L2 Acquisition and Category Formation of Spanish Voiceless Stops by Monolingual English Novice Learners

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1. Introduction

The present study reports quantitative results from research conducted on the acquisition of Spanish L2 voiceless stops by monolingual L1 English learners at the novice level (ACTFL). While there is a vast amount of research that explores the end state of L2 pronunciation in primarily early and late bilinguals in a variety of language pairings (Baker and Trofimovich 2005; de Leeuw, Schmid and Mennen 2010; Flege 1995, 2002; Flege and Eefting 1987, 1988; Sancier and Fowler 1997; Yavas 1996, 2002; Yeni-Komshian, Flege and Liu 2000; among others), there are only a few studies that focus on the early and intermediate stages of L2 category formation and if explicit instruction on pronunciation has an effect on production (Derwing, Munro and Wiebe 1998; González López 2012; Hurtado and Estrada 2010; Zampini 1998; or Zampini and Green 2001, inter alia). Based on results from previous experiments (see, for instance, Hurtado and Estrada 2010 and references therein), it is hypothesized here that the explicit training of articulatory phonetics will have a positive effect on the production accuracy of the L2 phones, which could be a reflection of a faster category-formation process on the part of L2 learners. This hypothesis is also in line with the Speech Learning Model (SLM), developed by Flege and colleagues (Flege 1987, 1991, 1992, 1995, 1999, 2002, 2003), which suggests that even though the ability to perceive and create new phonetic categories is available throughout one's lifespan, the monolingual-like production of L2 sounds is contingent upon the accurate discernment of the differences in the L1 phonetic categories and their L2 counterparts (Best and Strange 1992; Flege 1995 and subsequent). Based on this model, it stands to reason that pronunciation instruction will lead to increased knowledge concerning differences in L1 and L2 speech sounds, allowing for L2 categories to begin forming.

Results from research on the effect of explicit instruction on L2 Spanish pronunciation improvement in particular (Derwing, Munro and Wiebe 1998; Elliott 1997; Gonzalez-Bueno 1994, 1997; Lord 2005; but see Suter 1976, who found that formal pronunciation training did not predict better pronunciation) show that explicit instruction on L2 Spanish pronunciation leads to measurable pronunciation improvement. However, these experiments have examined the pronunciation improvement of students at intermediate or advanced levels exclusively. Thus, research is needed on the role of explicit instruction in beginner students' improvement in pronunciation. To redress this gap in the literature, the current experiment focuses on second-semester learners of Spanish. Most importantly, the present study examines the beginning stages of L2 category formation and explores whether the benefit of instruction observed at intermediate and advanced levels is also found at the beginner level. With that purpose in mind, this experiment analyzes the voiceless stop productions of two groups of monolingual L1 English second-semester Spanish students. One group (N=15) served as

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the target group and received explicit training in articulatory phonetics while the second group (N=11) served as the control group and did not receive any training in articulatory phonetics. If the hypothesis stated above is correct, the target group will exhibit improvement in their production of Spanish /ptk/ while the control group will not.

2. Design and Methodology

2.1. Participants

The participants in this study are 26 monolingual L1 English adults who, at the time of recruiting, were registered in two sections of a second-semester college-level Spanish course. Their ages ranged between 18-20 years of age, and even though the average age of first L2 exposure was 15 (see Bongaerts 1999 and references therein), not all participants recruited had experience with a second language. Furthermore, the selection process included a language background questionnaire to ensure that participants were either monolingual speakers of English who never had experience (formal or informal) with a second language, or who had one year of high school Spanish at most at least one year prior to the beginning of their college career (no other language contact or experience was reported). Thus, those students who had more advanced knowledge of a second language, more exposure to an L2, or who were bilingual were excluded from the study.

The participants' L2 proficiency at the novice level was determined following ACTFL guidelines applied to formal coursework and further assessed via informal personal interviews. In spite of the fact that some of the participants had been exposed to the target L2 in the past, this exposure was not extensive (those who had taken Spanish in high school had between two and three hours of contact per week and reported not having had any pronunciation instruction), which ensures that participants are novice learners in all respects. Even though there are some studies in which a correlation between increased auditory input and target-like pronunciation in adult learners was found at beginning levels (e.g. McCandless and Winitz 1986), the methodology employed in those studies to select participants and to analyze learners' production might be influencing the results. For instance, in McCandless and Winitz (1986), L2 sentence pronunciation was judged on a 5-point scale, but the study does not offer enough information regarding the specific instructions that judges received. In addition, it appears that L2 pronunciation was rated globally, taking into consideration segmental as well as suprasegmental features and not isolated sounds as in more recent studies. In fact, it has been found that when individual sounds are the focus of L2 pronunciation studies (i.e. Elliott 1995, 1997), the lack of phonological instruction in the L2 has "little effect or a slight non-significant negative effect on pronunciation" (Elliott 1997, p. 96). Therefore, it is unlikely that any participant in the present study made any meaningful advancement towards L2 category formation or more native-like pronunciation before the study began.

The group of participants was further divided into a target group, consisting of 15 individuals who received explicit training in articulatory phonetics; and a control group of 11 students who did not receive training in articulatory phonetics. Crucially, all 26 participants were exposed to the same type of instruction and practice in the foreign language, being explicit training in articulatory phonetics the only deviating aspect of the course.

2.2. Procedure

In order to quantify improvement in pronunciation over the course of the semester a pre-test, post-test design was used in which all participants were recorded reading the stimulus materials during the pre- and post-tests. The treatment phase consisted of instruction and training in articulatory phonetics for the target group, as described next. The control group did not receive instruction or practice regarding articulatory phonetics but received extra general language practice instead which consisted of brief recordings describing various cultural events and conversation sessions that students were required to attend regularly throughout the semester.

The target group received 10-15 minutes of formal instruction once a week (the class met four times a week for 50 minutes). This instruction provided articulatory descriptions of the L2 phones, which included images, diagrams, and videos that showed the movements made by the articulatory organs in order to produce both the L2 sounds and the closest L1 counterpart phones. When

appropriate, the instructor gave examples of the different graphemes employed to represent the L2 sounds orthographically (for instance, students were taught that the sound /k/ may be represented by 'qu-+e/i', as in 'queso' or 'quinta'; 'c+a/o/u', as in 'casa', 'cosa', or 'cuco'; or 'k', as in 'kilo'). These descriptions were followed by some perception activities in which students had to indicate if lists of L2 vocabulary words were produced using the L1 phones or the L2 phones that were just described (see Botero 2011 and Counselman 2010 for the impact of perception on L2 Spanish pronunciation). Corrections and further explanations and examples were introduced when needed. All L2 phones were located in stressed syllables in word-initial, word-medial, and word-final position when allowed by the phonotactics of Spanish.

Next, students repeated a list of 10 words and 5 sentences that included the targeted sounds described. As illustrated in the examples below, all of the L2 phones were located word-initially in the case of the word list (1), and in both sentence-initial and sentence-medial in the case of the sentence list (2) in both stressed and unstressed syllables. Crucially, all the target L2 phones were embedded in vocabulary items and syntactic constructions carefully selected from the textbook and class materials to ensure that participants were already familiar with the words and sentence structures used. A native speaker of Peninsular Spanish who learned English as an adult and came to the US after age 22 recorded the materials used for the production and perception activities. This dialect of Spanish was used because it was the native variety of all the instructors teaching all sections of second-semester Spanish at the time of testing; therefore, the participants in both the target and the control group were familiar with it and exposed to it regularly.

(1) a. /**p**/erfeccionista.
'perfectionist'
b. /**p**/u/**p**/itre
'desk'

(2) /**p**/epe es /**p**/oco /**p**/o/**p**/ular.
'Pepe is not very popular.'

Even though the description of specific L2 phones took place once a week, students were expected to practice their pronunciation regularly; thus, word lists and short sentence lists were pre-recorded and included with their regular online daily homework. Pronunciation was graded once a week and computed as part of the homework for the course. Errors in pronunciation were corrected immediately during class by either the instructor or, occasionally, fellow students. The following table includes a list of the allophones that were taught during the semester and indicates the week in which they sounds were introduced:

L2 Phone	Week
/p/	Week 3
/t/	Week 4
/k/	Week 5
/s/, /θ/, words that end in '–ción'	Week 7
/a, e, i, o, u/	Week 8
/ɾ/	Week 9
/l/	Week 11
/ɲ/	Week 12
Syllable rhythm	Week 13

Table 1. List of L2 phones covered during the semester of testing.

The pre-test was administered during week 3 of a 14-week semester, before the first L2 phone was introduced in class, and the post-test was given during week 13. All recordings were conducted with a Marantz PDM 660 (44 Hz, 16-bit quantization) and a head-mounted Shure A10 microphone. The treatment phase, which took place throughout the semester, started during week 3, as indicated in Table 1 above, and concluded during week 13.

2.3. Stimuli

All participants were asked to read 120 sentences, half in English and half in Spanish, which were presented on a computer screen in randomized blocks. The sentences contained carefully counterbalanced target /ptk/ tokens in sentence-initial and sentence-medial positions in stressed syllables, to control for possible phrasing effects (Cho and MacQueen 2005; Fougeron 1999). Participants were asked to read the sentences in a natural way, neither too fast nor too slowly, to control for speech rate effects (Allen, Miller and DeSteno 2003; Kessinger and Blumstein 1997, 1998; Miller and Baer 1983; Miller, Green and Reeves 1986; Pind 1995; Theodore, Miller and DeSteno 2007, 2009).[1] This experimental design renders 60 /ptk/ tokens in each language, 30 in sentence-initial position and 30 in sentence medial position. These 30 tokens in each position included 10 /p/, 10 /t/, and 10 /k/. All target sounds were separated by the same number of syllables in each sentence. The following examples illustrate the stimuli used in this study:

(3) a. **/p/**our some wine for dinner.
b. My friends drank a few **/p/**ints.

(4) a. **/t/**engo calor.
'I'm hot.'
b. Busca la **/t/**umba.
'(S)he looks for the tomb.'

The voice onset time (henceforth VOT) measurements for each voiceless stop were analyzed using Praat ® (Boersma and Weenink 2006). VOT was measured as the interval between the beginning of the release burst and the onset of the glottal signal reflected in F1 in the following vowel (Lisker and Abramson 1964). The analysis was done in a split panel that contained a spectrogram and a waveform on separate halves of the screen. The durational measurements were done using a manually controlled cursor. About 10% of the data were randomly selected and re-measured for reliability purposes, resulting in over a 95% accuracy rate. The data were analyzed using SPSS, and the statistical analyses consisted of a 4-way repeated-measures ANOVA (2 languages x 2 sites x 3 place of articulation (henceforth PoA) x 2 recordings) with "training" as a between-groups factor.

3. Results

Results from the 4-way repeated-measures ANOVA show a significant main effect for the factor "language," $F(3, 22) = 21.214$, $p = .000$, $\eta_p^2 = .74$ and "site," $F(3, 22) = 26.965$, $p = .000$, $\eta_p^2 = .79$. The results for the factor "site" show a significant difference for both /t/, $F(1, 24) = 4.512$, $p = .044$, $\eta_p^2 = .16$, and /k/, $F(1, 24) = 43.304$, $p = .000$, $\eta_p^2 = .64$, which indicates that mean VOTs for both /t/ and /k/ were significantly shorter in sentence-medial than in initial position. Mean VOTs for /p/ were shorter in initial position than in medial position, but this difference did not reach significance, $F(1, 24) = 3.631$, $p = .069$, $\eta_p^2 = .13$. There is a significant interaction between the factors "language" and "site," $F(3, 22) = 5.532$, $p = .006$, $\eta_p^2 = .43$, indicating that VOTs were significantly shorter in medial position in Spanish, but not in English. There is not a significant interaction between the factors "site" and "training" overall, $F(3, 22) = 2.036$, $p = .138$, $\eta_p^2 = .22$. However, the interaction between "site" and "training" is significant for /k/, $F(1, 24) = 5.970$, $p = .022$, $\eta_p^2 = .20$. The interaction between the

[1] Even though speaking rate has been shown to affect long lag VOTs in a variety of languages such as English, Thai, French, Icelandic, or Zulu (cf. Kessinger and Blumstein 1997; Midtlyng 2011; Miller and Baer 1983; Miller, Green and Reeves 1986; Pind 1995; just to mention a few), the phonetic inventory of a language remains unaltered. As indicated in Kessinger and Blumstein (1997), "the structure of the phonetic category remains stable across speaking rate and language" (p. 165). In addition, results from recent studies indicate that speech rate effects are talker-specific (cf. Allen, Miller and DeSteno 2003; Theodore, Miller and DeSteno 2007, 2009). Given that large differences in speech rate would yield large variations in VOT, as seen in the studies just mentioned, having standard deviations in VOT production that range from .002 to .006 (see Tables 2 – 5 below) suggests that speech rate did not vary greatly in this study and, thus, did not affect VOT production significantly.

factors “language” and “recording” is not significant, $F(3, 22) = 2.000$, $p = .143$, $\eta_p^2 = .21$. A closer observation of the VOT data (see below) suggests that there is no significant interaction between "language" and "recording" because the control group did not produce lower VOTs on the post-test relative to the pre-test, as the target group did. In fact, when considering the target group alone, the interaction between the factors “language” and “recording” is indeed significant, $F(3, 12) = 4.400$, $p = .026$, $\eta_p^2 = .52$. Moreover, this interaction is significant for all PoAs: /p/, $F(1, 14) = 14.155$, $p = .002$, $\eta_p^2 = .50$, /t/, $F(1, 14) = 6.311$, $p = .025$, $\eta_p^2 = .31$, and /k/, $F(1, 14) = 4.976$, $p = .043$, $\eta_p^2 = .26$.

The pairwise comparisons for the main effects of language corrected using a Bonferroni adjustment indicate significant differences for /p/ ($p = .000$) and /t/ ($p = .010$) but not for /k/ ($p = .262$). The estimates for the interaction between “language,” “recording” and “training” render the VOT values illustrated in table 1 and table 2 for the control group, and table 3 and table 4 for the target group.

Stop	Spanish		English	
	Mean (ms.)	SD	Mean (ms.)	SD
/p/	44	.006	58	.003
/t/	50	.006	63	.003
/k/	61	.004	64	.002

Table 2. Control group: VOT values for each voiceless stop in Spanish and English in Recording 1.

Stop	Spanish		English	
	Mean (ms.)	SD	Mean (ms.)	SD
/p/	44	.005	57	.003
/t/	50	.006	58	.003
/k/	60	.004	61	.003

Table 3. Control group: VOT values for each voiceless stop in Spanish and English in Recording 2.

Stop	Spanish		English	
	Mean (ms.)	SD	Mean (ms.)	SD
/p/	50	.005	55	.002
/t/	58	.005	66	.003
/k/	67	.003	68	.002

Table 4. Target group: VOT values for each voiceless stop in Spanish and English in Recording 1.

Stop	Spanish		English	
	Mean (ms.)	SD	Mean (ms.)	SD
/p/	39	.004	59	.002
/t/	51	.005	67	.003
/k/	61	.004	67	.003

Table 5. Target group: VOT values for each voiceless stop in Spanish and English in Recording 2.

As can be observed in Figures 1 and 2, the VOT values are consistent with previous experiments that reported a gradual increase of VOT value with each different PoA, (Cho and Ladefoged 1999; Docherty 1992; Fischer-Jorgensen 1954; Klatt 1975; Laeufer 1996; Lisker and Abramson 1964, 1967; Macken and Barton 1979; Peterson and Lehiste 1960; Rochet and Fei 1991; Stevens, Keyser and Kawasaki 1986; Thornburgh and Ryalls 1998; Volaitis and Miller 1992; Yavas 1996, 2002; Yavas and Wildermuth 2006; Zampini, Clarke and Green 1999; Zlatin 1974).

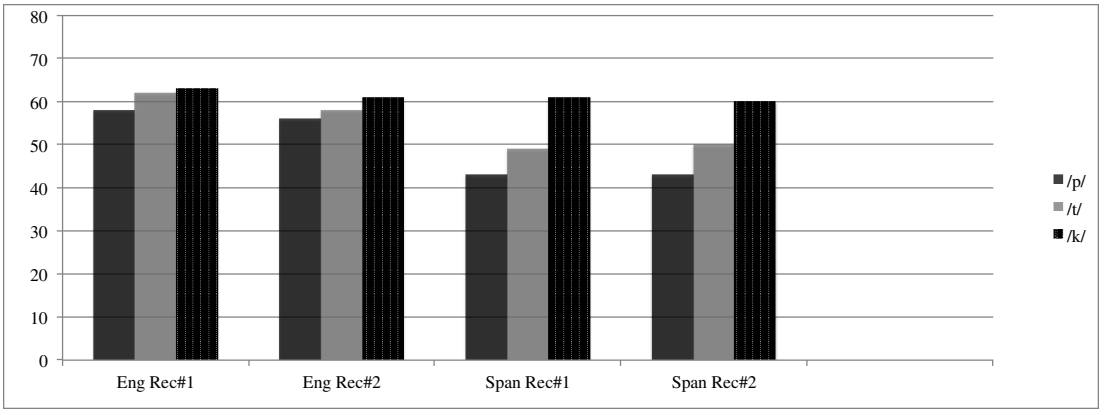

Figure 1. Mean VOT values for control group.

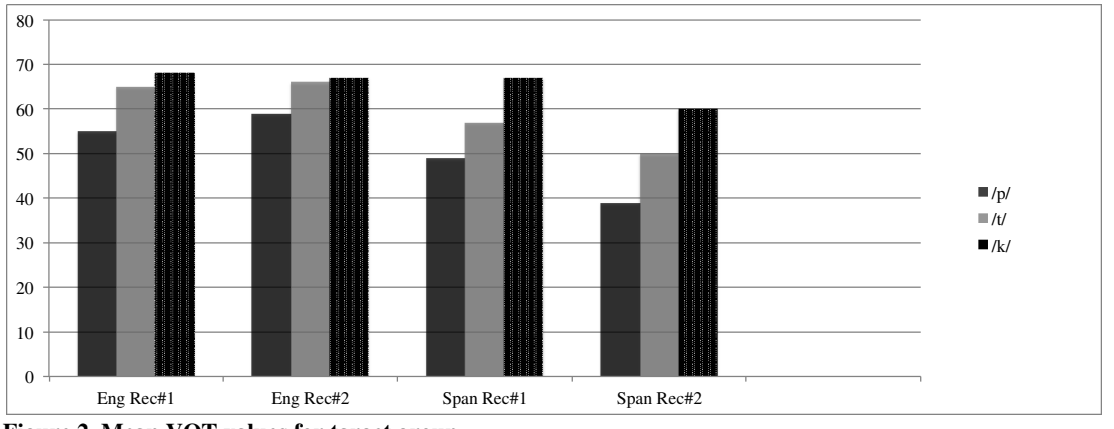

Figure 2. Mean VOT values for target group

4. Discussion and conclusions

The results of this study show that the control group did not improve their VOT production of /ptk/ significantly, while the target group did. This validates the hypothesis stated above regarding the effect of training on articulatory production. In addition, while the improvement in VOT may take longer for novice learners than for more advanced learners, the results show that formal training in articulatory phonetics may be beneficial not only to intermediate and advanced learners, but also to novice learners. This supports the notion that if explicit instruction in L2 pronunciation leads to improved L2 pronunciation, this instruction should be introduced as early as possible. This is because the early introduction of formal instruction in articulatory phonetics may facilitate L2 category formation in early stages and ultimately lead to better pronunciation over time.

The results of this study also show that the participants' VOT production in L1 English is different from their production in L2 Spanish even at a novice level. Specifically, a trend observable in Figure 1 and Figure 2 that Spanish /p/ and /t/ were significantly shorter than English /p/ and /t/ was found for both groups on both the pre-test and post-test. This implies that all participants had already begun forming a category for Spanish /p/ and /t/ after only one semester of college-level Spanish study in which they did not receive any instruction on articulatory phonetics. The fact that participants differentiated their English and Spanish /p/ and /t/ but not /k/ suggests that category formation for voiceless stops occurs not as a class but for each individual sound. This finding may also support other arguments that /p/ and /t/ are easier for L2 learners to acquire than /k/ (Cho and Ladefoged 1999; Major 1987). For example, Major (1987) found that L1 English L2 Portuguese speakers living between 12 and 35 years in Brazil acquired Portuguese /p/ more easily than Portuguese /k/. This suggests, parallel to the current study, that L1 English speakers acquire short-lag VOTs in other languages for /p/ (and maybe /t/) before /k/. The reason for this difference in ease of acquisition could be one of many possibilities or a combination thereof. Major (1987) hypothesizes that this difference may have

to do with the fact that English /p/ is articulated with a shorter VOT than English /k/. On the other hand, Cho and Ladefoged (1999) point out that L2 learners may have more difficulty acquiring velar consonants relative to bilabial, dental or alveolar consonants for physiological reasons, such as the size and configuration of the oral cavity and the articulators. Furthermore, it should be borne in mind that Lisker and Abramson (1964) report ranges for voiceless stop VOTs in both English and Spanish and show that while the VOT ranges for /p/ and /t/ in English and Spanish are clearly separate, the VOT ranges for English and Spanish /k/ actually overlap. Therefore, it is possible that L2 Spanish learners do not form a new phonetic category for L2 Spanish /k/ because the VOT values for Spanish /k/ they receive as input in the classroom do not usually differ from the range of possible VOT values for English /k/. It is not certain, however, if this would explain the findings of Major (1987). The notion that L2 learners acquire velar consonants later than bilabial and dental or alveolar ones is also in line with Jakobson's (1968) hypotheses regarding the order of phonological acquisition. Jakobson argues that back consonants are acquired only after front ones. However, data from child language acquisition does not always support this hypothesis and, in fact, suggests there is a large degree of intra- and inter-child variability with regard to the order of consonant acquisition (Fikkert 2000). Therefore, it is not clear whether the participants in this study formed categories for /p/ and /t/ before /k/ as a result of a language universal that applies to all language acquisition, as a result of L2 acquisition constraints, or as a result of natural inter-learner variation.

In addition, the fact that all participants in this study differentiated their English and Spanish /p/ and /t/ suggests that learners in general perceive VOT differences (at least at certain PoAs, i.e. /p/ and /t/ in this study) from the beginning and demonstrate new category formation during their first semester even without instruction on articulatory phonetics. If this is true, instruction on articulatory phonetics may not be absolutely necessary for the formation of certain L2 categories to take place. However, the results of this and previous studies (e.g. Derwing, Munro and Wiebe 1998; Elliott 1997; Gonzalez-Bueno 1994, 1997; Lord 2005) suggest that instruction on articulatory phonetics facilitates and accelerates L2 category formation. Furthermore, even though the control group had begun category formation for L2 /p/ and /t/, participants in this group did not show improvement over the semester, while participants in the target group did. It would be beneficial for future research to investigate the ease with which certain individual L2 sounds are acquired and whether instruction is a requirement for the category formation of L2 phones. In addition, different methodologies and pedagogical approaches to the teaching of L2 pronunciation should be explored.

The findings in this study regarding L2 learners' production of voiceless stops in sentence-initial versus sentence-medial position are much less conclusive than the other findings. The significant effect of the factor "site," as well as its interaction with "language" for the target group may indicate that learners improve their VOT production of voiceless stops in medial-position first. However, results indicate that participants exhibited shorter VOTs for /p/ in initial-position relative to medial-position, which is incongruous with the results found for /t/ and /k/. It is unclear whether this result is by happenstance or the consequence of a more intricate interaction with the acquisition order of different places of articulation. Due to the lack of a clear trend in the data observed here, more research is needed in the future to better understand the interaction between VOT improvement of voiceless stops in Spanish and their position in the sentence.

It is worth considering how the results of this study relate to the predictions of the SLM (Flege 1995 and subsequent). If perception of the articulatory differences between L2 phones and their closest L1 counterparts is necessary for the accurate production of L2 phones, then it stands to reason that formal instruction on and practice with L1 and L2 phonetic differences may lead to improved production of L2 phones. In this study, the second semester Spanish students who participated exhibited L2 categories, which they differentiated from their L1 categories, at the beginning of the study for /p/ and /t/ but not for /k/. Given that none of the participants had received instruction on articulatory phonetics before the study, it appears that even with very little experience with Spanish, monolingual L1 English students can perceive the differences in English and Spanish /p/ and /t/ and form L2 categories for these sounds. As indicated earlier, this suggests that instruction on articulatory phonetics may be unnecessary for the L2 category formation of certain L2 phones. However, considering that participants did not differentiate their English and Spanish /k/ at the beginning of the study and that the target group improved their production of /k/ over the course of the semester, it appears that instruction on articulatory phonetics is indeed beneficial for particular sounds that may not be acquired as quickly as /p/ and /t/.

One limitation of this study is that the target group received both formal instruction on articulatory phonetics and practice with both perception and production exercises while the control group received no instruction on articulatory phonetics and no practice with pronunciation. For this reason, it cannot be determined how much of the target group's improvement is due to formal instruction and how much is due to practice. Given that the results of this study suggest that pronunciation instruction and practice lead to improvement in VOT production at novice levels, while a lack of instruction and practice does not lead to such improvement, future research should aim to tease apart the impact of instruction versus the impact of practice on L2 phonological acquisition. Furthermore, much is left to be understood about the effectiveness of particular types of pedagogical strategies or practice exercises for L2 phonological acquisition (but see Botero 2011 and Counselman 2010). Ideally, future research will soon shed more light on this area, which will allow Spanish language program coordinators to better understand how to incorporate pronunciation instruction and practice into L2 Spanish curricula.

Finally, unlike more advanced L2 learners and fluent bilinguals (see González López 2012, Bullock et al. 2006 and references therein), the early stages of L2 category formation do not appear to affect the production of L1 phones for the novice learners in this study. However, since the L2 phonological system has been shown to affect the L1 phonological system (cf. Flege 1995 and subsequent), future research should investigate more profoundly the processes involved in this phenomenon. For example, questions regarding the moment, the pace and the amount of L2 exposure needed for the effect of L2 phonological acquisition on the L1 phonological system to become apparent should be explored.

References

Allen, J. Sean, Joanne L. Miller and David DeSteno. (2003). Individual talker differences in voice-onset time. *Journal of the Acoustical Society of America* 113(1), 544-552.

Baker, Wendy and Pavel Trofimovich. (2005). The effect of perceived phonetic similarity on non-native sound learning by children and adults. In Sarah Fisch, Barbora Skarabela and Anna H.-J. Do (Eds.), *Proceedings of the 26th Boston University Conference on Language Development*, pp. 36-47. Somerville, MA: Cascadilla Press.

Best, Catherine T. and Winifred Strange. (1992). Effects of phonological and phonetic factors on cross-language perception of approximants. *Journal of Phonetics* 20, 305-330.

Boersma, Peter and David Weenink. (2006). *Praat: Doing Phonetics by Computer* (Version 4.45.2.4), 4 November 2010, http://www.praat.org (4 November 2010).

Bongaerts, Theo. (1999). Ultimate attainment in L2 pronunciation: The case of very advanced late L2 learners. In David Birdsong (Ed.), *Second language acquisition and the critical period hypothesis*, pp. 133-159. Mahwah, NJ: Lawrence Erlbaum.

Botero, Christopher. (2011). Factors underlying the improvement of L2 phonological production using technology outside the classroom. PhD Dissertation: The Pennsylvania State University.

Cho, Taehong and Peter Ladefoged. (1999). Variation and universals in VOT: Evidence from 18 languages. *Journal of Phonetics* 27, 207-229.

Cho, Taehong and James M. McQueen. (2005). Prosodic influences on consonant production in Dutch: Effects of prosodic boundaries, phrasal accent and lexical stress. *Journal of Phonetics* 33, 121-157.

Counselman, David. (2010). Improving pronunciation instruction in the second language classroom. PhD Dissertation: The Pennsylvania State University.

De Leeuw, Esther, Monika Schmid and Ineke Mennen. (2010). The effects of contact on native language pronunciation in an L2 migrant setting. *Bilingualism: Language and Cognition*, 13(1), 33-40.

Derwing, Tracey M., Murray J. Munro and Grace Wiebe. (1998). Evidence in favor of a broad framework for pronunciation instruction. *Language Learning* 48(3), 393-410.

Docherty, Gerard J. (1992). *The Timing of Voicing in English Obstruents.* Berlin: Foris.

Elliott, A. Raymond. (1995). Foreign language phonology: Field independence, attitude, and the success of formal instruction in Spanish. *The Modern Language Journal* 79(iv), 530-542.

Elliott, A. Raymond. (1997). On the teaching of acquisition and pronunciation within a communicative approach. *Hispania* 80, 95-108.

Fikkert, Paula. (2000). Acquisition of phonology. In Lisa Cheng and Rint Sybesma (Eds.), *The First Glot International State-of-the-Article Book. The Latest in Linguistics. Studies in Generative Grammar 48*. pp. 221-250. Berlin/New York: Mouton de Gruyter.

Fisher-Jorgensen, E. (1954). Acoustic analysis of stop consonants. In Ilse Lehiste (Ed.), *Readings in Acoustic Phonetics*, pp. 137-154. Cambridge, MA: The MIT Press.

Flege, James E. (1987). The production of "new" and "similar" phones in a foreign language: Evidence for the effect of equivalence classification. *Journal of Phonetics* 15, 47-65.

Flege, James E. (1991) Age of learning affects the authenticity of voice onset time (VOT) in stop consonants produced in a second language. *Journal of the Acoustical Society of America* 89, 395-411.

Flege, James E. (1992) Speech learning in a second language. In Charles A. Ferguson, Lise Menn and Carol Stoel-Gammon (Eds.), *Phonological Development: Models, Research, and Application*, pp. 565-604. Timonium: York Press.

Flege, James E. (1995). Second-language speech learning: Theory, findings, and problems. In Winifred Strange (Ed.), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research*, pp. 229-273. Timonium: York Press.

Flege, James E. (1999). Age of learning and second-language speech. In David Birdsong (Ed.), *Second Language Acquisition and the Critical Period Hypothesis*, pp. 101-132. Mahwah: Lawrence Erlbaum Press.

Flege, James E. (2002). Interactions between the native and second-language phonetic systems. In Petra Burmeister, Thorsten Piske and Andreas Rohde (Eds.), *An Integrated View of Language Development: Papers in Honor of Henning Wode*, pp. 217-244. Trier. Wissenschaftlicher Verlag.

Flege, James E. (2003). Assessing constraints on second-language segmental production and perception. In Antje S. Meyer and Niels O. Schiller (Eds.) *Phonetics and Phonology in Language Comprehension and Production, Differences and Similarities*, pp. 319-355. Berlin. Mouton de Gruyter.

Flege, James E. and Wieke Eefting. (1987). Production and perception of English stops by native Spanish speakers. *Journal of Phonetics* 15, 67-83.

Flege, James E. and Wieke Eefting. (1988). Imitation of a VOT continuum by native speakers of English and Spanish: Evidence for phonetic category formation. *Journal of the Acoustical Society of America* 83(2), 729-740.

Fougeron, Cécile. (1999). Prosodically conditioned articulatory variations: A review. *UCLA Working Papers in Phonetics* 97, 1-74.

González-Bueno, Manuela. (1994). Effects of formal instruction on the improvement in the pronunciation of Spanish stops by second language learners: changes in Voice Onset Time in initial stops /p, t, k/ and /b, d, g/. PhD dissertation: The Pennsylvania State University.

González-Bueno, Manuela. (1997). The effects of formal instruction on the acquisition of Spanish stop consonants. In William R. Glass and Ana Teresa Pérez-Leroux (Eds.), *Contemporary perspectives on the acquisition of Spanish: Vol. 2. Production, processing, and comprehension*, pp. 57-75. Somerville, MA: Cascadilla Press.

González López, Verónica. (2012). Spanish and English word-initial voiceless stop production in code-switched vs. monolingual structures. *Second Language Research* 28(2), 243-263.

Hurtado, Luz Marcela and Chelsea Estrada. (2010). Factors influencing the second language acquisition of Spanish vibrants. *The Modern Language Journal* 94, 74-86.

Jakobson, Roman. (1968). *Child Language, Aphasia and Phonological Universals*. The Hague: Mouton.

Kessinger, Rachel H. and Sheilah E. Blumstein. (1997). Effects of speaking rate on voice-onset-time in Thai, French, and English. *Journal of Phonetics* 25, 143-168.

Kessinger, Rachel H. and Sheilah E. Blumstein. (1998). Effects of speaking rate on voice-onset time and vowel production: Some implications for perception studies. *Journal of Phonetics* 26, 117-128.

Klatt, Dennis H. (1975). Voice onset time, frication, and aspiration in word-initial consonant clusters. *Journal of Speech and Hearing Research* 18, 686-706.

Laeufer, Christiane. (1996). The acquisition of complex phonological contrast: Voice timing patterns of English initial stops by native French speakers. *Phonetica* 53, 86-110.

Lisker, Leigh and Arthur Abramson. (1964). A cross-language study of voicing in initial stops: Acoustical measurements. *Word* 20, 384-422.

Lisker, Leigh and Arthur Abramson. (1967). Some effects of context on voice onset time in English stops. *Language and Speech* 10, 1-28.

Lord, Gillian. (2005). (How) Can we teach foreing language pronunciation? On the effects of a Spanish Phonetics course. *Hispania* 88(3), 557-567.

Macken, Marlys and David Barton. (1979). The acquisition of the voicing contrast in English: A study of voice onset time in word-initial stop consonants. *Journal of Child Language* 7, 41-74.

Major, Roy C. (1987) English voiceless stop production by speakers of Brazilian Portuguese. *Journal of Phonetics* 15, 197–202.

McCandless, Peter and Harris Winitz. (1986). Test of pronunciation following one year of comprehension instruction in college German. *The Modern Language Journal* 70(iv), 355-362.

Midtlyng, Patrick J. (2011). The effects of speech rate on VOT for initial plosives and click accompaniments in Zulu. In Eyamba G. Bokamba, Ryan K. Shosted and Bezza Tesfaw Ayalew (eds.), *Selected Proceedings of the 40th Annual Conference on African Linguistics: African Languages and Linguistics Today*, pp. 105-118. Somerville, MA: Cascadilla Press.

Miller, Joanne L. and Thomas Baer. (1983). Some effects of speaking rate on the production of /b/ and /w/. *Journal of the Acoustical Society of America* 73(5), 1751-1755.

Miller, Joanne L., Kerry P. Green and Adam Reeves. (1986). Speaking rate and segments: A look at the relation between speech production and speech perception for the voicing contrast. *Phonetica* 43, 106-115.

Peterson, Gordon and Ilse Lehiste. (1960). Duration of syllable nuclei in English. *Journal of the Acoustical Society of America* 32, 693-703.

Pind, Jörgen. (1995). Speaking rate, voice-onset time, and quantity: The search for higher-order invariants for two Icelandic speech cues. *Perception and Psychophysics* 57(3), 291-304.

Rochet, Bernard L. and Yanmei Fei. (1991). Effect of consonant and vowel context on Mandarin Chinese VOT: Production and perception. *Canadian Acoustics* 19(4), 105-106.

Sancier, Michele L. and Carol A. Fowler. (1997). Gestural drift in a bilingual speaker of Brazilian Portuguese and English. *Journal of Phonetics* 25, 421-436.

Stevens, Kenneth, Samuel J. Keyser and Haruko Kawasaki. (1986). Toward a phonetic and phonological theory of redundant features. In Joseph S. Perkell and Dennis H. Klatt (Eds.), *Invariance and Variability in Speech Processes*, pp. 426-463. Mahwah, NJ: Lawrence Erlbaum.

Suter, Richard W. (1976). Predictors of pronunciation accuracy in second language learning. *Language Learning* 26(2), 233-253.

Theodore, Rachel M., Joanne L. Miller and David DeSteno. (2007). The effect of speaking rate on voice-onset-time is talker-specific. In Jürgen Trouvain and William J. Barry (eds.), *Proceedings of the XVIth International Congress of Phonetic Sciences*, pp. 473-476. Saarbrücken, Germany.

Theodore, Rachel M., Joanne L. Miller and David DeSteno. (2009). Individual talker differences in voice-onset time: Contextual influences. *Journal of the Acoustical Society of America* 125(6), 3974-3982.

Thornburgh, Dianne F. and John H. Ryalls. (1998). Voice onset time in Spanish-English bilinguals: Early vs. late learners of English. *Journal of Communication Disorders*, 31, 215-229.

Volaitis, Lydia E. and Joanne L. Miller. (1992). Phonetic prototypes: Influence of place of articulation and speaking rate on the internal structure of voicing categories. *Journal of the Acoustical Society of America* 92, 723-735.

Yavas, Mehmet. (1996). Differences in voice onset time in early and later Spanish English bilinguals. In John B. Jensen and Ana Roca (Eds.), *Spanish in Contact: Issues in Bilingualism*, pp. 151-161. Somerville, MA: Cascadilla Press.

Yavas, Mehmet. (2002). Voice onset time patterns in bilingual phonological development. In Fay Windsor, M. Louise Kelly and Nigel Hewlett (Eds.), *Investigations in Clinical Phonetics and Linguistics*, pp. 341-350. Mahwah, NJ: Lawrence Erlbaum.

Yavas, Mehmet and Renée Wildermuth. (2006). The effects of place of articulation and vowel height in the acquisition of English aspirated stops by Spanish speakers. *IRAL* 44, 251-263.

Yeni-Komshian, Grace, James E. Flege and Serena Liu. (2000). Pronunciation proficiency in the first and second languages of Korean-English bilinguals. *Bilingualism: Language and Cognition* 3(2), 131-149.

Zampini, Mary. (1998). The relationship between the production and perception of L2 Spanish stops. *Texas Papers in Foreign Language Education* 3, 85-100.

Zampini, Mary and Kerry P. Green. (2001). The voicing contrast in English and Spanish: The relationship between perception and production. In Janet Nicol (Ed.), *One Mind, Two Languages: Bilingual Language Processing*, pp. 23-48. Malden, MA: Blackwell.

Zampini, Mary, Connie M. Clarke and Kerry P. Green. (1999). Language experience and the perception of stop consonant voicing in Spanish: The case of late English-Spanish bilinguals. In Ronald P. Leow and Cristina Sanz (Eds.), *Spanish Applied Linguistics at the Turn of the Millenium*, pp. 194-209. Somerville, MA: Cascadilla Press.

Zlatin, Marsha A. (1974). Voicing contrast: Perceptual and productive voice onset time characteristics of adults. *Journal of the Acoustical Society of America*, 56, 981-994.

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