguese learner participants according to the high phonological self-awareness group (HiPhonA) and low phonological self-awareness group (LoPhonA).

Figure 9 shows a vowel plot by region for the mid and low front vowels /ɛ æ/ pronounced by learners and one reference mark for each of the native speakers' mean scores of the same target vowels. It is possible to see overlapping regions for the two target vowels by the HiPhonA and LoPhonA groups. Their vowel productions appear to be close to the

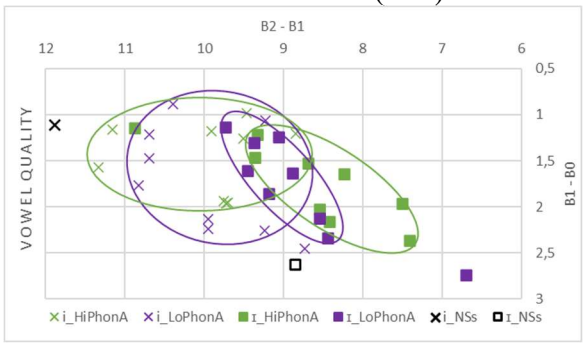
NSs' mean score for the vowel /ɛ/. The low front vowel /æ/ regions from both groups are located above and in front of the reference mark for the same target vowel which means HiPhonA and LoPhonA groups pronounced /æ/ higher and more anterior than the NSs. Moreover, the same two regions occupy almost the same space in the vowel plot, in between the reference marks for the vowels /ɛ æ/, suggesting that phonological self-awareness did not affect the production of this vowel by NNSs in terms of spectral quality. In addition, the mid front vowel /ɛ/ regions suggest that the HiPhonA and LoPhonA groups pronounced the target vowel higher and more anterior than the NSs, which is especially true for the LoPhonA group. The two regions for this vowel show to be overlapping although the LoPhonA region is somewhat more anterior and higher to the native reference mark than the HiPhonA region. Furthermore, the /ɛ/ region for the LoPhonA group is apparently wider than the region for the HiPhonA, meaning a wider range between the participants. Therefore, the vowel /ɛ/ quality values by the HiPhonA and LoPhonA groups appear to be dissimilar to the NSs' quality values and no evidence was found for phonological self-awareness benefitting L2 vowel production in this regard.

Figure 9 - Mid and low front vowels by region for the HiPhonA (n=9) and LoPhonA (n=9)



Source: the author
Key: HiPhonA=high phonological self-awareness group, LoPhonA=low phonological self-awareness group, NSs=native speakers' mean score

Figure 10 - Tense and lax high front vowels by region for the HiPhonA (n=9) and LoPhonA (n=9)

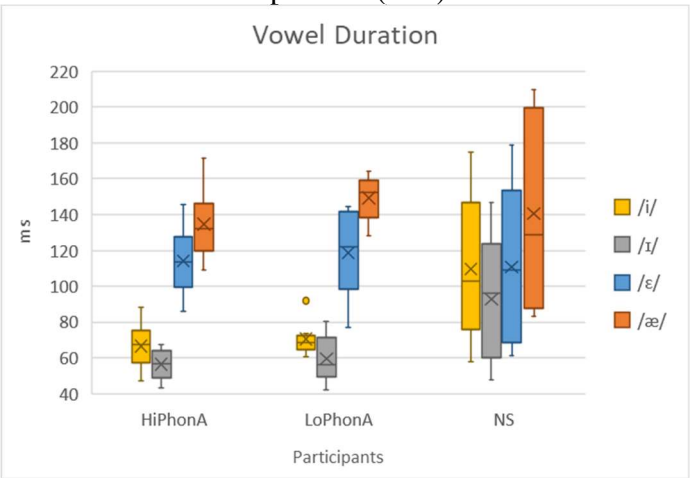


Source: the author
Key: HiPhonA=high phonological self-awareness group, LoPhonA=low phonological self-awareness group, NSs=native speakers' mean score

Figure 10 is a vowel plot by region for the lax and tense high front vowels /i ɪ/ in relation to the HiPhonA and LoPhonA groups and the native reference marks for the target vowels. The four vowel regions are shown to overlap in a position behind the native reference mark for /i/ and above the native reference mark for /ɪ/, which suggests the vowel pairs were not contrasted by the two groups. The two vowel /i/ regions by HiPhonA and LoPhonA groups are placed in between the marks for the NSs' vowel pair, in a slightly higher position

in relation to the NSs' /ɪ/, so both groups produced the vowel /i/ more posterior and lower than the NSs. Additionally, the two /i/ regions are almost completely overlapped, meaning phonological self-awareness did not influence the pronunciation of the tense high front vowels by NNSs regarding spectral quality. Moreover, the lax high front vowel /ɪ/ region for HiPhonA is above the native reference mark for the same vowel and spreads both to the front and back of it, although a wider portion is located in the back of the mark, thus, the group pronounced higher /ɪ/ vowels than NSs with divergent frontness values. A similar situation can be seen in the /ɪ/ region for LoPhonA but a wider portion is situated in front of the native reference mark which means the group also pronounced higher /ɪ/ vowels than NSs, differing in frontness values. Therefore, the spectral quality mean values for HiPhonA and LoPhonA groups indicate that phonological self-awareness was not related to the L2 pronunciation of the high front vowel pair by NNSs in the present study taking the vowel plot into consideration.

Figure 11 - Vowel duration mean scores for HiPhonA (n=9), LoPhonA (n=9), and native speakers (n=5)



Source: the author
Key: ms=milliseconds, HiPhonA=high phonological self-awareness group, LoPhonA=low phonological self-awareness group, NS=native speaker. Line within the boxplot indicates the median value. Cross mark indicates the mean value. Whiskers indicate standard deviation

Figure 11 is a vowel duration box plot of the target vowels duration mean scores for both the HiPhonA and LoPhonA groups and the native speakers. By looking at the yellow and gray boxes, the mean scores (cross marks) of the /i/ and /ɪ/ vowels for the HiPhonA and LoPhonA groups are very much alike to each other and considerably lower than the NSs' mean scores. Although the NSs' ranges are noticeably wider than the NNSs', the boxes for the two high front vowels barely occupy the boxes of the same target vowels by the NSs. Still,

both NNS groups pronounced the vowel /i/ longer than its counterpart, akin to the NSs. Therefore, phonological self-awareness showed no influence on the duration of lax and high front vowels by NNSs as the boxes for the two target vowels for the two groups are very similar. When looking at the blue and orange boxes, one can see that the production of the /ɛ/ and /æ/ vowels by the HiPhonA and LoPhonA groups are very similar as well as inside the area occupied by the NSs' boxes. Moreover, both NNS groups pronounced the mid and low front vowels with similar mean values compared to the NSs although the HiPhonA mean scores for the two vowels are slightly lower than the mean scores of the LoPhonA, still, the distinction between the two groups is very low. Also, both groups generally pronounced the /æ/ vowel longer than its counterpart /ɛ/, just like NSs, and this distinction is even clearer for the NNS groups. Nonetheless, phonological self-awareness seemed not to considerably affect the duration of the /ɛ/ and /æ/ vowels by Brazilian Portuguese learners.

Thereupon, the vowel plots presented in the present subsection show that the participants who have higher phonological self-awareness did not produce the four English front vowels /i ɪ ɛ æ/ more accurately than those participants who have a lower phonological self-awareness. Instead, the HiPhonA and LoPhonA groups pronounce target vowels with similar acoustic values for spectral quality and quantity, differing from the vowel productions by native speakers to a higher or lesser degree.

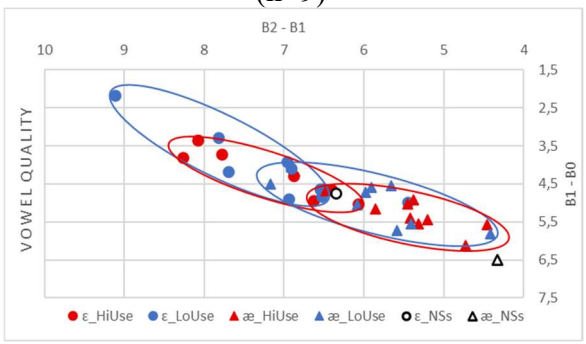
4.3 LANGUAGE USE

Research Question 2 asks if the participants who have higher L2 use produce the four English front vowels /i ɪ ɛ æ/ more accurately than those participants who have a lower L2 use, and the answer will be provided by looking into the following vowel plots according to the high- (HiUse) and low- (LoUse) level groups of L2 use by Brazilian Portuguese learners and the native speakers.

Figure 12 is a vowel plot of the productions of the low and mid front /ɛ æ/ vowels by the HiUse and LoUse groups as well as the reference marks from the native speakers' mean scores of the same target vowels. By looking at the regions for the two target vowels by the two groups, it is possible to see that the four of them overlap near the mark for the mid vowel /ɛ/ by the NSs, consequently, HiUse and LoUse groups did not contrast the English vowel pair /ɛ æ/. The two regions for the low vowel /æ/ by the HiUse and LoUse groups are almost completely overlapped in a position above and in front of the native reference mark for the same vowel, demonstrating both NNS groups pronounced higher and more anterior /æ/

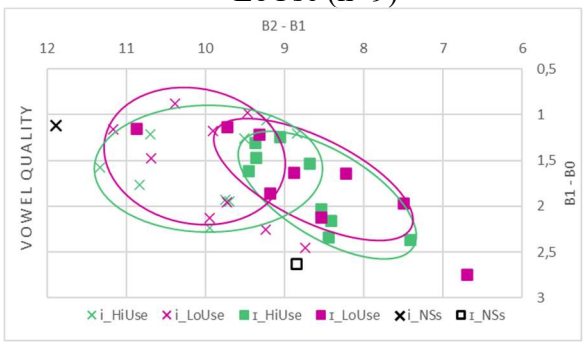
vowels than NSs. Moreover, the two regions for the mid front vowel /ɛ/ by the two L2 use groups overlap in front of, and slightly above, the native reference mark of the same vowel, the same place where most of the productions by the groups are located, hence, the groups of learners produced more anterior and slightly higher /ɛ/ vowels than the NSs. Therefore, L2 use did not appear to influence the production of mid and low front vowels /ɛ æ/ by Brazilian Portuguese learners in spectral quality.

Figure 12 - Mid and low front vowels by region for the HiUse (n=9) and LoUse (n=9)



Source: the author
Key: HiUse=high second language use group, LoUse=low second language use group, NSs=native speakers' mean score

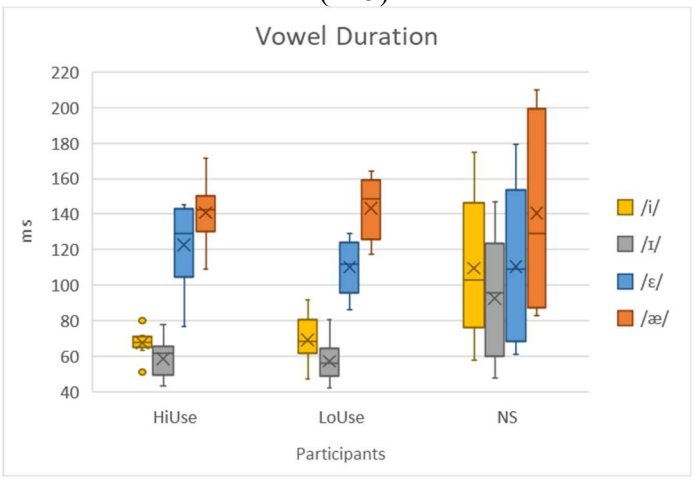
Figure 13 - Tense and lax high front vowels by region for the HiUse (n=9) and LoUse (n=9)



Source: the author
Key: HiUse=high second language use group, LoUse=low second language use group, NSs=native speakers' mean score

Figure 13 displays the tense and lax high front vowels by learners in regions, and the two reference marks using the native speakers' mean scores of the two target vowels. With the help of the green and pink elliptical formats, one can see that the lax high front vowels pronounced by the HiUse and LoUse groups practically overlap. The two regions are positioned above the native reference mark for the same vowel and spread both to the front and back of it, meaning both NNS groups pronounced higher /ɪ/ vowels than NSs, with differing frontness values in relation to the NSs' mean score. Furthermore, by looking at the other two formats, we find that the tense high front vowels produced by the HiUse and LoUse groups are also overlapping. The two regions are located behind the native reference mark for the same vowel, spreading to a region below it, thus, both NNS groups pronounced more posterior, and generally lower, /i/ vowels than NSs. Consequently, the HiUse and LoUse groups showed to pronounce similar high front vowels either in relation to the lax /ɪ/ or the tense /i/ target vowels, hence second language use appeared not to affect the production of /i/ and / ɪ/ regarding height and frontness acoustic features.

Figure 14 - Vowel duration mean scores for HiUse (n=9), LoUse (n=9), and native speakers (n=5)



Source: the author
Key: ms=milliseconds, HiUse=high second language use group,
LoUse=low second language use group, NS=native speaker. Line within the boxplot indicates the median value.
Cross mark indicates the mean value. Whiskers indicate standard deviation

Figure 14 regards the target vowels duration mean scores for the HiUse and LoUse groups and native speakers. Considering the yellow and the gray boxes, one can see that the HiUse and LoUse groups pronounced the tense and the lax high front vowels with similar duration mean scores although both groups have much lower duration mean scores for the vowel pair than the NSs. Moreover, the blue and orange boxes show that the HiUse and LoUse groups pronounced mid and low front vowels similarly to the NSs concerning mean scores, except for the mid vowel /ɛ/ by the HiPhonA in which the mean score is slightly higher. It is important to note that although NSs consist of only 5 participants, while each NNSs group is formed by 9 participants, the former displays a considerably wider range for the duration of the four target vowels than the latter, which may be due to the elicitation method and data collection previously mentioned. In addition, both HiUse and LoUse groups as well as the NSs pronounced the target vowels /æ/ and /i/ longer than their counterparts, in general terms, and this distinction is more visible in the productions by NNSs. Despite some variations, in examining Figure 14, language use did not show to be related to the durations of the four English front vowels /i ɪ ɛ æ/ by Brazilian learners of English.

Therefore, the results presented here found no evidence for a relation between L2 use and accuracy of /i ɪ ɛ æ/ production. On the contrary, the HiUse and LoUse participants produced comparable target vowels that mostly differed from the native speakers' production in spectral quality and quantity.

5 DISCUSSION

The present section discusses the results presented in the previous section along with other findings from the literature as well as some implications and limitations from the present study.

By looking at the vowel quality plots, Brazilian Portuguese learners differing in the degree of phonological self-awareness and second language use did not appear to differ in the pronunciation of the four English front vowels /i ɪ ɛ æ/, which tended to be pronounced differently from the native reference models. While native speakers contrasted the four target vowels by means of spectral quality, with no overlapping regions, Brazilian learners did not, independently of the level of the two variables. The regions for the mid and low front vowels /ɛ æ/ by the HiPhonA and LoPhonA, and the HiUse and LoUse groups appeared to overlap close to the native reference mark for /ɛ/. Moreover, the four groups generally pronounced higher and more anterior /æ/ and /ɛ/ than native speakers, which is especially true for the low front vowel /æ/. However, for the mid front vowel /ɛ/, both high-level groups produced slightly more accurate vowels than the low-level groups, with regions less anterior and closer to the native reference mark.

Regarding the high front vowel pair /i ɪ/, the four regions (for the two vowels and two groups) for the two variables showed to overlap in a position behind the reference mark for /i/, and in between the vowel pair reference marks. Generally, all four groups of NNSs produced lower and more posterior /i/ than native speakers, and higher /ɪ/, with different frontness values in relation to the native reference mark for the same vowel. Although the regions for high front vowels are nearly overlapping for the all high- and low-level groups, the HiPhonA pronounced somewhat more posterior /ɪ/ vowels than the LoPhonA. Despite the small variation, no considerable differences were found in the spectral quality of the four English target vowels by the high- and low-level groups of phonological self-awareness and second language use in the present study.

With respect to vowel duration, no considerable differences were found either in the high- and low-level groups of the two variables, which generally performed better in the production of the mid and low front vowels /ɛ æ/ than in the production of high front vowels /i ɪ/. One thing that calls attention in relation to the quantity values is that the native speakers' duration mean values are much wider than the mean values from the groups of learners even though native speakers are in 5 participants while each group has 9 learners. The duration values of the /ɛ/ and /æ/ vowels by the four groups of learners showed to be inside the NSs'

wider values range and the mean scores for the four groups were considerably similar to the NSs' means scores of the same target vowels. In opposition, the high front vowel pair was pronounced considerably shorter than the NSs by all groups of learners. The duration mean scores were very much alike between the low- and high-level groups. Moreover, almost all learner and native participants pronounced the /æ/ and /i/ vowels longer than their counterparts, and surprisingly, this quantity distinction is more visible in the groups of learners. Therefore, learners were shown to use means of duration to contrast the vowel pairs in the place of vowel quality. However, by looking at the vowel duration plots, it was possible to see that neither phonological self-awareness or L2 use affected the duration of the four target vowels by learners.

In the present study, no evidence was found for a relation between L2 use and vowel production accuracy. These results are different from the Flege, Munro and McKay (1995) study. However, Muñoz (2008) calls attention to the differences between naturalistic and instructed language learning settings and results from one cannot be generalized to the other. Thus, it is also important to mention that individual variables such as quality of input were not regarded here in the data analysis which limits the results. Muñoz (2008) argues that the amount and quality of input in the instructed setting is not adequate as learners are usually exposed to the target language for a limited short time when the source may be only the teacher in place of the abundant meaningful input found in immersion settings. Also, recent studies in L2 speech acquisition posit that the quality of input may be more relevant than the quantity (Flege, 2008; Flege; Bohn, 2021). Moreover, the L2 use score was assessed by linguistic questionnaires that learners answered mostly based on their self-perception of their usage of each language they spoke, which can be unreliable for making comparisons among different participants. Besides, the division of participants into the high- and low-level groups of language use may have been inaccurate as the HiUse group (range: 35-85) demonstrated a considerably wider range than the LoUse group (range: 15-32.5) and some participants of the latter would possibly be considered low L2 users if more participants took part in the study.

Additionally, no evidence was found for a relation between phonological self-awareness and vowel production accuracy in this study. This outcome may be related to the method employed. Firstly, the high- and low-level groups of phonological self-awareness did not differ greatly in their mean score for the variable (HiPhonA= 37.89, LoPhonA= 29.78). The HiPhonA participants were considered with higher phonological self-awareness in this study in relation to the LoPhonA, however, their phonological self-awareness scores were not very high, and if the case was more participants took part in the study, several of the HiPhonA

participants would likely be in the LoPhonA group. Moreover, the phonological self-awareness background questionnaire consisted of more generic questions about pronunciation and did not directly address vowels, mainly the three questions used to measure the variable score. By the same token, participants answered the questionnaire based on their self-perception of the matter which may not accurately tell their phonological self-awareness, and what is more, even if participants showed to be aware, the production of L2 vowels also depends on the development of motoric abilities which by the time might not have been acquired by the learners. In addition, individual variables influencing phonological self-awareness are not substantially discussed in the field and were not taken into consideration in the present study either, which might have limited the results.

Altogether, Brazilian Portuguese learners tended to pronounce comparable target vowels independently of the groups of variables and their English vowel characteristics resembled, in parts, the characteristics of those already found in the literature mentioned in *section 2.4*. Similarly to what Lima Junior (2012) found, Brazilian participants here tended to pronounce the /ɛ/ and /æ/ closer to the /ɛ/ by the NSs, and the high front vowel pair tended to be placed in a position between the natives' productions for the two vowels. However, the common case found (Lima Junior, 2012; 2016b; 2019; Rauber *et al.*, 2005) in relation to the ease and difficulty by Brazilians to pronounce the /i ɪ/ and the /ɛ æ/ vowel pairs, respectively, remained unsettled here as both pairs seemed to be hardly contrasted by NNSs through quality values whereas quantity values for the high front vowels were distant from those by native speakers. Yet, it is important to note that spectral analysis can differ from what the listener perceives, thus, the vowel pairs shown to overlap here might be heard as different target vowels by listeners or not, the only way to assess that is to conduct a study with humans judging the vowel productions or maybe playing the audio files to automatic speech recognition.

That being said, the present study has implications for pronunciation teaching of English segments to Brazilian learners of English. As Kelly (2006) mentions, pronunciation teaching is commonly neglected and not given the necessary attention, thus, some aspects of English phonetics and phonology like the contrast of vowel pairs may be left aside. However, considering the learners analyzed here tended to differentiate the vowel pairs by means of acoustic quantity only with subtle contrasts in spectral quality, English teachers in Brazil may want to give extra prominence to the pronunciation of English vowels addressing not only the difference in duration between the vowels but also the change in vowel quality.

Notwithstanding, the present study encountered several methodological limitations thus results have to be carefully regarded. Firstly, as the present study uses secondary data from two different studies, different elicitation methods were employed in each of them and therefore comparison between the Brazilian learners' productions and the native reference models may have been inaccurate, especially taking the reading elicitation text pronounced by learners into account. As mentioned before, linguistic studies employing acoustic analysis of vowels usually have the target vowels inserted in CVC words to isolate acoustic variations (e.g. Lima Junior, 2012; 2016b; 2019; Rauber *et al.*, 2005), additionally, tokens are customarily elicited inside a carrier sentence to better control the vowel characteristics. However, the present study acoustically analyzed vowels in different phonological contexts found inside a texting reading, then target vowels are likely to not receive considerable attention by readers, posing more challenges in the analysis and resulting in values different from those found in the typical elicitation method. Yet, different elicitation methods are necessary to back up the findings from studies using more controlled elicitation methods.

Other limitations concern the number of participants, instruments, and data analysis. As only 18 Brazilian Portuguese learners took part in the present study, each group of participants for the two variables had only 9 participants, which is a small sample. Therefore, results cannot be generalized to every learner, and more studies investigating phonological self-awareness and language use with larger samples are necessary. Moreover, both phonological self-awareness and language use scores were obtained through background questionnaires which may be inaccurate in measuring the two variables and comparing them among participants as subjects may differ in their self-perception of language use and awareness or misunderstand/miscalculate the questions and answers. Besides, as the vowels pronounced by learners were acoustically analyzed one by one by the researcher, with no use of scripts, the spectral quality and quantity measurement among the vowels may slightly differ by error as the phonological context was not controlled. By the same token, another limitation refers to the data analysis being certified only by examining the vowel plots, and no statistical analysis was used to mathematically confirm the findings. Nonetheless, as Brazilian participants' productions showed to be generally comparable and corresponding, the aforementioned limitations did not pose a lack of reliability to the present study.

6 CONCLUSION

Aiming to examine the phonological self-awareness and second language use (both assessed through background questionnaires) impact in the production of the English front vowels /i ɪ ɛ æ/ by Brazilian Portuguese learners, the present study acoustically analyzed text readings of 18 learners and compared the spectral quality and quantity values with values by 5 English native speakers from the literature. By looking at the vowel plots for vowel quality and quantity, it was possible to see that Brazilian participants pronounced corresponding target vowels independently of the high and low levels of the two variables analyzed. Moreover, learners were shown to differentiate the vowel pairs only by means of durations but not through vowel quality. Therefore, phonological self-awareness and language use appeared not to relate to the production of the target vowels by the Brazilian participants.

The present study was not free of limitations and further research needs to be carried out on the topic so as to draw a more concrete conclusion on the effect of phonological self-awareness and language use on second language pronunciation.

Finally, the findings have implications for pronunciation teaching as Brazilian learners of English appear to have difficulty pronouncing English vowels, mainly by means of vowel quality. As the four target vowels constitute different phonemes in English, the replacement of one vowel by another can lead to communication breakdowns and affect comprehensibility and intelligibility. Therefore, English teachers should focus on the differences found between English vowels, giving prominence not only to duration but also to vowel quality. Moreover, language learners could use didactic materials such as the phonetic alphabet by colors, The Color Vowel Chart (Taylor; Thompson, 1999), to better understand the different phonemes and vowel characteristics. By producing more target-like English vowels, learners can communicate better in the language and may feel more secure doing so.

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APPENDIX A - DEMOGRAPHIC AND LINGUISTIC CHARACTERISTICS OF THE BRAZILIAN PARTICIPANTS

ID	Place of Birth	Age	Vocabulary Size	AOL English	Academic English Experience	Native English Experience	L1 Use Average	L2 Use Average	N° of FAs	L3 Daily Use	Major	Phonetics/ Phonology Exp	Phonetics Class Years Ago	Phonological Self-Awareness Score
p01	São José	22	7100,00	11	16	0,5	60	40	1	0	English	yes	1	27
p08	Florianópolis	24	7350	6	19	0	77,5	22,5	1	0	English	no		30
p12	Campo Grande	22	8550	12	17	0,25	82,5	17,5	3	0	English	no		34
p15	Porto Alegre	23	7000	10	14	60	77,5	22,5	1	0	English	yes	3	35
p22	São Paulo	25	6550	12	16	0	70	30	1	0	English	no		28
p32	Garopaba	25	6450	10	18	0	67,5	32,5	1	0	English	no		39
p41	Florianópolis	27	8800	10	18	0,5	60	40	3	0	English	no		39
p42	Criciúma	22	6650	11	17	0	60	37,5	2	0	English	no		36
p44	São José	23	7350	7	18	0	60	40	1	0	English	no		25
p45	Rio do Sul	26	5050	2	29	0,25	15	85	2	0,428	English	no		42
p46	Brasília	27	8550	4	20	5	45	47,5	2	0,571	English	no		36
p47	Londrina	27	7250	8	19	4	85	15	1	0	Translation	no		37
p48	Curitiba	23	6800	9	20	2	82,5	15	2	0	English	no		27
p52	Florianópolis	31	7250	7	18	10,5	65	35	2	0	English	no		42
p58	Turvo	19	6850	11	17	0	80	20	1	0	English	no		35
p62	Gaspar	27	7550	8	23	0	57,5	42,5	3	0	English	no		34
p63	Florianópolis	31	4250	12	14	0	75	25	1	0	English	yes	3	32
p65	Alegrete	27	6600	12	21	36	27,5	70	1	0	English	no		31

Key: ID= Identification, Major= English= English language, literature and translation; AOL English= Age of Onset of Learning of English (age in years); Academic English Experience (time in years spent formally studying English), Native English Experience (length of stay in English speaking countries in months); L1 Use Average= % of L1 use over 5 years; L2 Use Average= % of English use over 5 years; N° of FAs= Number of foreign languages besides English; L3 Daily Use (hours); Phonetics/Phonology Exp= attended a class in English Phonetics and Phonology (yes/no); Source: Kivistö-de Souza (2015)

APPENDIX B - INFORMATION ON THE AMERICAN NATIVE SPEAKER PARTICIPANTS

IDENTITY	L1 ACQUISITION LOCATION	AGE AT THE TIME OF TESTING
cM01	GAINESVILLE, FLORIDA	52
cM02	ORRVILLE, OHIO	71
cM03	KENTUCKY	30
cM04	DALLAS, TEXAS	25
cM05	NEW HAVEN, CONNECTICUT	25

Source: Lima Junior (2012, p. 160)

APPENDIX C - PHONOLOGICAL SELF-AWARENESS QUESTIONNAIRE

NAME: _____

PART I: Task related questions

1. When answering, how often did you...? (TO BE FILLED AFTER THE PROSODIC AWARENESS TASK)

Write X on the corresponding box.

	All the time	Often	Sometimes	Rarely	Never
Guess					
Use intuition					
Use knowledge of a rule					

2. When answering, how often did you...? (TO BE FILLED AFTER THE SEGMENTAL AWARENESS TASK)

Write X on the corresponding box.

	All the time	Often	Sometimes	Rarely	Never
Guess					
Use intuition					
Use knowledge of a rule					

---------- **PART II: Phonological Awareness**

3. Give your opinion on the following statements. *Write X on the corresponding box.*

	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
I can hear there are some English sounds *I don't pronounce correctly although I try.*					
I can hear my English intonation and rhythm are not correct although I try.					
I can hear I have a foreign accent when I speak in English.					

4. Give your opinion on the following statements. *Write X on the corresponding box.*

	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
There are some specific English sounds that are difficult for Brazilians.					
There are some specific features in English intonation/rhythm that are difficult for Brazilians.					
Brazilians have a characteristic accent when they speak in English.					

Source: Kivistö-de Souza (2015, p. 301)

5. How easy it is for you to....

Write X on the corresponding box.

	Very easy	Quite easy	Quite difficult	Very difficult	I can't do this at all
notice pronunciation mistakes in the production of *individual* sounds in other non-native speakers' speech?					
notice pronunciation mistakes in the *intonation and rhythm* in other non-native speakers' speech?					
tell where a *native* speaker of English comes from based on their English accent?					
tell whether a *non-native* speaker of English is Brazilian based on their English accent?					
tell where a *non-native* speaker of English (other than Brazilian) comes from based on their English accent?					

6. How easy it is for you to....

Write X on the corresponding box.

	Very easy	Quite easy	Quite difficult	Very difficult	I can't do this at all
notice whether *a sound combination* you hear is possible in English or not?					
notice whether the *intonation and rhythm* you hear in an English sentence are possible or not?					
notice whether an *individual sound* you hear is pronounced correctly in English or not?					

7. How easy it is for you to....

Write X on the corresponding box.

	Very easy	Quite easy	Quite difficult	Very difficult	I can't do this at all
explain why a sound combination you hear is possible or impossible in English?					
explain why the intonation and rhythm you hear are correct or incorrect in English?					
explain why an individual sound you hear isn't pronounced correctly in English?					

Source: Kivistö-de Souza (2015, p. 302)

APPENDIX D – ELICITATION TEXT

HOUSEWORK GETS YOU DOWN[1]

Work in the home has no job description and family members rarely appreciate just how much work has gone into preparing an evening **meal**[2] or cleaning the bathroom. Women **still** take responsibility for the lion's share of domestic chores and the **vast** majority of **men** continue to shy away from doing the dishes. In other situations financial reward can go some way to compensating for dull repetitive work, but housework is a strenuous job **with** no pay.

It may come as no surprise to learn that household chores can make you **feel** depressed. There is evidence to suggest that the more housework **men** and women do, the more likely they are to suffer from mood swings. "Any form of repetitive cyclical work is bound to be depressing. Domestic chores are open-ended **tasks**, so there is no defined end-point. People prefer **tasks** they can complete, and without a satisfactory conclusion they become **stressed**", **says** psychologist Nicholas Emler.

Writer Tracy Kerry believes that many people nowadays just don't know how to do housework. Sweeping a room may **seem** an easy enough **task** to perform, but there's a right way and a wrong way to do it. To make housework easier, she suggests we **get rid** of possessions **that** are of no use to us anymore. "**Keep** clutter under control and you **will feel** more able to cope".

[1] Edited from Norris (2008, p. 129)
[2] Bold marks here for better localizing the tokens.

APPENDIX E - GROUPS FOR THE VARIABLES

Brazilian Portuguese learners of English (n=18)							
Phonological self-awareness score				Second language use score			
HiPhonA		LoPhonA		HiUse		LoUse	
ID	Score	ID	Score	ID	Score	ID	Score
p45	42	p12	34	p45	85	p32	32.5
p52	42	p62	34	p65	70	p22	30
p32	39	p63	32	p46	47.5	p63	25
p41	39	p65	31	p62	42.5	p08	22.5
p47	37	p08	30	p01	40	p15	22.5
p42	36	p22	28	p41	40	p58	20
p46	36	p01	27	p44	40	p12	17.5
p15	35	p48	27	p42	37.5	p47	15
p58	35	p44	25	p52	35	p48	15

Source: the author

Key: ID= Identification, HiPhonA= High Phonological Self-Awareness, LoPhonA= Low Phonological Self-Awareness, HiUse= High second language use, LoUse= Low second language use