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Training Catalan Speakers to Identify L2 Consonants and Vowels: A Short-Term High Variability Training Study

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Abstract

This study investigated the effect of short-term high variability phonetic training on the perception of English consonant and vowel contrasts by Catalan-Spanish bilinguals. Generalization of improvement to novel words and novel talkers was also assessed. The experimental group (N=16) underwent a three-week training regime, which included discrimination and identification tasks. Post training identification results revealed a positive effect of phonetic training for the vowel sounds /i/ and /ʌ/ and the consonants /b/, /v/ and /d/. However, despite a numerical difference between pre- and posttest results, no significant improvement was found for the better identified sounds /ɪ/, /æ/ and /ð/). Interestingly, context-dependent vowel duration differences were found to affect vowel identification. Further, generalization results indicated that "robust learning" (Logan & Pruitt, 1995) may occur even after a short training period.

Adult learners of a second language are faced with the difficulty of acquiring sounds that are not found in their first language (L1). Models of second language (L2) speech relate this difficulty to the inability to establish separate categories for non-native sounds (see Munro & Bohn, 2007). According to the Speech Learning Model (Flege, 1995, 2003), an L2 sound that is not too similar to an L1 sound will be easier to acquire than an L2 sound that is relatively similar to an L1 sound. This is so because the more dissimilar sound will be perceived as more obviously "different" from L1 categories and thus the learner may eventually, given enough input and experience, be able to establish a separate category from the existing L1 categories. Similarly, the Native Language Magnet (NLM) model (Kuhl & Iverson, 1995) claims that the perception of non-native sounds occurs within the native language (L1) frame so that L1 speech sounds act as magnets attracting perceptually similar L2 sounds and blocking category formation. The effect of the interference from L1 categories is also explored by the Perceptual Assimilation Model (PAM-L2, Best & Tyler, 2007), which describes possible cross-language category assimilation patterns that are the basis for predictions of degree of L2 discrimination accuracy.

In addition to the influence of the L1 phonological system, several other factors may contribute to a foreign accent such as the starting age of learning, the length of residence in the target-language country, or the amount of L2 experience, among others (Piske, MacKay & Flege, 2001). Research has shown that an increase in L2 experience, that is, a longer period of residence in a naturalistic setting or a greater amount of L2 use, helps to enhance L2 categorization. Exposure to the L2 is crucial to develop the ability to distinguish L2 from L1 sounds (Flege, 1991; Ingram & Park, 1997) and results in better perception and production of L2 sounds in naturalistic settings (e.g., Flege, Bohn & Jang, 1997). However, in an instructional setting with limited exposure to the target language outside the classroom, experience, understood as amount of instruction, has not been found to have a notable effect in perception and production of L2 sounds. For example, Fullana and Mora (2009) did not observe a significant impact of formal instruction on the perception and production of English final consonant contrasts by 48 Spanish/Catalan bilinguals in an EFL context. Similar results were found in a study involving vowels (Mora & Fullana, 2007).

By contrast, several studies have shown that phonetic training can make up for the absence of regular L2 experience. Phonetic training has been found to have a positive effect on the ability to correctly perceive and produce L2 consonant sounds (Hardison, 2003; Hazan, Sennema, Iba & Faulkener, 2005; Iverson & Evans, 2007; Pisoni, Lively & Logan, 1994; Strange & Dittmann, 1984, Yamada, Tohkura, Bradlow & Pisoni, 1996;

among others) and L2 vowel sounds (Aliaga-García, 2011; Aliaga-García & Mora, 2009; Ceñoz & Lecumberri, 1999; Iverson & Evans, 2007; Gómez Lacabex, Lecumberri & Cooke, 2008, among others). According to Wang and Munro (2004), phonetic perceptual training programs are efficient in reinforcing sound traces left in the learners' memory and can help to form more accurate target sound categories. Moreover, phonetic training can help learners focus on specific phonetic cues and target language contrasts (Aliaga-García & Mora, 2009). The phonetic training approach adopted in this study is the High Variability Phonetic Training approach (Logan, Lively & Pisoni, 1991). HVPT places an emphasis on exposing the trainees to normal phonetic variability within a phonetic category (various talkers). It prevents participants from relying on specific vocal characteristics of the talkers, rather than on the target sounds.

Perceptual training studies do not only test the ability to learn trained items, but they also assess what Logan and Pruitt (1995) define as "generalization of learning". The authors describe generalization as the ability to transfer the acquired knowledge to multiple dimensions, such as novel productions by new talkers, new productions of the same talker, new tasks, and so on. Generalization allows us to see if the potentially positive effect of training goes beyond the specific training stimuli. Logan and Pruitt (1995) claim that "if generalization occurs, we can be more confident that robust learning has occurred" (p. 371). Several previous studies have reported generalization of learning. For example, Yamada et al. (1996) and Wang and Munro (2004) found generalization to new words and new speakers and Hazan et al. (2005) observed generalization of learning to new stimuli.

THE PRESENT STUDY

The present study investigates the effectiveness of a short-term high variability phonetic training method on the perception of the English /v/-/b/ and /d/-/ð/ consonant contrasts and the /i/-/ɪ/ and /æ/-/ʌ/ vowel contrasts by Spanish/Catalan bilingual learners of English. These sounds pose a problem to these learners because they either do not exist or have a different status in the L1.

Regarding the vowel sounds, the vowel pair /i/-/ɪ/ is problematic since neither Spanish nor Catalan has a comparable tense-lax distinction. Catalan learners of English have been found to assimilate English /i/ to their L1 /i/ category, while /ɪ/ is less consistently classified, being mapped onto Catalan /e/, and to a lesser extent to /i/ (Cebrian, 2006). The vowel pair /æ/-/ʌ/ is problematic for these learners as there is no low front-back distinction in Spanish or Catalan, both languages having one low vowel /a/.

As for the consonant sounds, the English contrasts /v/-/b/ and /d/-/ð/ are also a source of difficulty for Spanish/Catalan EFL learners (Cortés 2003, 2007). On the one hand, the phoneme /v/ does not exist in most varieties of Spanish and Catalan and it tends to be produced as one of the context-dependent variants of Spanish/Catalan /b/, i.e., [b] and [β] (e.g., Cebrian, 2000). On the other hand, while in English /d/ and /ð/ are contrastive phonemes, in Catalan and Spanish they are context-dependent variants of a single phoneme, [d] and [ð̞] (e.g., Hualde, 2005; Recasens, 1993). Further, /d/ is alveolar in English while [d] is dental in Spanish and Catalan.

Given the issues discussed above and the differences between the L1s and the L2, the present study was designed to address the following questions:

1. Does high variability short-term phonetic training positively affect the perception of a set of English consonants and vowels by Spanish/Catalan learners of English?
2. Is phonetic training equally effective for different types of target sounds (L1-L2 differences in status)?
3. Does the knowledge acquired through training generalize to novel items and to novel talkers?

METHOD

Particpants

Sixteen Catalan/Spanish native speakers in their third year of an English Studies degree at Universitat Autònoma de Barcelona participated in a pretest/posttest training methodology. All the experimental subjects were Catalan-Spanish bilinguals living in Barcelona and neighbouring areas. They had completed at least two prior semesters of formal study of English phonetics. Four additional Catalan/Spanish bilinguals undertook a different training program and acted as control subjects. All participants reported normal hearing and they were given class participation credit for taking part in the study.

Materials

Testing and training materials were recordings of CVC words containing the two vowel contrasts /i/-/ɪ/, /æ/-/ʌ/ and CVC words containing the two consonant contrasts, /v/-/b/ and /d/-/ð/. Vowels and consonants were trained separately, therefore there were minimal pairs involving the target consonants (e.g., bet-vet, dare-there) and minimal pairs involving the vowel sounds, (e.g., bit-beat, cat-cut). A total of 180 tokens were used in the pre- and post-test, 210 tokens in the generalization test and 240 tokens made up the training phase. Both testing and training stimuli consisted of three to four repetitions of 5-8 different words per target sound, elicited from 3-4 talkers per word. There were six minimal pairs for the consonant contrasts /v/-/b/ and /d/-/ð/, eight minimal pairs for the vowels /æ/-/ʌ/ and five minimal pairs for /i/-/ɪ/.

As for the generalization test, out of the 210 tokens, 84 tokens (3-5 words per sound) were produced by a talker whose stimuli did not appear in testing or training tasks, and served to test generalization to a novel speaker. Generalization to new items was tested with three repetitions of 2-3 new words per sound and per talker, amounting to 126 new stimuli.

The testing and training stimuli were elicited from a total of six native English speakers by means of a word list. Two additional native speakers provided the stimuli for the generalization assessment.

Procedure

This study followed a pre-test/training/post-test design as illustrated in Table 1. Tasks were preceded by a short practice session, so as to familiarize the participants with the computer program.

Table 1. Study Design (ID=identification tasks, DIS=discrimination tasks).

Pretest	Perceptual Training	Posttest + Generalization test
Vowel (ID)	Vowel + consonant (ID)	Vowel (ID) +
Consonant (ID)	Vowel + Consonant (DIS)	Consonant (ID)

Pre-test and post-test. The pretest and posttest were carried out individually at the speech laboratory at Universitat Autònoma de

Barcelona. The pre- and posttest were identical and they consisted of a 6-alternative forced choice task for consonants followed by a 6-alternative forced choice task for vowels. The participants listened to words through good quality headphones and were asked to identify the sound they heard by selecting one of the options presented on a computer screen. Each option label consisted of a phonetic symbol and a keyword (e.g., /ɪ/-hid, /i/-heed). Test stimuli were randomized. Both the experimental and the control groups performed the posttest three weeks after they completed the pretest. The test was administered with the same computer software as the training, but without feedback (see below). Three native English speakers performed the pretest (and posttest) identification tasks and obtained very high percentages of correct identification (97-99%) indicating that the test stimuli were appropriately representative of each category tested.

Generalization test. The generalization test was administered immediately after the posttest and included 42 new words (x 3 repetitions) produced by the same talkers used during training and 28 words (x 3 repetitions) recorded by one novel speaker.

Training. Training consisted of four sessions administered with the program TP (Rauber, Rato, Kluge & Santos, 2011) over a period of three weeks. Training tasks included discrimination and identification tasks with natural stimuli from six different native speakers. Both the vowels and the consonants were trained in each session; half of the participants were trained first on vowels and then on consonants and the order was reversed for the other half. On the day of the first session, the participants were introduced to the target sounds by means of articulatory explanations in a brief "awareness session" carried out by the experimenter. Then participants performed an auditory AX discrimination task (i.e., with stimuli by a single speaker). The second session consisted of categorical AX discrimination tasks (stimuli produced by different speakers). The following two sessions used a yes/no forced-choice identification task and an AXB categorical discrimination task. The participants received immediate feedback after each token indicating if their answer was correct or incorrect and global feedback at the end of each session indicating the total number of hits and errors.

The experimental group received training on the specific target sounds, whereas the control group received the same number of hours of training but were trained on aspirated and un-aspirated stops /p/, /t/ and /k/. The training for the control group was designed to ensure that they received the same amount of L2 input as the trainees.

RESULTS

The effect of phonetic training was calculated by comparing the percentage of correct identification obtained at pre- and posttest for all sounds and participant groups. The results for the experimental group are given in Table 2. Globally, there was an improvement in the perception of English vowels by Catalan speakers with training. No improvement was observed for the four individuals who undertook a different training and acted as a control group: pretest and posttest correct identification percentages were 55% and 59% for vowels and 66% and 64% for consonants. Their overall lower test results can be explained by the fact that they were not English majors and had an overall lower proficiency. Still, the lack of significant difference from pre- to posttest for these participants indicates that the improvement found with the trained group was not simply due to familiarity with the test.

Generalization results (to a new talker and to new words) were assessed by comparing the values achieved by the participants in the generalization test to the posttest results. Generalization was assumed to occur when the generalization results were equal or higher than the posttest results.

Consonants. In the pretest, the mean consonant identification was 74.6% (s.d.=13) and at posttest it was 86.8 (s.d.=9). The numerical improvement suggests that the experimental group improved their perception of consonant sounds and this is confirmed by a Test (2 levels: pre- and posttest) x Consonant (4) repeated-measures ANOVA. There was a significant overall main effect of Test, $F(1, 15) = 25.44$, $p<0.01$, and a significant main effect of Consonant, $F(1.48, 22.27) = 20.18$, $p<0.01$. The overall lower scores for /d/ account for the main effect of Consonant. Moreover, a significant Consonant x Test interaction was found, $F(1.6, 24) = 14.21$, $p<0.01$, which can be explained by the greater difference from pre- to posttest for /d/ (29%, vs. 7% for /b/ and 12% for /v/) and the lack of significant improvement for /ð/ (see below).

The mean % identification scores for each individual consonant sound in all three conditions (pretest, posttest and generalization test) is presented in Figure 1. Regarding improvement from pre- to posttest, t-test comparisons revealed that the sounds /v/, /b/ and /d/ improved significantly with training, /v/: t(15) = - 2.9, p<.01, /b/: t(15) = - 2.7, p<.05 and /d/: t(15) = - 4.8, p<.001, /d/ having the lowest percent identification scores at pretest and the greatest improvement after training. No significant difference was found for /ð/ from pre- to posttest.

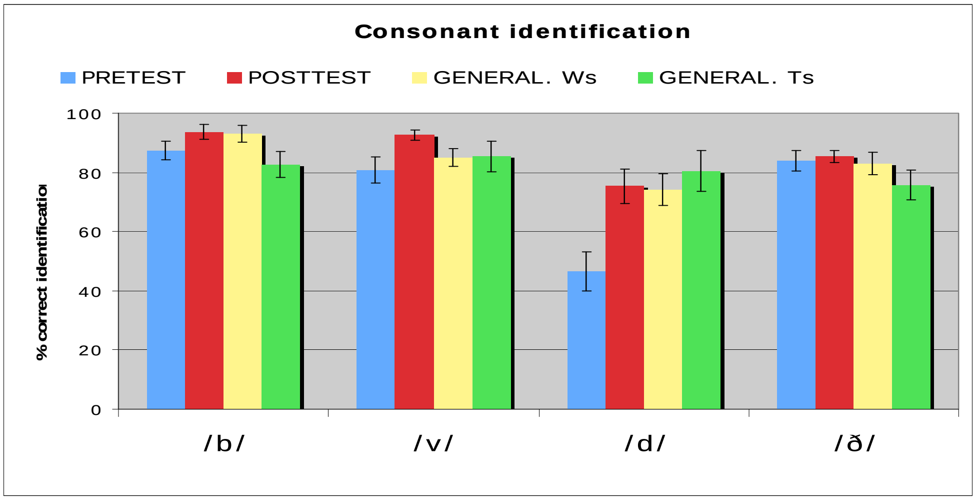

Figure 1. Overall % correct identification for each consonant by the experimental group.

Table 2. Mean correct identification percentages at pre-, post- and generalization tests (standard deviations are given in parentheses), NW=new words, NT=new talker.

Sound	Pre test	Post test	Gen 1 (NW)	Gen 2 (NT)
/v/	80.8 (18)	92.6 (7)	86.4 (12)	91.6 (22)
/b/	87.4 (13)	93.7 (10)	93.1 (11)	82.6 (17)
/d/	46.4 (26)	75.3 (23)	74.3 (22)	80.5 (27)
/ð/	83.9 (13)	85.4 (8)	82.9 (15)	75.7 (20)
Consonants	74.6 (13)	86.8 (9)	84.2 (10)	82.6 (11)
/ʌ/	86.7 (9)	95.1 (8)	96.5 (15)	89.5 (12)
/æ/	81.2 (23)	86.4 (12)	79.3(19)	84.7 (15)
/ɪ/	86.7 (10)	84.5 (11)	NA	73.7 (13)
/i/	66.8 (21)	81.9 (17)	NA	79.1 (22)
Vowels	80.3 (11)	87 (9)	87.9 (15)	81.7 (9)

Generalization. Generalization was assessed by means of t-tests comparing posttest and generalization results for each consonant. A lack of significant difference was interpreted as evidence of generalization. Results showed that generalization occurred for the sound /d/ both to new items (t(15)= .27, p=.791), and to a new talker (t(15) =-.99, p=.336)]; for /v/ to new items (t(15)= 1.7, p=.116) and to a new talker (t(15) =-59, p=.559), but only partially for /b/, as the results only generalized to new items (t(15)= -.22, p=.829).

Vowels. In the pretest, the overall vowel identification was 80.3% (s.d.=11) and at posttest it was 87.0 (s.d.=9). The numerical improvement suggests that the trained group improved their perception of vowel sounds. The results of a Test (2) x Vowel (4) repeated-measures ANOVA confirms this improvement, as there was a significant main effect of Test, F(1, 15) = 20.5, p<0.01, and a significant main effect of Vowel, F(2.17, 32.59) = 4.5, p< .05. No Vowel x Test interaction was observed. Even though the vowel sound /ʌ/ was well identified from the outset, a significant improvement from pre- to posttest was found, t(15)= -2,9, p <.01. Regarding the vowel sound /i/, participants obtained the poorest results at pretest and yielded the greatest improvement with training, t (15)= -4, p <.001. No significant improvement was observed for the vowels /æ/ and /ɪ/, which accounts for the main effect of Vowel.

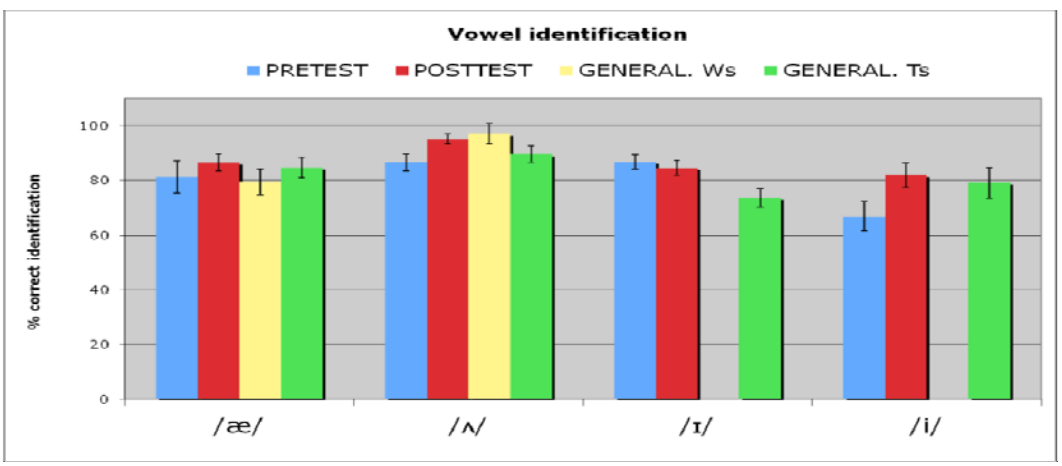

Figure 2. Overall % correct identification for each vowel by the experimental group.

For the two sounds that improved from pre to posttest, generalization also occurred. Recall that a lack of significance is taken as positive result. Generalization to both a new talker, (t(15) = -1.04, p=.316), and to new items, (t(15) = -1.774, p=.096), was found for /ʌ/. In the case of the high front vowel /i/, only generalization to a new talker was tested due to stimuli limitations ($t\ (15) = 1.13$, $p = .277$).

DISCUSSION

The present study tested the effectiveness of a short-term high variability phonetic training method on the perception of English sounds that pose a problem to Spanish/Catalan learners of English. Globally, the trained group showed a perceptual improvement from pretest to posttest, despite comparatively general high initial results scored by the third-year English majors. These results indicate that even a short-term HVPT training regime can positively affect the perception of target-language consonant and vowel sounds. However, despite general tendencies, individual sounds patterned differently. With respect to the consonants, the overall identification scores were initially higher for /v/, /b/ and /ð/, but considerably low for /d/. Moreover, an effect of training for the sounds /v/, /b/ and /d/ was observed, but not for /ð/. A possible explanation for the different results for individual consonants may be the effect of word familiarity or word frequency. Some /d/-/ð/ minimal pairs were made up of a /ð/ word that was more frequent than the corresponding /d/ word (e.g., there vs dare). Notice that the better results for /ð/ cannot be explained by the influence of the L1 as, of the two allophones of Spanish/Catalan /d/, the stop is the one that is found in initial position.

Vowel sounds also patterned differently. The overall identification was initially higher for the sounds /æ/-/ʌ/ and then for the tense high front vowel. Regarding the training, it was more effective for /ʌ/ and /i/ than for /æ/ and /ɪ/. Word familiarity or frequency is an unlikely explanation in this case as results show that some less frequent words such as *flush* were better identified than their more common counterpart, i.e., *flash*. A more plausible explanation could be the potential influence of contextually conditioned duration differences, at least in the case of the high front vowels. The items containing the high front vowel pair included both words ending in a voiced consonant and words ending in a voiceless consonant. In English vowels are shorter before a voiceless consonant (Hillenbrand, Getty, Clark & Wheeler, 1995) and this was true of the test words in the current study, as illustrated in Table 3.

Table 3. Mean duration of /i/ and /ɪ/ in test words ending in voiced and voiceless obstruents.

	/i/	/ɪ/
Before Voiced C	183 ms	157ms
Before Voiceless C	108 ms	94 ms

Non-native speakers tend to rely on temporal cues when identifying tense-lax vowel pairs (Flege, Bohn, & Jang, 1997) and specifically Catalan learners of English have been found to rely mostly on duration for the /i/-/ɪ/ contrast (Aliaga Garcia & Mora, 2009; Cebrian, 2006). If we analyse the results for each context separately, we can observe (see Figure 3 below) that the tense high front vowel /i/ was better identified before a voiced consonant than before a voiceless consonant at pre-training phase (88% and 46% respectively), whereas the lax high front vowel /ɪ/ was initially better identified preceding a voiceless obstruent (94%, as opposed to 71% when preceding a voiced obstruent). Interestingly, a decrease in reliance on duration was observed at posttest, as the difference in the identification scores between the two contexts is smaller at posttest. The posttest results yielded 75% for /ɪ/ and 92% for /i/ when preceding a voiced context, and 91% for /ɪ/ and 76% for /i/ when preceding a voiceless context. Thus, training may have made subjects aware of other differences between these two sounds, namely vowel quality differences, resulting in a decrease in the reliance on duration.

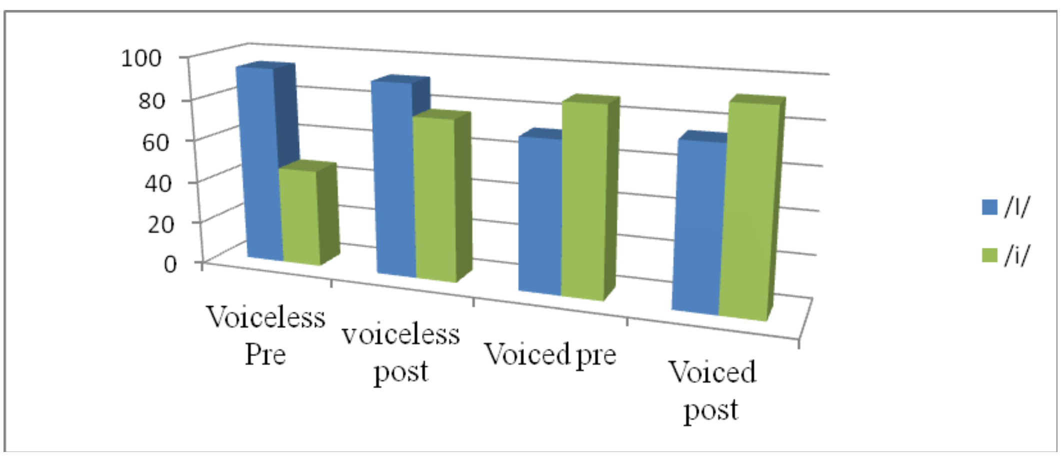

Figure 3. Pre and post training identification of /i/-/ɪ/ before voiced and voiceless consonants.

Finally, regarding the third and last research question about whether learning generalized to new talkers and items, generalization to new words and to a new talker took place for the vowel sounds that had improved with training, and for the consonant sounds in most cases. This result is in agreement with some previous studies (Hazan et al., 2005; Wang and Munro, 2004; Yamada et al., 1996) and shows that the potential benefit of high variability phonetic training goes beyond the testing and training stimuli and may actually have an effect on target-language category formation.

CONCLUSION

This study has shown that high variability phonetic training, even when it is implemented as a short-term training regime on a group of relatively experienced learners in an instructional setting, can have a positive effect on the perception of target L2 sounds. This outcome suggests that "robust learning" (Logan & Pruitt, 1995) may occur even after a short training period. Factors like word familiarity and contextual variation probably interact with the effect of training for the specific sounds tested. More research with a more balanced design including a larger control group and more controlled test and training items in terms of word familiarity/frequency is necessary to evaluate these issues further. In addition, the study could be extended to test lower proficiency learners, as the current participants were third year English majors whose identification scores in some cases were very high already at pretest. Similarly, the effect of perceptual training on the production of these English sounds by Catalan/Spanish learners of English remains to be tested. Still, the current results do provide support for the beneficial effect of HVPT in an instructional setting and add to the increasing number of studies supporting the effect of training on L2 category formation.

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