Concordia Working Papers in Applied Linguistics

Proceedings of the International Symposium on the Acquisition of Second Language Speech
Concordia Working Papers in Applied Linguistics, 5, 2014

Perception of Brazilian Portuguese Vowels by Australian English and Spanish Listeners

Jaydene Elvin
University of Western Sydney

Paola Escudero
University of Western Sydney

Abstract

Many studies on non-native speech and second language (L2) perception suggest that a second language learner hears with a foreign accent when listening to or perceiving the sounds of the new language (for a review see Strange, 1995, 2007; Escudero, 2005). It is well-established that the learners' native or first language influences how they hear and categorise L2 sounds (e.g., Flege, 1995; Flege, Bohn & Jang, 1997; Escudero, 2005; Best & Tyler, 2007). The present study examined group differences in the discrimination of Brazilian Portuguese (BP) vowels by Australian English monolinguals and Spanish listeners who learned English as their L2. It also investigated whether vowel inventory and vowel acoustic properties are equally good predictors of cross-language perception difficulty.

Acquiring the sounds of a new language is a challenging task for many adult second language (L2) learners. They struggle to attain native-like proficiency even when surrounded by the second language (Escudero, 2005). Failure to attain native-like pronunciation (i.e., foreign accented speech) is often related to how learners perceive the sounds of their target language (Best, 1994; 1995; Flege, 1995; Escudero, 2005). However, not all learners have the same degree of difficulty when perceiving and producing new L2 sounds. Theoretical models such as the Perceptual Assimilation Model (PAM; Best, 1995), which was extended to PAM-L2 to incorporate L2 development (Best & Tyler 2007), and the Second Language Linguistic Perception (L2LP) model (Escudero, 2005) propose that the learners' linguistic background predicts difficulty in learning new L2 sounds. The models explain that when we are introduced to a new speech sound, we filter and categorise it according to the sounds already present in our native language.

The present study investigates whether Australian English and Spanish listeners have the same problems in their perception of Brazilian Portuguese vowels. It also aims to determine whether vowel inventory and vowel acoustic properties are equally good predictors of listeners' cross-language perception difficulty or lack thereof. The languages investigated in this study vary in the size of their vowel inventories: Spanish has the smallest inventory with only five monophthongs /i, e, a, o, u/, Brazilian Portuguese (BP) has a slightly larger inventory of seven oral monopthongs, /i, e, ɛ, a, o, ɔ, u/, and Australian English (AusE) has the largest vowel inventory with 12 monophthongs, /iː, ɪ, e, eː, ɜ, ɐ, ɐː, æ o, ɔ, ʊ, ʉː/. BP was chosen as the target language as it contains more vowels than Spanish yet less than AusE, which allows us to compare cross-language perception in listeners with a smaller versus a larger vowel inventory.

Research on the acquisition of target languages with vowel inventories larger than that of the learner's native language is abundant. One of the most common problems in this scenario is Single category assimilation (SC, PAM; Best, 1995), which occurs when two non-native sounds are perceived as equally good or poor examples of the same native category (Best, 1994, 1995). Numerous studies (Escudero, 2000; 2005; Flege, 1997; Morrison, 2009) report SC assimilation for Spanish learners' perception of the English vowel contrast /i-ɪ/, since they map the two English sounds on to their single native category /i/. It has also been shown that Brazilian Portuguese learners of English have difficulty discriminating the vowels /æ, ɑ and ʊ/ in the contrasts /ɛ-æ/, /ɔ-ɑ/ and /u-ʊ/ (Rauber, et al., 2005), likely because they map them to their native vowels /ɛ/, /a/, and /u/, respectively. Spanish learners of Dutch have also been reported to map /a-ɑ/ to their Spanish /a/ and to have difficulty when distinguishing this Dutch contrast (Escudero & Wanrooij, 2010; Escudero & Williams, 2011).

Fewer studies have investigated the acquisition of a target language with a smaller vowel inventory than that of the learner's native language

(Escudero & Boersma, 2002; Morrison, 2003; Vasiliev & Escudero, 2011; Gordon, 2011). When learners have to shift from a larger to a smaller vowel inventory, they commonly exhibit Multiple Category Assimilation (MCA, L2LP; Escudero & Boersma, 2002). MCA occurs when two vowels in a binary contrast are perceived as more than two categories in the L1. For example, Dutch learners of Spanish exhibit MCA for the Spanish front vowels /i/ and /e/. As Dutch has three short vowels /i, ɪ and ɛ/ they will sometimes perceive the Spanish /i/ as the Dutch /i/ or /ɪ/. For the Spanish /e/ it can be perceived by Dutch learners as /ɪ/ or /ɛ/ (Escudero & Boersma, 2002). However, there are competing views as to whether or not MCA is problematic for L2 learners. Escudero and Boersma (2002) suggest that MCA is problematic because it leads to a *subset problem* where the learner needs to realize on the basis of positive evidence alone that some features or vowels of their own language do not exist in the target language. Additionally, even if the learner overcomes this subset problem, they may have difficulty to stop perceiving the false category (Escudero & Boersma, 2002; Gordon, 2011). Morrison (2003) and Gordon (2011) also found MCA in the perception of Spanish vowels by Canadian and American English learners, respectively. However, unlike Escudero and Boersma (2002) whose Dutch learners had difficulty in categorizing the Spanish front vowels in an identification task, Morrison (2003) and Gordon's (2011) learners did not exhibit such a difficulty.

It has been suggested that the most effective way of predicting discrimination difficulties is through the administration of a perceptual assimilation task, where listeners are asked to classify the vowels of the target language as their own native vowels (Strange, 2007). While this is an effective means of predicting discrimination difficulty, it can only be applied after a perceptual assimilation task has been conducted. Alternatively, one could compare the vowel inventories of the two languages or the vowels' acoustic properties prior to conducting a perceptual assimilation task. In the present study, we first compared vowel inventories and acoustic properties in order to predict difficulty in the discrimination of BP vowels by Spanish and AusE listeners.

Iverson and Evans (2007) explained that learning an L2 vowel system may be fundamentally different for individuals with a larger and more complex vowel system than for those with a smaller and simple vowel system. Although most studies have examined the L2 acquisition of pairwise contrasts (Flege & Bohn, 1997; Morrison, 2009), Iverson and Evans (2007) investigate broader implications of L1 phonetic categories on the learning of entire vowel systems. The authors tested German and

Norwegian learners who possess a larger vowel inventory and compared their identification of English vowels to that of French and Spanish learners who have a smaller vowel system. While their results demonstrated that there was no fundamental differences in the way the individuals learned the new language, it was shown that listeners with a larger and more complex native vowel inventory (German and Norwegian) were more accurate at identifying English vowels than those with smaller and less complex vowel inventories (Spanish and French).

Table 1 shows that AusE has more vowels than BP and Spanish If having a larger vowel inventory is indeed advantageous for vowel perception as demonstrated in Iverson and Evans (2007), AusE listeners should find the discrimination of BP vowels easier than Spanish listeners, since AusE vowels include, among others, most BP vowels, while Spanish lacks /ɛ/ and /ɔ/. Despite the fact that Spanish and Portuguese belong to the same language family, AusE listeners should be better than Spanish listeners when learning BP vowels if having a larger vowel inventory is the sole predictor.

Table 1. A Comparison of the Portuguese, Australian English and Spanish Vowel Inventories

Australian English	Portuguese	Spanish
iː	i	i
ɪ		
e	e	e
eː		
ɜ	ɛ	
ɐ	a	a
ɐː		
æ		
o	o	o
ɔ	ɔ	
ʊ	u	u
ʉː		

Escudero's L2LP model states that a listener's native sound perception should closely match the same sounds that are produced in the listener's native language (Escudero & Boersma, 2004; Escudero, 2005; Escudero, Simon & Mitterer, 2012; Escudero & Williams, 2012). The model thus proposes an alternative way of predicting non-native perception difficulties thorough acoustic comparisons of the native and target language. In that respect, it has been suggested that this method may not be successful if the analyses include productions of vowels only in their "canonical" forms, or in any single phonetic context (Strange, 2007, p.54). However, recent studies have shown acoustics to accurately predict L2 difficulty (Escudero & Chladkova, 2010; Escudero & Williams, 2011; Escudero & Vasiliev, 2011; Escudero & Williams, 2012 and Escudero, Simon & Mitterer, 2012). Following these studies, we included predictions based on the comparison of AusE, Spanish and BP vowel acoustics. Figure 1 shows the average F1 and F2 values of AusE (Cox, 2006), BP (Escudero, Boersma, Rauber & Bion, 2009) and Peruvian Spanish (PS; Chladkova, Escudero & Boersma, 2011) vowels measured at the vowel midpoint.

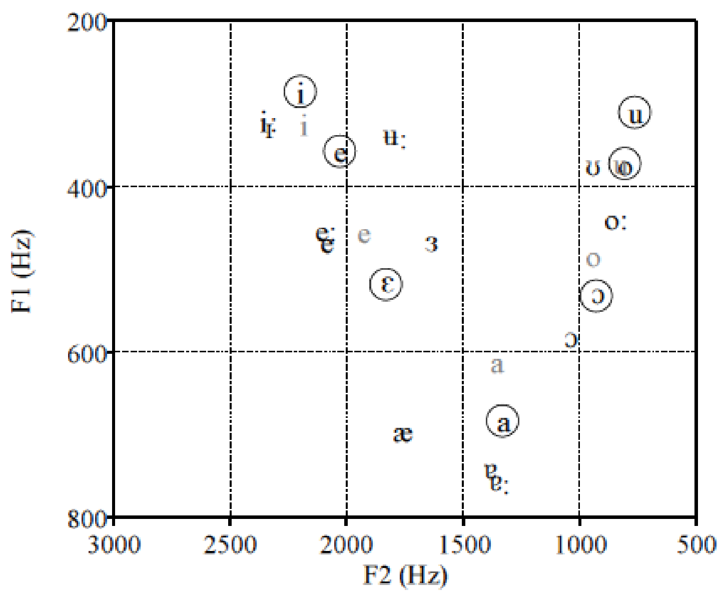

Figure 1. Male speakers' average F1 and F2 values for Brazilian Portuguese (black with circles), Australian English (black) and Peruvian Spanish (grey).

It can be observed that although AusE has /iː/ and /ɪ/, these vowels are produced with very similar F1 and F2 values and just like Spanish /i/, they are acoustically close to both BP /i/ and /e/. This should lead to comparable degrees of difficulty in discriminating this contrast for both listener groups. Although AusE has /ʉː/ and /ʊ/, the former is acoustically close to BP front vowels, while the latter is close to BP /o/, which should cause difficulty for the discrimination of BP /u-o/. Spanish listeners should match this difficulty since Spanish /u/ acoustically overlaps with BP /o/. Conversely, the lower BP vowel contrasts /a-ɛ/ and /a-ɔ/ seem to correspond to similar contrasts in Australian English and Spanish which should lead to ease in in discrimination for both groups of listeners.

In sum, if the size of native vowel inventories predict non-native discrimination difficulties then AusE listeners should be better than

Spanish listeners in discriminating BP vowel contrasts. Alternatively, if perception difficulties are more in line with the acoustic comparison between the three languages, the two listener groups should have comparable levels of discrimination accuracy.

METHOD

Participants

The participants in this study were nine AusE listeners from Western Sydney and nine Spanish listeners from Central and South America, who were between 19 and 52 years of age (AusE mean age: 28.77; Spanish: 34.88). The AusE listeners had little to very basic knowledge of languages other than English. The Spanish listeners were second language learners of English with varying degrees of English proficiency and were living in Sydney, Australia at the time of testing. Of the Spanish participants, 2 also reported advanced knowledge of a language other than English and Spanish. None of the listeners reported any knowledge of BP.

Stimuli

The listeners in this study were presented with the same stimuli as those presented to Californian English listeners in Vasiliev and Escudero (2011). They were 70 BP vowel tokens that were selected from Escudero et al.'s (2009) corpus. These tokens were isolated vowels (V) extracted from words of the form /fVfe/, which were produced by five male and five female monolingual speakers of BP from Sao Paulo and were in a carrier phrase (Escudero et al., 2009). Figure 2 shows the male and female F1 and F2 values for the natural vowel tokens used as stimuli in the present study.

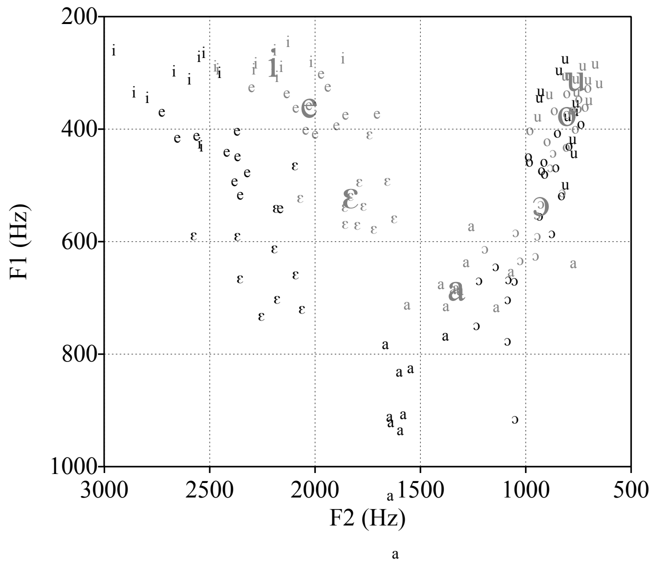

Figure 2. F1 and F2 values for the male (grey, small font) and female (black, small font) natural vowel tokens, and for the synthetic vowel tokens (grey, large font).

Seven BP vowel prototypes, which were created using the computer program Praat (Boersma & Weenink, 1992-2010), were also used as the A and B stimuli in the XAB categorical discrimination task, as will be described below. These synthetic vowels were created by Vasiliev and Escudero, 2011, based on the values of natural tokens produced by the 10 BP speakers and had steady-state F1, F2, F0 and durational values based on the averages reported in Escudero et al. (2009) and are also shown in Figure 2.

Procedure

Participants were presented with the same listening experiment used in Vasiliev and Escudero (2011), which was created and run using Praat (Boersma & Weenink, 1992-2012). It consisted of six categorical discrimination tasks, each presented in an XAB format. Listeners were presented with three vowel tokens and were asked to click using the mouse on the square on the screen with "2" if the first sound they heard was like the second sound or on the square on the screen with "3" if the first sound was more like the third. The X stimuli consisted of the 10 BP vowel tokens and the 4 synthesised prototypes. The A and B stimuli were the two synthetic vowel prototypes described above, which mimic the acoustic properties of the specific BP vowels involved in each of the six XAB tasks. The order of the A and B sounds was counterbalanced. The inter-stimulus interval between the three sounds was set to 1.2 sec. to ensure language specific phonological processing (see Escudero, Benders & Lipski, 2009). All listeners were tested in a quiet room in the MARCS Institute at the University of Western Sydney.

Each XAB task contained one of six BP contrasts, /a-ɔ/, /a-ɛ/, /e-i/, /o-u/, /e-ɛ/, and /o-ɔ/. The order of the six tasks was randomized across listeners. Each XAB contained 44 trials, including 10 natural and one synthetic token of each of the two vowels each presented twice (XAB and XBA). The synthetic prototypes were also presented as X stimuli to ensure that listeners understood the task and were able to match acoustically equal tokens (Vasiliev & Escudero, 2011). Testing was conducted in English and listeners were not told the language of the tokens. A practice session was conducted using a fairly easy contrast, namely /i-u/ (Vasiliev & Escudero 2011). Listeners took approximately 5 min to complete each XAB task.

RESULTS

Figure 3 shows the percentage correct with which AusE and Spanish listeners discriminated the six Brazilian Portuguese vowel contrasts. As can be observed, there seems to be little difference between the two groups.

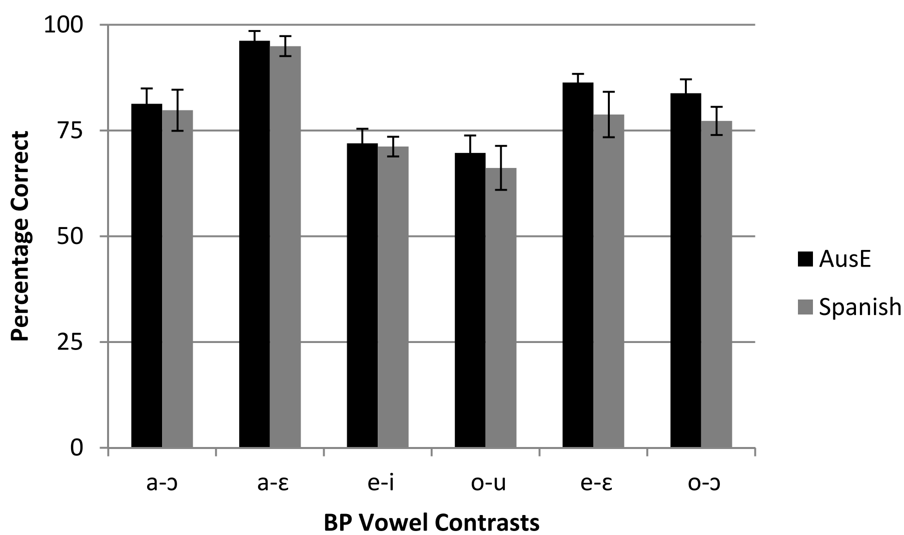

Figure 3: Australian English and Spanish listeners' accuracy scores for the 6 Brazilian Portuguese contrasts.

A repeated measures ANOVA with group as a between-subjects factor and contrast as a within-subject factor yielded no main effect of group (F [1, 16] = 1.156, p = .298) and no interaction contrast * listener (F [5, 80] = .428, p = .828), but a main effect of contrast (F [5, 80] =18.815, p = <0.001). Bonferroni corrected t-tests with all listeners showed that /a-ɛ/ had a significantly higher accuracy than all other contrasts (p = < 0.023). Further, listeners were less accurate on /o-u/ than on all other contrasts (p = < 0.039) except for /e-i/ (p = 1.0), which, in turn, had a significantly lower accuracy than /o-ɔ/ (p = 0.019) and /a-ɛ/ (p = < 0.001). There were no significant differences between /a-ɔ/, /e-ɛ/ and /o-ɔ/. Based on the ranking for discrimination difficulty reported in Escudero and Wanrooij (2010), the following hierarchy, ranging from most to least difficult, was found for BP contrasts: /o-u/ ~ /e-i/ >> /a-ɔ/ ~ /e-ɛ/ ~ /o-ɔ/ >> /a-ɛ/.

DISCUSSION

The results of the present study show that Australian English (AusE) listeners, who have a large vowel inventory, and Spanish listeners, who have a small vowel inventory, had similar accuracy scores for seven Brazilian Portuguese (BP) contrasts, suggesting that it is not easier for listeners with larger vowel inventories to discriminate non-native vowel contrasts. This means that contrary to Iverson and Evans' (2007) suggestion, vowel inventory size does not always successfully predict non-native vowel perception accuracy. The current results seem more in line with predictions based on vowel acoustic comparisons, since AusE and Spanish vowels compare equally to BP vowels in terms of acoustic properties.

Another prediction based on vowel inventories which was not borne out was that the BP mid-vowel contrasts, namely /e-ɛ/ and /o- ɔ/, would be more difficult for Spanish than AusE listeners. Conversely, an acoustic comparison of vowels in the three languages correctly predicted that BP /e-i/ and /o-u/ would be the most difficult for both groups to discriminate. This indicates that despite suggestions that acoustics may not be a good predictor for cross language speech perception (Strange, 2007), our findings contribute to the line of research that has demonstrated the accuracy of acoustic comparisons in predicting L2 perception difficulty (Escudero & Chládková, 2010; Escudero & Williams, 2011; Escudero & Vasiliev, 2011; Escudero & Williams, 2012 and Escudero, Simon & Mitterer, 2012).

Despite these clear findings, it is important to recall that the Spanish listeners in the present study had English as their second language with self-proficiency ratings of intermediate and above. Spanish listeners may have simply used their English and not their Spanish vowel perception to perform the task, since all instructions were given in English. Therefore, the suggestion that acoustic rather than vowel inventory comparisons predict L2 vowel perception difficulty more accurately can only be taken as preliminary. Testing Spanish monolinguals with the same tasks and with Spanish instructions seems crucial to confirm the findings of the present study.

REFERENCES

Best, C. T. (1994). The emergence of native-language phonological influences in infants: perceptual assimilation model. *The development of speech perception: The transition from speech sounds to spoken words*, 167-224.

Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 171-204). Timonium, MD: York Press.

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In M. J. Munro & O.–S. Bohn (Eds.), *Second language speech learning: The role of language experience in speech perception and production*, (pp. 13-34). Amsterdam: John Benjamins.

Boersma, P. and Weenink, D. (1992-2012). "Praat: doing phonetics by computer (Version 5.1.30)" [Computer program], retrieved April 1st, 2007 from http://www.praat.org/, (University of Amsterdam, Amsterdam)

Bundgaard-Nielsen, R. L., Best, C.T., & Tyler, M. D. (2011). Vocabulary size matters: The assimilation of second-language Australian English vowels to first-language Japanese vowel categories. *Applied Psycholinguistics,* 32, 51-67.

Escudero, P. (2000). Developmental patterns in the adult L2 acquisition of new contrasts: The acoustic cue weighting in the perception of Scottish tense/lax vowels in Spanish speakers. *Unpublished M. Sc. thesis, University of Edinburgh*.

Escudero, P. (2005). Linguistic perception and second language acquisition: Explaining the attainment of optimal phonological categorization. PhD dissertation, Utrecht University: LOT Dissertation Series 113.

Escudero, P., Benders, T., & Lipski, S. C. (2009). Native, non-native and L2 perceptual cue weighting for Dutch vowels: The case of Dutch, German, and Spanish listeners. *Journal of Phonetics*, *37*(4), 452-465.

Escudero, P., & Boersma, P. (2002). The subset problem in L2 perceptual development: Multiple-category assimilation by Dutch learners of Spanish, *Proceedings of the 26th annual Boston University Conference on Language Development,* edited by B. Skarabela, S. Fish, and A. H. –J. Do. Cascadilla Press, Somerville, MA, pp. 208-19

Escudero, P., & Boersma, P. (2004). Bridging the gap between L2 speech perception research and phonological theory. *Studies in Second Language Acquisition*, *26*(4), 551-585.

Escudero, P., Boersma, P., Rauber, A. S., & Bion, R. A. (2009). A cross-dialect acoustic description of vowels: Brazilian and European Portuguese. *The Journal of the Acoustical Society of America*, *126*, 1379.

Escudero, P., & Chládková, K. (2010). Spanish listeners' perception of American and Southern British English vowels: Different initial stages for L2 development. *Journal of the Acoustical Society of America, 128*, EL254-260.

Escudero, P., Simon, E., & Mitterer, H. (2012). The perception of English front vowels by North Holland and Flemish listeners: Acoustic similarity predicts and explains cross-linguistic and L2 perception. *Journal of Phonetics*, *40*(2), 280-288.

Escudero, P., & Wanrooij, K. (2010). The Effect of L1 Orthography on Non-native Vowel Perception. *Language and Speech, 53*(3), 343-365. doi: 10.1177/0023830910371447Escudero, P., & Williams, D. (2011). Perceptual assimilation of Dutch vowels by Peruvian Spanish listeners. *The Journal of the Acoustical Society of America*, *129*(1), EL1-EL7.

Escudero, P., & Williams, D. (2012). Native dialect influences second-language vowel perception: Peruvian versus Iberian Spanish learners of Dutch. *The Journal of the Acoustical Society of America*, *131*(5), EL406-EL412.

Escudero, P., & Vasiliev, P. (2011). Cross-language acoustic similarity predicts perceptual assimilation of Canadian English and Canadian French vowels. *The Journal of the Acoustical Society of America*, *130*(5), EL277-EL283.

Flege, J. E. (1995). Second language speech learning theory, findings, and problems. In W. Strange (Ed.), *Speech perception and linguistic experience: issues in cross-language research* (pp. 229-273). Timonium, MD: York Press.

Flege, J. E., Bohn, O.-S., & Jang, S. (1997). Effects of experience on non-native speakers' production and perception of English vowels. *Journal of Phonetics, 25*, 437-470.

Gordon, L. S. (2011). English Speakers' Perception of Spanish Vowels: Evidence for Multiple-Category Assimilation. *Implicit and Explicit Language Learning: Conditions, Processes, and Knowledge in SLA and Bilingualism*, 177

Iverson, P., & Evans, B. G. (2007). Learning English vowels with different first-language vowel systems: Perception of formant targets, formant movement, and duration. *The Journal of the Acoustical Society of America*, *122*, 2842.

Morrison, G. S. (2003). In M. J. Solé, D. Recansens, & J Romero (Eds.), *Proceedings of the 15th International Congress of Phonetic Sciences: Barcelona 2003* (pp. 1533–1536). Adelaide, South Australia: Causal Productions.

Morrison, G. S. (2009). L1-Spanish Speakers' Acquisition of the English/i/ - /ɪ/Contrast II: Perception of Vowel Inherent Spectral Change. *Language and Speech, 52*(4), 437-462.

Rauber, A. S., Escudero, P., Bion, R. A., & Baptista, B. O. (2005). The interrelation between the perception and production of English vowels by native speakers of Brazilian Portuguese. In *Proceedings of INTERSPEECH* (Vol. 2005, pp. 2913-1916).

Strange, W. (1995). Cross-language study of speech perception: a historical review. In W. Strange (Ed.), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research* (pp. 3-45). Timonium, MD: York Press.

Strange, W. (2007). Cross-language phonetic similarity of vowels: Theoretical and methodological issues. In O.-S. Bohn & M. Munro (Eds.), *Language experience in second* *language speech learning: In honor of James Emil Flege* (pp. 35-55). Amsterdam: John Benjamins.

Vasiliev, P., & Escudero, P. (2011). Cross-language perception of Brazilian Portuguese vowels by Californian English speakers. *The Journal of the Acoustical Society of America, 130*(4), 2573.