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Language Dominance Modulates the Perception of Spanish Approximants in Late Bilinguals

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Received: 3 December 2019; Accepted: 20 January 2020; Published: 22 January 2020

Abstract: The ability to discriminate phonetically similar first language (L1) and second language (L2) sounds has significant consequences for achieving target-like proficiency in second-language learners. This study examines the L2 perception of Spanish approximants [β, ð, ɣ] in comparison with their voiced stop counterparts [b, d, g] by adult English-Spanish bilinguals. Of interest is how perceptual effects are modulated by factors related to language dominance, including proficiency, language history, attitudes, and L1/L2 use, as measured by the Bilingual Language Profile questionnaire. Perception of target phones was assessed in adult native Spanish speakers (n = 10) and Spanish learners (n = 23) of varying proficiency levels, via (vowel-consonant-vowel) VCV sequences featuring both Spanish approximants and voiced stops during an AX discrimination task. Results indicate a significant positive correlation between perceptual accuracy and a language dominance score. Findings further demonstrate a significant hierarchy of increasing perceptual difficulty: β < ð < ɣ. Through an examination of bilingual language dominance, composed of the combined effects of language history, use, proficiency, and attitudes, the present study contributes a more nuanced and complete examination of individual variables that affect L2 perception, reaching beyond proficiency and experience alone.

Keywords: L2 speech perception; bilingual language dominance; second language acquisition; Spanish approximants; late bilinguals

1. Introduction

The ability to discriminate similar first language (L1) and second language (L2) sounds may have significant consequences for L2 learning, both in perception and production skills (Escudero 2007; Flege 1993). The present study aims to take a broad approach to learner variables that may determine L2 perception abilities by considering multiple dimensions of language experience in one concise bilingual dominance score, integrating language history, use, proficiency, and attitudes. Previous studies (Kissling 2015; Vokic 2010) suggest that course level and language experience do not adequately reflect perceptual accuracy. Furthermore, even within groups of speakers matched for age of arrival (AoA) and length of residence (LOR), there is variation in L2 perception abilities (Aoyama and Flege 2011). Research has shown that increased exposure to the target language leads to perception gains, but not uniformly (Aoyama and Flege 2011; Bohn and Flege 1990). This study proposes that the ability to perceive L2 phones may be a function of language dominance, considering multiple dimensions of an individual's linguistic profile simultaneously. As such, we investigate how language dominance, as measured by the Bilingual Language Profile questionnaire (Birdsong et al. 2012), may variably modulate late bilinguals' ability to discriminate similar sounds in Spanish and English. This study therefore examines if, and how, language dominance correlates with the ability to discriminate between L2 and L1 similar phones, namely [β]/[b], [ð]/[d], and [ɣ]/[g], as these particular phones have shown to be the most perceptually difficult in previous studies examining L1 English learners of L2 Spanish (e.g., Kissling 2015). We furthermore aim to determine which specific phonetic contrasts ([β]/[b], [ð]/[d], [ɣ]/[g]) present the greatest perceptual difficulty and for whom. In the following section, we discuss what previous research tells us about L2 speech perception and how Spanish approximant sounds are acquired by L1 speakers of English. We briefly discuss the findings of previous research on the effect of experience on language perception and we conclude our review of previous literature with a discussion of bilingual language dominance in L2 perception and how dominance is measured on the Bilingual Language Profile (BLP) questionnaire. We then present our hypotheses within the context of previous research. In Section 2, we provide a description of our methods and procedure, and in Section 3 we present both the descriptive and inferential results. Finally, in Sections 4 and 5, we conclude with a discussion of how our findings fit within the body of L2 perception research and provide a preliminary explanation of the varying perceptual difficulty of our target phone contrasts as well as suggest avenues of future research.

1.1. The Speech Learning Model

L2 speech perception presents unique difficulties in that the learner must discriminate similar sounds between L1 and L2. Various models exist to theorize about the process of acquiring L2 phones, such as the Perceptual Assimilation Model (PAM) (Best 1995), which posits that adults perceive unknown non-native phones in terms of articulatory similarities and differences with native phonemes and contrasts such that if two foreign speech sounds are assimilated to two different native sounds, discrimination is predicted to be excellent; however, if two sounds are assimilated to a single native category, discrimination will be poor. Nonetheless, as noted (Best and Tyler 2007), the PAM focuses primarily on naïve listeners, whereas models of L2 speech acquisition, such as the Speech Learning Model (SLM) (Flege 1987, 1995; Flege et al. 2003), have focused on experienced listeners. Therefore, in the present study, we chose to focus our theoretical framework around Flege's SLM, since we examine the perception of late bilinguals of varying proficiency levels, as opposed to naïve (i.e., nonnative) listeners. The SLM (Flege 1987, 1995; Flege et al. 2003) views perception as language-specific, in which L2 sounds are related to L1 sounds resulting in an often erroneous "equivalence classification" (Flege 1987). The SLM proposes that L1–L2 phonological categories are in a relationship of mutual influence by virtue of being stored in a "common phonological space" (Flege 1995) in which 'old' sounds will not be problematic and 'new' sounds will be acquired, but 'similar' sounds will be problematic. Similarity is defined in terms of the acoustic/phonetic distance between the L1 and the L2 sounds. If the acoustic/phonetic distance between the L1 and the L2 sound is small, equivalence classification will take place and the learner will perceive the L2 sound as the L1 sound. Thus, L2 sounds that have a perceptual equivalent in L1, or are perceptually accommodated to L1, are less salient than completely novel sounds, and therefore more vulnerable to being inaccurately perceived as an L1 phone.

1.2. The Acquisition of Spanish Approximant [β], [ð], and [ɣ] by English-Speaking Learners

This study focuses on the learners' ability to discriminate between the Spanish approximants, [β], [ð], and [ɣ], and their English voiced stop equivalents, [b], [d], and [g]. In most varieties of Spanish, there exists a systematic weakening or lenition of the voiced stops such that the/b/,/d/, and/g/are realized as an approximant allophone. This lenition process can also be described as a case of phonological assimilation in which voiced stops acquire the [+continuant] feature from the surrounding vowels (Lavoie 2001). For example, the word abogado ("lawyer" or "attorney") is articulated as [a.βo.ɣa.ðo], the word baba ("drool") is articulated as [ba.βa], the word adonde ("(to) where") is articulated as [a.ðon.de], and the word daga ("dagger") is articulated as [da.ɣa] (Face and Menke 2009). Note that this lenition (weakening) process of voiced stops in Spanish does not only occur at the word level, but also across word boundaries, such that una beca ("a scholarship") is realized as [u.na.βe.ka], and although sin dinero ("without money") is pronounced with the stop/d/, the phrase mi dinero (“my money”) is articulated as [mi.ẟi.ne.ɾo], because the/d/sound is found in the intervocalic position at the phrase level. The lenition of voiced stops in Spanish also occurs in several other contexts, such as when preceded by a rhotic, as in arde (“burns”), [aɾ.ẟe], and voiced stops are often (but not always) realized as an approximant when preceded by a sibilant, as in desde (“since”), [des.ẟe]. Voiced stops are maintained in absolute initial position (i.e., proceeding a pause), after a nasal, and after/l/in the case of/d/, whereas voiced stops are realized as approximants in all other contexts (Martínez-Celdrán 2013; González-Bueno 2019). However, Hualde et al. (2011) argue that stops and approximants do not necessarily occur in complementary distribution, as described above, but rather along a “continuum of constriction” (p. 906) that is dependent upon a number of conditioning factors such as stress, preceding segments, tempo, and the presence of word boundaries (Hualde et al. 2011). Nonetheless, the approximant realization of voiced stops in intervocalic position in Spanish is extremely common. Martínez-Celdrán (2013) reports a 96.3% rate of approximants [β, ẟ, ɣ], 2.1% fricatives [β, ð, ɣ], and only 1.7% stop articulations following a vowel. Some confusion has existed in previous literature regarding the phonetic symbol for the allophonic variation of the phoneme/d/, in which the approximant allophone symbol [ẟ] has been confused with the fricative allophone symbol [ð]. However, as Martínez-Celdrán (2013) points out, the most common articulation of the voiced stops/b/,/d/, and/g/in the postvocalic position is an approximant allophone, such as [ẟ], and not the fricative [ð]. Nonetheless, it is worth noting that, in English, the fricative [ð] and the stop [d] form a phonemic contrast (e.g., [ðo] “though” vs. [do] “dough”). Therefore, whereas the/d-ð/contrast is phonemic in English, it is phonetic in Spanish. The effect on perception of phonemic versus allophonic contrast will be explored further in our discussion of Boomershine et al. (2008). English speakers do lenite both voiced and voiceless stops in fast and casual speech, but approximants (i.e., [ẟ]) are much less frequent than in Spanish and their articulation is primarily an effect of speech style (Brown 1990; Gimson 1989). Bouavichith and Davidson (2013) note that American English speakers never lenite to fricatives but rather produce approximants whenever lenition occurs. This is in line with Bauer (2008) argument that lenition cannot result in a fricative due to the increased muscle control required for fricative productions. Bouavichith and Davidson (2013) argue that stress plays a key role in determining the approximant articulation of stops; they report that 51% of stops in American English are produced as approximants when stress is on the preceding syllable (e.g., yoga [ʎo.ɣa]) but only 7% when stress is on the following syllable (e.g., lagoon [la.gun]), which is remarkably similar to the earlier findings of Warner and Tucker (2011). Lavoie (2001) asserts that stress patterns in English are a substantial determinant of duration, which in turn conditions lenition or reduction. Nevertheless, it is important to note that there is no obligatory allophonic rule of voiced stop lenition in English, therefore making its L2 acquisition difficult for English-speaking learners of Spanish (González-Bueno 2019; Zampini 1994).

The perception of both the fricative and approximant variants of the Spanish stops by English-speaking learners have been previously examined. Boomershine et al. (2008) investigated the impact of phonemic contrast versus allophony on the perception of speech sounds by Spanish and English speakers. Their results showed that Spanish-speaking listeners rated pairs of stimuli contrasting [ð]-[d] (fricative vs. stop) in an AX discrimination task (i.e., ‘same’ or ‘different’ binary perceptual task) as being much more similar-sounding than American English listeners, likely because the two sounds are contrastive in English (but not in Spanish) and, therefore, native English speakers are more sensitive to this contrast than native Spanish speakers. They concluded that speech perception is not only mediated by phonemic categories in L1 and L2, but also by the phonological relation between sounds, that is, allophones vs. phonemes (Boomershine et al. 2008).

Nonetheless, as mentioned above, in most varieties of Spanish, the voiced stop alternates with the approximant in intervocalic position and, unlike the fricative vs. stop distinction, this is an allophonic distinction that does not occur in standard English (Colantoni et al. 2015). Therefore, English-speaking learners of Spanish must learn to perceive and produce approximants where they would normally produce stops or flaps in their L1, thus inducing the creation of a new allophonic rule in the mental grammar of the L2 Spanish learner (Colantoni et al. 2015).

A number of studies have shown that English learners have difficulty with both the perception and production of the Spanish approximants (e.g., Kissling 2015; Face and Menke 2009; González-Bueno 1995; Zampini 1994). Zampini (1994) studied how adult native English-speaking learners of Spanish acquire Spanish lenition of the/b, d, g/sounds in an instructed context and found that all L2 learners produced the approximant in less than 32% of the expected instances. Zampini (1994) concluded that L2 learners may be aware of the lenition rule in Spanish but have difficulty with its implementation due to the absence of an obligatory allophonic rule for lenition in English, thereby transferring the phonemic status of English/b, d, g/to Spanish. These findings to some extent support the Speech Learning Model (Flege 1987). English and Spanish share a mutual effect in perceiving the voiced stops. For learners of Spanish, the voiced stops in L2 Spanish with similarly articulated allophone variants acoustically resemble the voiced stops in L1 English, and, therefore, equivalence classification is likely to occur, causing the transfer of the L1 equivalent. González-Bueno (1995) acoustically analyzed the speech of native English-speaking adult L2 learners of Spanish at the intermediate level during an oral proficiency interview (OPI) and found that learners produced lenited sounds about 50% of the time. González-Bueno (1995) attributed these results to the phonemic and allophonic differences between English and Spanish. Later, González-Bueno and Quintana-Lara (2011) examined both the production and perception of the Spanish approximants [β, δ, ɤ] during a binary discrimination task of English-speaking L2 learners of Spanish at three different proficiency levels (i.e., low, intermediate, and advanced). They determined that learners made more errors in the production than in the perception of the lenited allophones, thus supporting the perception-before-production theory (González-Bueno and Quintana-Lara 2011). Face and Menke (2009) analyzed a total of 2471 intervocalic productions of/b, d, g/by native English-speaking L2 learners of Spanish of three different levels (i.e., fourth semester, graduating Spanish majors, and graduate students in Spanish) during a story reading task. Results indicated that intervocalic approximant productions became increasingly more common as learner level increased, thus demonstrating the development of the interlanguage system of English-speaking learners of Spanish. Furthermore, Face and Menke (2009) note that English-speaking learners of Spanish tend to produce approximants, not fricatives, and that the small percentage of fricatives produced in the intervocalic position decreased with increasing learner group level. Rafat (2016) also examined the production of the approximants [δ] and [β] together with some other ‘old’ or familiar (i.e., present in L1) sounds in naïve learners of Spanish. There were three auditory-orthographic conditions and one auditory only condition. The results indicated that learners had the most difficulty with the production of these two ‘similar’ sounds in all conditions and that exposure to orthographic input resulted in higher error rates than in the auditory only condition. In a perceptual discrimination pretest of similar L1L2 sounds among L1 English speakers learning Spanish (n = 87), Kissling (2015) found that [β]/[b], [δ]/[d], [ɤ]/[g] phonetic contrasts all presented the greatest perceptual difficulty, while the Spanish rhotics were the most perceptually salient (average accuracy score = 99%). The average perceptual accuracy score for the [β]/[b] contrast was 48%, and 62% was the average for both the [ɤ]/[g] and [ð]/[d] target token contrast types. Although Kissling organized the study participants by language course level (years 1–3), as an imprecise indicator of proficiency, a significant amount of variability in perceptual accuracy was observed within each level group, indicating that discriminating similar sounds may be strongly influenced by other learner variables, such as experience.

1.3. Language Experience in L2 Perception

In addition to L1–L2 similarity, research has demonstrated that language experience can also shape L2 perception. Bohn and Flege (1990) investigated the role of foreign language experience in adult German speakers' L2 English vowel perception. The studied vowels were grouped as "similar" ([i, I, ε]) and "new" ([æ]), as determined by the respective phonemic inventories of English and German. Results showed a more nuanced interpretation of the effect of language experience in that increased L2 experience led to perception gains only of the "new" vowel sound but did not affect perception of "similar" vowels, thus suggesting a crucial interaction between both equivalence classification in phonological transfer and experience. Aoyama and Flege (2011) showed similar results in their study of the effects of L2 experience on the perception of the English contrasts between [r], [l], [s], and [θ] by native Japanese speakers; learners' ability to notice small phonetic differences increased with longer LORs yet increased significantly more for the more perceptually salient [s]-[θ] contrast. Therefore, although L2 experience is a proven influencing factor in speech perception, it is critically constrained by the perceptual similarities between L1 and L2 phonemic and allophonic inventories.

Fox et al. (1995) examined the perceptual response to English and Spanish vowel pairs on a 9-point dissimilarity scale and found that the vowel space of the more experienced L2 listeners became more target-like than that of the less experienced L2 listeners. They concluded that perceptual dimensions used by L2 listeners to identify L2 sounds may be gradually modified as L2 proficiency and experience increase. However, language experience and proficiency may be incomplete measures of an individual's language profile. Perhaps an L2 learner's language profile could be more aptly characterized by a measurement of language dominance, which includes a more holistic view constructed from language history, use, attitudes, and proficiency, in order to access the cognitive and social reality behind language development.

1.4. Language Dominance in L2 Perception and the Bilingual Language Profile Questionnaire

Even though language dominance is often equated with fluency or proficiency in a language, Birdsong (2014) provides a more nuanced and complete view of language dominance as an inherently gradient and relative construct in which bilinguals are dominant to varying degrees with respect to their other language, and balance between two languages does not imply high proficiency. Furthermore, in the context of bilingualism, dominance refers to "observed asymmetries of skill in, or use of, one language over the other" (Birdsong 2014, p. 374), covering different dimensions of language use and experience, such as proficiency, fluency, ease of processing, frequency of use, and cultural identification. The Bilingual Language Profile (BLP) questionnaire (Birdsong et al. 2012) describes and quantifies bilingual language dominance through self-report on 19 questions across four dimensions: language history, language use, proficiency, and attitudes.

The BLP has been validated as a grouping and predictive factor in multiple empirical studies (e.g., Amengual 2016; Gertken et al. 2012). Amengual and Chamorro (2015) examined the role of language dominance in the perception and production of the Galician mid vowel contrasts among Spanish-Galician bilinguals and found language dominance to be a strong predictor of the production and perception abilities of these bilingual individuals. In addition, Amengual (2016) used the BLP to assess the effect of language dominance in the production and perception of Catalan mid-vowels and found that the degree of language dominance affects the Euclidean distance maintained between the mid-vowel targets; individuals who produced the target mid-vowels with smaller Euclidean distances were more likely to have a higher error rate in the perception task than bilinguals who produced a more robust contrast. More specifically, Spanish dominance (versus Catalan dominance) showed a higher perceptual error rate as Euclidean distances were smaller for Spanish-dominant bilinguals. However, more recently, Amengual and Simonet (2019) acoustically analyzed the effect of language dominance on Catalan-Spanish bilinguals' production of the Catalan [a]~[ə] alternation, a phonological process induced by lexical stress. Their results demonstrated no effect of language dominance and Amengual and Simonet (2019) therefore concluded that the phonological process of unstressed vowel reduction may be easier to acquire than phonemic contrasts with a low functional load (i.e., /e/-/ɛ/,/o/-/ɔ/). Therefore, language dominance effects may be more relevant for phonemic contrasts than for phonological processes. Nonetheless, Amengual (2016) and Amengual and Chamorro (2015) conclude that the effect of language dominance (perhaps uniquely on phonetic contrasts and not necessarily on phonological processes (Amengual and Simonet 2019) is gradient and strongly affected by an individual's amount of use (language use) and exposure (language history), which together account for half (two out of four domains) of the global language dominance score, as assessed and quantified by the BLP questionnaire.

In summary, the SLM (Flege 1987, 1995; Flege et al. 2003) posits that L2 sounds with a perceptual equivalent in L1 (i.e., 'similar sounds') are vulnerable to being inaccurately perceived as an L1 phone (i.e., 'equivalence classification'). Spanish exhibits a systematic weakening (i.e., 'lenition') of voiced stops to approximant allophones in the intervocalic position at both the word and phrase levels. English speakers also lenite voiced stops in fast and casual speech, but approximant articulation is much less frequent in English and is primarily an effect of speech style (Brown 1990; Gimson 1989) with no specific allophonic rule for approximant production. Previous studies (e.g., Kissling 2015; Face and Menke 2009; González-Bueno 1995; Zampini 1994) have shown that English-speaking learners of Spanish have difficulty with the perception and production of approximant allophones in Spanish. Furthermore, language experience has been shown to variably affect perception; however, experience appears to be critically constrained by the perceptual similarities between L1 and L2 phonemic and allophonic inventories such that, as language experience increases, greater perception gains tend to be observed for 'new' (i.e., completely novel) sounds than they are for 'similar' ones. Finally, bilingual language dominance provides a more holistic description of an individual's linguistic profile, considering the relative balance between two languages across the dimensions of language history, use, proficiency, and attitudes. Previous research (e.g., Amengual 2016; Amengual and Chamorro 2015; Gertken et al. 2012) has established a significant correlation between a language dominance score on the BLP (Birdsong et al. 2012) and production and perception abilities among bilingual individuals. Therefore, the present study examines the effect of bilingual language dominance on the L2 perception of an allophonic contrast that is susceptible to equivalence classification due to a small acoustic-phonetic distance with its L2 counterpart.

1.5. Questions and Hypotheses

It is important to note that no previous studies, to our knowledge, have specifically examined the effect of bilingual language dominance on the perception of similar phones by late bilinguals of English and Spanish. Therefore, based on previous research of adult perception and production of similar sounds in Spanish and English (e.g., Kissling 2015; Vokic 2010; Face and Menke 2009; Boomershine et al. 2008; González-Bueno 1995; Fox et al. 1995; Zampini 1994), and on research demonstrating a correlation between language dominance and speech perception (e.g., Amengual and Chamorro 2015; Amengual and Chamorro 2015; Amengual 2016), we predict the following:

Question 1. How does language dominance correlate with the ability to discriminate L2 and L1 similar phones, namely [β]/[b], [ð]/[d], and [ɣ]/[g]?

Hypothesis 1. *English-dominant participants will show lower perceptual accuracy scores than Spanish-dominant participants, which would support the results of Amengual and Chamorro (2015) who examined Spanish-Galician bilinguals' perception of Galician mid vowel contrasts and found language dominance to be a strong predictor of bilinguals' production and perception abilities.*

Question 2. Which specific phonetic contrasts ([β]/[b], [ð]/[d], or [ɣ]/[g]) are most difficult to discriminate?

Hypothesis 2. *The most difficult phonetic contrast for English-dominant speakers to discriminate will be [β]/[b], followed by [ɣ]/[g] and [ð]/[d], in line with Kissling (2015) perceptual discrimination findings of English-speaking L2 learners of Spanish in the instructed context, which would also be partially supported by the findings of various other studies that examine L2 production of the voiced stop~approximant contrast (e.g., González-Bueno and Quintana-Lara 2011; Face and Menke 2009; González-Bueno 1995; Zampini 1994).*

2. Materials and Methods

2.1. Participants

A total of 23 L2 Spanish learners (English L1) and 10 L1 Spanish speakers (L2 English learners) were included in the study. L1 Spanish speakers were graduate students in Hispanic Studies at Western University who immigrated to Canada from Spanish-speaking countries. L2 Spanish learners were undergraduate students at the same university enrolled in an introductory or intermediate Spanish course. All participants confirmed they had no speech or hearing impairments and had either learnt Spanish (L1 group) or English (L2 group) as their first language from birth. There were more women (n = 23) than men (n = 10) recruited for this study. The average age was 24.24 (range: 17–55, mode = 20). In terms of Spanish course level, 14 of the Spanish learner participants were in Year 1 of the Spanish program, 3 were in Year 2, and 6 were in Year 3. Knowledge of another language (other than English or Spanish) was reported, but not tested for. The most common other languages reported were French (n = 19) and Portuguese (n = 5), followed by Italian (n = 4) and Farsi (n = 4), yet it is worth noting that very few participants (n = 4) reported any use at all of a third language during a typical week (as determined by the Language Use module of the BLP questionnaire). Even though French is an official language of Canada, and most students are required to take some French in school, only low proficiency in French was reported by these participants. Furthermore, a qualifying criterion to participate in this study was to have very low or no proficiency in another language other than Spanish and English. Whether there could be transfer effects on speech perception due to some knowledge of or exposure to other languages will need further investigation. An overview of the bilingual language dominance scores per dominance group for each module of the BLP questionnaire is provided in Table 1. Average scores for each sub-section are provided, with standard deviations in parentheses. Relative dominance is assessed in each module based on degree of difference between each language. Global bilingual dominance scores are calculated on a scale from −218 to +218, oriented towards Spanish, such that more positive scores indicate stronger dominance in Spanish and more negative scores indicate stronger dominance in English. The global dominance score was calculated by subtracting the total English score from the total Spanish score. Complete instructions for the scoring and interpretation of results can be found on the Bilingual Language Profile website (https://sites.la.utexas.edu/bilingual/scoring-and-interpreting-the-results/). All L1 Spanish speakers immigrated to Canada or the United States after the age of 13 (range: 18–51); all L1 English/L2 Spanish learners had started learning Spanish after the age of 13 (range: 14–21). The intention behind these age limits was to focus on cases of late bilingualism as it is the most applicable to the Spanish as a foreign language classroom context in Canada and the United States, in line with Vokic (2010) description of "a prototypical Anglo learner" as someone who " [. . .] starts learning an L2 relatively late in life [and] who thereafter is exposed to that L2 on average three hours a week" (p. 434). All L1 Spanish speakers (n = 10) had been living, at the time of the study, in Ontario, Canada, where English is the majority language. Therefore, it is important to consider participants' LORs, as reported in the language history section of the BLP questionnaire. The average LOR was 3.7 years with a range of 0–15 years (SD = 4.47). All but one participant immigrated to Canada to pursue their graduate studies. L1 Spanish participants' average age at the time of testing was 36 years (SD = 8.6). L2 Spanish participants' average age at the time of testing was 19.1 years (SD = 1.12).

Table 1. BLP language dominance results for Spanish-dominant group (n = 5), near-balanced group (n = 7), and English-dominant group (n = 21).

		Lang Hist		Lang Use			Proficiency		Attitudes		Overall Scores		
	N	**Sp.**	**Eng.**	**Sp.**	**Eng.**	**Other**	**Sp.**	**Eng.**	**Sp.**	**Eng.**	**Sp.**	**Eng.**	**Global Dom.**
Sp. Dom.	5	50.7 (3.6)	7.9 (6.9)	46.0 (2.1)	8.5 (2.1)	0.0 (0.0)	54.5 (0.0)	32.7 (14.3)	49.9 (8.9)	14.5 (9.0)	201.1 (10.9)	63.6 (21.0)	**135.7 (15.3)**
Near Bal.	7	37.6 (18.0)	20.2 (12.9)	29.1 (14.9)	24.8 (13.9)	0.6 (1.2)	49.0 (6.5)	49.9 (5.1)	42.5 (13.2)	40.2 (11.0)	158.2 (41.8)	135.1 (37.8)	**23.0 (75.8)**
Eng. Dom.	21	2.8 (2.5)	44.2 (3.0)	2.9 (2.0)	48.0 (5.6)	3.6 (5.5)	19.3 (9.8)	54.0 (1.2)	19.9 (11.3)	53.4 (2.0)	44.9 (21.6)	199.6 (7.9)	**−154.7 (22.2)**

2.2. Tasks

To assess bilingual language dominance, participants completed a 10-min Bilingual Language Profile questionnaire (BLP) developed by the Center for Open Educational Resources and Language Learning (COERLL) of the University of Texas at Austin (Birdsong et al. 2012), which serves as a concise instrument for assessing language dominance through self-report of language history, proficiency, use, and attitudes. Participants had the option of completing the BLP in Spanish or English.

In Task 2, perception of target phones was assessed via VCV (vowel-consonant-vowel) sequences featuring both Spanish approximants [β, ð, ɣ] and voiced stops [b, d, g] in intervocalic position in an AX discrimination task, as adapted from Kissling (2015) and Boomershine et al. (2008). An AX discrimination task is designed to ask participants to listen to two sounds and decide whether they are the same or different. Ten contrastive tokens of each set of target phones (30 total) were utilized, in addition to fifteen distractors of VCV/VCV with no change (XX distractor) and fifteen distractors of contrasts with non-target stops as a CV (consonant-vowel) syllable (AX distractor) (see Appendix A for randomization of tokens per trial). The CV syllable control phones were acoustically more salient than the target phones as they differed in place, manner, and/or voicing, and the XX (same) phones were acoustically identical (a copy and paste of the audio segment). Together, both distractor types serve as an indicator of participant reliability and level of engagement with the task; if a participant did not perform well (≥13/15 = 87%) on these distractors, this was interpreted as a lack of understanding of the task instructions and/or a lack of engagement with the task. The tokens were recorded with a professional condenser microphone using Audacity 2.3.0 for Windows by a native male Spanish speaker, highly proficient in English and trained in phonetics. Normalization and noise reduction were applied to each recording to ensure the highest possible sound quality. Participants used Srhythm model NC 25 active noise-cancelling headphones to listen to the recordings individually in a quiet room. Before beginning the task, participants were instructed to listen to each token pair played twice and to mark their response, "same" or "different", on the paper provided. Participants were specifically instructed to mark "different" if they heard any difference whatsoever between the two tokens, regardless of how different they sounded or in what way they sounded different. Otherwise, if no difference was perceived, they were instructed to mark "same". Participants were not exposed to any phonetic transcriptions or orthographic representations of the task stimuli sounds—they only marked "same" or "different" on the provided paper corresponding to the trial number for each block (see Appendix A for token randomization per block). Between each of the six 2-min blocks of trials, participants were asked how they were doing, if they had any questions/confusions, and if they needed a break. Breaks were taken as needed to avoid the possibility of fatigue. The sixty total tokens (30 target phones, 15 XX same distractors, 15 AX distractors) were divided up randomly over six blocks of ten token pairs each (see Appendix A). In line with previous studies (Kissling 2015; Boomershine et al. 2008), the average duration of stimulus exemplars was 1 s, with a 1500 ms inter-stimulus interval (ISI). A longer ISI was used in order to draw on the phonetic/phonemic knowledge of the listener and not just on the acoustic memory store, as established by Kissling (2015).

3. Results

Global dominance scores were calculated for each BLP questionnaire, according to the outlined BLP scoring instructions. Overall scores on the perceptual discrimination task were calculated out of 60 possible points (a maximum of 10 points on each of the six trial blocks); target phone contrastive pairs were calculated out of 30 possible points; participant reliability scores were calculated out of 30 possible points from the two groups of distractor tokens; and specific phonetic contrast scores were calculated out of 10 possible points for each pair. One point was awarded for each correct response of same/different. Due to the binary nature of this discrimination task, each response received a score of '1' or '0': A response of "same" received 0 points on the AX different token pairs and 1 point on the XX same token pairs; a response of "different" received 1 point on the AX different token pairs and 0 points on the XX same token pairs. All scores were converted into a percentage for comparison purposes. Perceptual accuracy scores were grouped by global language dominance scores in which more negative numbers indicated English-dominance, more positive numbers indicated Spanish-dominance, and numbers closer to zero indicated near-balanced bilingualism. Within our dataset of global dominance scores, three distinct groups emerged in which scores were either well above or below, ±100, or were around zero in either direction. Therefore, the following three numerical groupings were established to compare between groups: Spanish-dominant (BLP score ≥ 100); English-dominant (BLP score ≤ −100); and near-balanced bilinguals (BLP score range: −99 to +99). The BLP scores of the L1 Spanish participants (n = 10) were equally divided between Spanish-dominant and near-balanced groups and all but two participants from the L2 Spanish learners group had BLP scores that placed them in the English-dominant group (n = 21). The near-balanced group (n = 7) consisted of L1 Spanish speakers (n = 5) and L2 Spanish learners (n = 2). However, the Spanish-dominant group (n = 5) consisted entirely of L1 Spanish speakers. Therefore, L1 English status patterned closely with English-dominance in our sample (with only two cases of near-balanced bilingualism among L1 English participants), yet L1 Spanish status yielded mixed outcomes for bilingual language dominance, displaying an even split between near-balanced bilingualism and Spanish-dominant bilingualism. These patterns are to be expected given that the L1 Spanish speakers, as discussed above in Section 2.1, had an average LOR of 3.7 years in an English majority country, while none of the L2 Spanish learners reported any time spent in a region where Spanish is the majority language. Although our descriptive results of language dominance scores highlighted these three distinct groups, the average perceptual accuracy scores were identical (0.94) among the near-balanced and Spanish-dominant groups, as shown in Figure 1, below. Therefore, participants were ultimately grouped as either Spanish-dominant (positive BLP scores) or English-dominant (negative BLP scores). For clarity, we present our results in both the three distinct groups (Sp-dom, near-balanced, and Eng-dom) and in the two main groups (Sp-dom and Eng-dom).

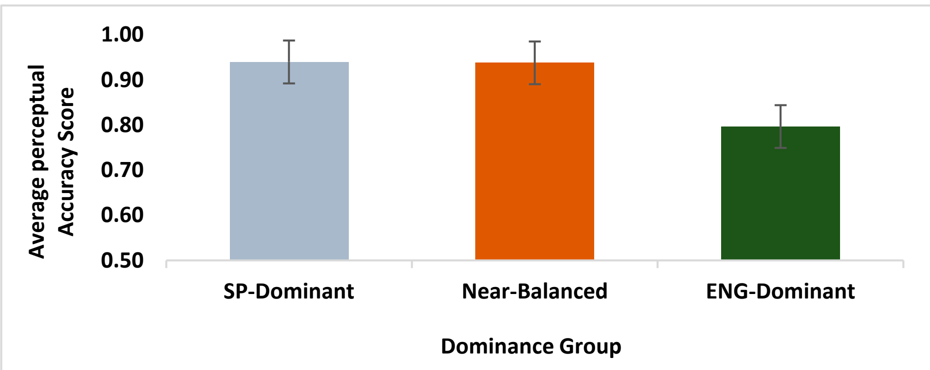

Figure 1. Average target token score per dominance group for all three contrast types combined: [β]/[b], [ð]/[d], [ɣ]/[g].

Our first question was: How does language dominance correlate with the perceptual accuracy of similar phones? Both the Spanish-dominant group (actual BLP dominance score range: +119 to +155), with an average perceptual accuracy score of 0.94 (range: 0.90–1.0, SD = 0.055), and the near-balanced bilingual group (actual BLP dominance score range: −89 to +97), with an average perceptual accuracy score of 0.94 (range: 0.87–1.0, SD = 0.056), showed higher overall perceptual accuracy on the target stop-approximant contrast phones than the English-dominant group (actual BLP dominance score range: −118 to −189), with an average perceptual accuracy score of 0.80 (range: 0.50–0.93, SD = 0.145). As shown in Figure 1, the overall target token perceptual accuracy scores of both the Spanish-dominant and near-balanced groups were remarkably the same and high, whereas the target perceptual accuracy scores of English-dominant participants were markedly lower overall.

Due to the similarity in perceptual accuracy scores and the relatively small sample size, dominance groups were reduced to two for statistical analysis: Spanish-dominant (positive dominance scores) and English-dominant (negative dominance scores). To evaluate whether any of the two participant groups demonstrate greater perceptual accuracy, an independent-samples t-test with the total token scores as a dependent variable was performed. The results of this test were significant, $t(30) = -3.85$, $p = 0.001$, with a large effect size (Cohen's d = 1.16). Specifically, the average total token score in the English-dominant group (M = 0.80, SD = 0.15) is significantly smaller than in the Spanish-dominant group (M = 0.94, SD = 0.05).

A significant and moderately strong positive correlation was found between the dominance scores and the target token scores, $r = 0.49$, $p < 0.001$. Figure 2 demonstrates this positive correlation in a scatterplot. The result of the correlation analysis indicates that participants with higher dominance scores tend to demonstrate greater perceptual accuracy in discriminating similar sounds.

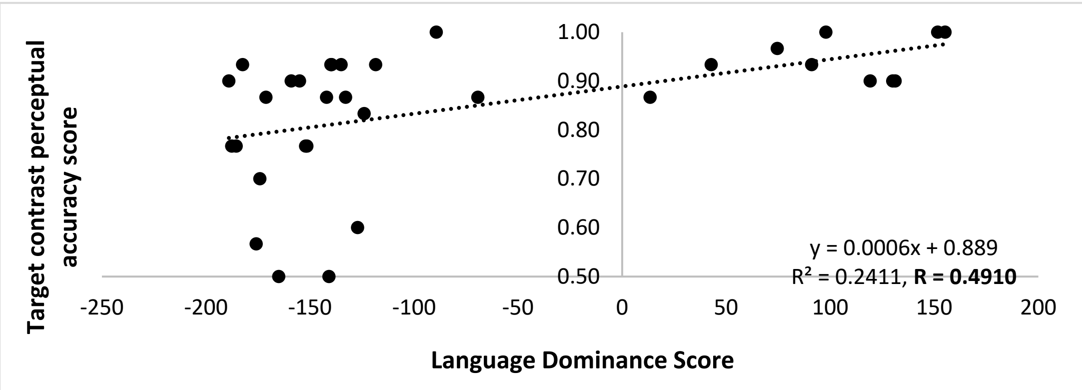

Figure 2. Scatterplot linear correlation between language dominance scores and target token perceptual accuracy scores. Positive scores indicate Spanish-dominance; negative scores indicate English-dominance.

It is worth noting that despite varying perceptual accuracy scores, the average reliability score for each of the three dominance groups was remarkably similar: 0.93 for Spanish-dominant, 0.92 for English-dominant, and 0.94 for near-balanced bilinguals. With regards to intra-group variation, the English-dominant participant group demonstrated the greatest variation in perceptual accuracy scores, as observed in both the intra-group score range (0.50–0.93) and the intra-group standard deviation (0.145) of scores. According to the BLP results, the English-dominant participants varied most on their self-reported Spanish proficiency (range: 6.81–40.86, SD = 9.8) and attitudes about Spanish (range: 2.27–38.59, SD = 11.30) (as assessed in the Language Proficiency and Language Attitudes modules of the BLP questionnaire), despite much lower variation in Spanish language history (range: 0.45–9.99, SD = 2.50) and use of Spanish (range: 1.09–7.63, SD = 2.0). Refer to Table 1 for an overview of the bilingual language dominance results for each group.

Our second question asked which phonetic contrasts ([β]/[b], [ð]/[d], [ɣ]/[g]) are most difficult to discriminate. Variation in perceptual difficulty was observed among the three target phone contrasts. Further analysis revealed that, across all three dominance groups, the intervocalic [ɣ] was the most difficult to perceive, followed by [ð], and finally [β] was the most perceptible target phone. Figure 3 presents the average target contrast scores per dominance group, starting at 0.50, as chance-level. The greatest variation in perceptual accuracy between target phones was observed in the English-dominant group (average perceptual accuracy per phone range: 0.69–0.91, SD = 0.112). In contrast, both the Spanish-dominant group (average perceptual accuracy per phone range: 0.90–1.0, SD = 0.053) and the near-balanced group (average perceptual accuracy per phone range: 0.90–0.96, SD = 0.033) showed much less variation between phone contrast types. To investigate these differences, a repeated-measures ANOVA with three types of phonetic contrasts as a within-factor was conducted. The results of this analysis were significant; Wilk's $\Lambda = 0.46$, $F(2, 31) = 18.46$, $p < 0.001$, with large effect size (partial $\eta^2 = 0.54$). Pairwise comparisons were conducted using the Bonferroni method. The results indicated that the intervocalic [ɣ] was the most difficult to perceive (M = 0.76, SD = 0.20), followed by [ð] (M = 0.85, SD = 0.15), and finally [β] was the most perceptible target phone (M = 0.93, SD = 0.11).

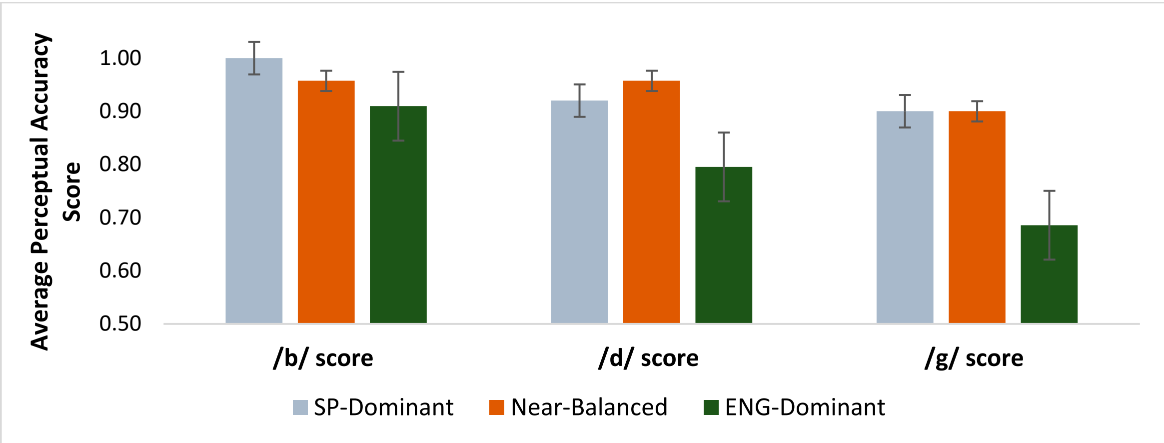

Figure 3. Average target contrast score per dominance group.

To further explore whether these differences in the difficulty of the three phonetic contrasts hold across both English- and Spanish-dominant groups, a mixed ANOVA, with dominance group as a between-factor and the scores for three phonetic contrasts as a between-factor, was conducted. The interaction effect in this analysis was not significant; Wilk's $\Lambda = 0.86$, $F(2, 30) = 2.54$, $p = 0.096$, with a medium effect size (partial $\eta^2 = 0.15$), indicating that the differences in the relative difficulty of the three phones were similar for the English- and Spanish-dominant groups.

4. Discussion

The goal of the present study was to determine if a correlation exists between language dominance and perceptual accuracy of the voiced stop [b, d, g] vs. approximant [β, ð, ɣ] contrast in the intervocalic position in Spanish as well as to determine which, if any, phone contrasts present the greatest perceptual difficulty and for whom.

The first hypothesis that English-dominant participants will show lower perceptual accuracy scores than the Spanish-dominant participants was confirmed. English-dominant participants showed a much lower average perceptual accuracy score (0.80) than their Spanish-dominant (0.94) and near-balanced (0.94) counterparts. Statistical analysis revealed that there is, in fact, a significant positive correlation between language dominance and perceptual accuracy. These findings support the argument that language dominance and perception are correlated, as Amengual and Chamorro (2015) and Amengual (2016) found among Catalan-Spanish bilinguals in their varying perception of mid-vowel contrasts.

The second hypothesis that the most difficult phonetic contrast for English-dominant speakers to perceive will be [β]/[b] and [ɣ]/[g], was partially confirmed. The results indicated the following hierarchy of difficulty, where the degree of difficulty increased from left to right: β < δ < ɣ. An average perceptual accuracy score of 0.63 was found in the English-dominant group for the [ɣ]/[g] contrast, effectively making it the most perceptually difficult contrast for this group; however, the [β]/[b] contrast was in fact the least perceptually difficult contrast for this group (and for all groups) as demonstrated by an average score of 0.91. Furthermore, the [δ]/[d] contrast was also perceptually difficult for English-dominant speakers, with an average accuracy rate of 0.80. Clearly, the fact that the fricative-stop, [ð]/[d], is in a relationship of phonemic contrast in English (Boomershine et al. 2008), has no bearing on the perceptual difficulty of its approximant Spanish equivalent [δ], which also runs contrary to the idea that equivalence classification will be less likely for/d/than for other stops simply because English has a stop-fricative contrast with coronals (Colantoni et al. 2015). It is also worth noting that scores for all three target phone contrasts were well above chance-level (0.50, given the binary same/different discrimination task structure), therefore indicating that L2 Spanish learners are in fact in the process of acquiring this perceptual contrast, but are currently at different stages in their interphonology development. Furthermore, it is likely that the English-dominant perception of [δ] and [ɣ] Spanish allophones are still constrained by some degree of equivalence classification with their voiced stop counterparts in English, in line with Flege (1987) findings regarding English-French bilinguals' production of "similar" sounds.

If we focus on the English-dominant group in this study, which consisted entirely of L1 English-speaking learners of L2 Spanish, we can draw some interesting comparisons to prior L2 Spanish learner perception research. For example, the findings of the present study somewhat align with Kissling (2015), in which a 0.62 pre-test average perceptual accuracy rate for the [ɣ]/[g] contrast was reported, and the present study reports a remarkably similar perceptual accuracy of 0.69 on the same contrast. However, this study's results do deviate from Kissling (2015) for the other two phonetic contrasts: Kissling reported a 0.62 accuracy rate on the [δ]/[d] contrast, compared to a 0.80 accuracy rate in the present study, and also reported a surprisingly low accuracy rate of only 0.48 on the [β]/[b] contrast. This means that the [β]/[b] contrast presented the greatest perceptual difficulty among L2 Spanish learners in Kissling's study. The present study, however, reports that the [β]/[b] contrast was in fact the easiest contrast to perceive, with an average perceptual accuracy rate of 0.91 for this contrast among English-dominant listeners. Therefore, further research on the L2 perception of the [β]/[b] phonetic contrast is needed. Nonetheless, the results of the present study suggest that the further back the place of articulation of 'similar' contrast, the more difficult it is to perceive it. This might be because the visual cues are degraded as sounds are produced further in the back of the oral cavity. The more salient visual cues to the place of articulation of the [β] may have promoted the establishment of a new category for this sound in comparison with the other two approximant sounds whose visual cues are not as salient. Hazan et al. (2006) found that L2 learners are sensitive to visual cues when identifying target language phonemic contrasts, such that increasing auditory proficiency is linked to increasing proficiency in using visual cues. This suggests that, although the perceptual stimuli for this study's discrimination task were only auditory, with no visual cue provided, the visual cue encoded in the place of articulation may still modulate perception of the isolated aural stimuli. It might also be the case that the learners may map [β] to its English equivalent [w] and [δ] to [ð] and are able to better discriminate between these sounds and their stop counterparts than [ɣ] and [g] because the approximant [ɣ] is mapped on to [g]. In other words, learners are better able to discriminate between two sounds if these sounds map on to two different sounds in their L1, as suggested by the Perceptual Assimilation Model (PAM) (Best and Tyler 2007).

With regards to other learner variables, it is worth noting that course level (Year 1, Year 2, Year 3) in the Spanish program did not correlate with perceptual accuracy: Year 1 learners showed an overall perceptual accuracy of 0.81, Year 2 learners showed a 0.90 accuracy rate, and Year 3 learners' perceptual accuracy was only 0.82, meaning that the most advanced-level learners in the study demonstrated nearly identical perceptual accuracy to the novice-level learners. Therefore, language dominance proved to be a much more reliable predictor of perceptual accuracy than language course level. The present study effectively collapses the combined effect of history, use, proficiency, and attitudes into one concise score (language dominance) to determine correlation with perception. In doing so, this study contributes to the understanding of how the perception of similar phones may change as a function of varying degrees of language dominance and not only as a function of varying degrees of proficiency and experience, as previously studied (Bohn and Flege 1990; Aoyama and Flege 2011; Kissling 2015). Integrating a robust, quantifiable measure of language dominance as a grouping or predictive factor presents the opportunity to examine an individual's dynamic linguistic profile through time. Even though this is not a longitudinal study, bilingual language dominance as assessed with the BLP questionnaire necessarily accommodates to changing experience, proficiency, use, and attitudes such that if we were to test the same individuals again, we would likely find different dominance results as the balance between both languages changes through time. Further research should therefore pursue a longitudinal design, tracking how dominance changes, and in what specific domains (history, use, proficiency, and attitudes), and examine how changing dominance variably affects perception abilities.

The pedagogical implications of this study are also noteworthy as the study findings indicate which similar phones present the most perceptual difficulty (namely, [ɣ]/[g] and [ð]/[d]) and therefore should be the focus of explicit phonetic instruction for adult Spanish learners in the university classroom context. Perceptual accuracy scores steadily increased from Block 1 to Block 6 across all three dominance groups, indicating that there was a training effect. Even though this training effect could be considered a limitation for this study, it is likewise an encouraging finding because it suggests that L2 learners can, in fact, become more sensitive to small phonetic differences when their attention is directed to these differences and when these differences are repeated in succession. González-Bueno (2019) notes that the teaching of approximant allophones in Spanish is challenging, precisely because they are allophones and not phonemes, meaning that the replacement of one by the other does not change the meaning of words (e.g., *[de.do] and [de.ðo], "finger", mean the same thing). Despite their allophonic status, the explicit teaching of when and how to produce approximants in Spanish is important for many L2 learners who wish to acquire native-like pronunciation since, as Elliott (1997) notes, [β, ð, ɣ] are sounds that significantly contribute to the perception of a foreign accent by native speakers of Spanish. Moreover, numerous studies (e.g., Kissling 2015; Lord 2010; Elliott 1995) demonstrate the validity and effectiveness of phonetic training for adult L2 learners, although there is some evidence to the contrary (e.g., Díaz-Campos 2004). Rao (2019) argues that pronunciation is a skill that takes time and therefore its teaching should begin early on and is beneficial at all levels of instruction. Furthermore, perceptional training should be prioritized since accurate speech perception is a fundamental component of listening comprehension (Rafat and Perry 2019).

A limitation of the present study is with regards to the nature of self-reports as an objective measure of individual linguistic reality. Namely, idealization in self-reports, particularly with regards to proficiency, use, and attitudes, may limit the validity of a self-reported dominance score as a predictive measure of perceptual accuracy. Individuals may over- or under-estimate their proficiency in a language or how often they actually use the language in daily life, and they may also idealize their attitudes about and identification with the target language community based on what they think they should feel and not how they actually feel. A further limitation of this study is the small group size for L1 Spanish participants as well as the broad range (0–15 years) in LORs of this group. Research in language experience, as previously discussed in Section 1.3, indicates that increasing LORs can affect perception and production skills in L2 and may lead to attrition in L1. Therefore, future research should both expand the sample size of the Spanish L1 group as well as limit the L1 Spanish participants to a shorter LOR.

5. Conclusions

The results of this study demonstrate that discrimination of similar phones, namely Spanish approximants and their voiced stop equivalents, is still difficult for adult L2 learners of Spanish, particularly those phonetic contrasts whose visual cue is less salient (i.e., [ð]/[d] and [ɣ]/[g]). Results further provide insight into how the ability to discriminate similar phones changes as a function of an individual's language dominance. The current study therefore offers evidence that language dominance is, in fact, correlated with perceptual accuracy of similar phones in English and Spanish. Furthermore, the findings show that perceptual accuracy depends on the specific phonetic contrast, indicating that certain similar phone contrasts may be inherently more perceptible (e.g., due to encoded visual cues) or acquired earlier than others. Future research should pursue a longitudinal study of how the perception of these particular contrasts changes with increased Spanish dominance in adult L2 Spanish learners. The inadvertent training effect observed in this study demonstrates the validity and relevance of phonetic training for adult language learners. Future research should therefore pursue a pedagogical application of these findings to determine which method(s) of instruction are most effective for increasing perceptual accuracy among adult learners of Spanish.

Author Contributions: Conceptualization, M.B.; methodology, M.B. and M.F.J.; formal analysis, M.B.; investigation, M.B.; data curation, M.B.; writing—original draft preparation, M.B.; writing—review and editing, M.B., Y.R., and M.F.J.; supervision, Y.R.; project administration, M.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: We would like to acknowledge and thank Ana García-Allén, Spanish Coordinator and Undergraduate Chair of the Department of Modern Languages and Literatures of Western University, and the undergraduate Spanish instructors and TAs for their support in participant recruitment among undergraduate Spanish students.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Trial 1

1.	[eβu]	[ebu]	AX target
2.	[ebo]	[eβo]	AX target
3.	[abo]	[abo]	XX distractor
4.	[ra]	[sa]	AX distractor
5.	[aðo]	[ado]	AX target
6.	[la]	[ba]	AX distractor
7.	[aβo]	[aβo]	XX distractor
8.	[eɣu]	[egu]	AX target
9.	[iðo]	[iðo]	XX distractor
10.	[egu]	[eɣu]	AX target

Trial 2

1.	[ibo]	[ibo]	XX distractor
2.	[ago]	[aɣo]	AX target
3.	[eɣo]	[ego]	AX target
4.	[iɣo]	[igo]	AX target
5.	[eðo]	[edo]	AX target
6.	[aβa]	[aβa]	XX distractor
7.	[ti]	[mi]	AX distractor
8.	[aðo]	[aðo]	XX distractor
9.	[eβo]	[ebo]	AX target
10.	[bi]	[li]	AX distractor

Trial 3

1.	[ada]	[ada]	XX distractor
2.	[aða]	[ada]	AX target
3.	[igo]	[igo]	XX distractor
4.	[aɣa]	[aga]	AX target
5.	[pa]	[ra]	AX distractor
6.	[abo]	[aβo]	AX target
7.	[ni]	[ki]	AX distractor
8.	[iβo]	[iβo]	XX distractor
9.	[aβo]	[abo]	AX target
10.	[ebu]	[eβu]	AX target

Trial 4

1.	[aða]	[aða]	XX distractor
2.	[aga]	[aɣa]	AX target
3.	[aɣo]	[ago]	AX target
4.	[iðo]	[ido]	AX target
5.	[ido]	[ido]	XX distractor
6.	[ido]	[iðo]	AX target
7.	[sa]	[ra]	AX distractor
8.	[fa]	[ta]	AX distractor
9.	[ado]	[aðo]	AX target
10.	[na]	[ka]	AX distractor

Trial 5

1.	[edo]	[eðo]	AX target
2.	[aɣa]	[aɣa]	XX distractor
3.	[igo]	[iɣo]	AX target
4.	[ibo]	[iβo]	AX target
5.	[ba]	[la]	AX distractor
6.	[ta]	[ma]	AX distractor
7.	[ado]	[ado]	XX distractor
8.	[ri]	[si]	AX distractor
9.	[eðu]	[edu]	AX target
10.	[iβo]	[ibo]	AX target

Trial 6

1.	[ma]	[ta]	AX distractor
2.	[aba]	[aβa]	AX target
3.	[pi]	[ri]	AX distractor
4.	[ada]	[aða]	AX target
5.	[edu]	[eðu]	AX target
6.	[fi]	[ti]	AX distractor
7.	[aga]	[aga]	XX distractor
8.	[aba]	[aba]	XX distractor
9.	[ego]	[eɣo]	AX target
10.	[aβa]	[aba]	AX target

Figure A1. Perceptual stimuli randomized per trail.

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