

CONTEXT OF LEARNING IN THE ACQUISITION OF SPANISH SECOND LANGUAGE PHONOLOGY

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Studies in SLA have debated the importance of context of learning in the process of developing linguistic skills in a second language (L2). The present paper examines whether study abroad, as it provides opportunities for authentic L2 context, facilitates the acquisition of Spanish phonology. The corpus of this investigation is composed of speech samples from 46 students of Spanish: 26 studying abroad in Spain and 20 in a regular classroom environment in the United States. The students read a paragraph with 60 target words including segments such as word-initial stops (i.e., [p t k]),¹ intervocalic fricatives (i.e., [β ð ʒ]), word-final laterals (i.e., [l]), and palatal nasals (i.e., [ɲ]). The findings reveal the following patterns for both regular classroom and study abroad students across time: (a) similar gain in the case of voiced initial stops and word-final laterals, (b) lack of gain in the case of intervocalic fricatives, and (c) high levels of accuracy in the case of the palatal nasal in the pretest. Concerning the external data, the following factor groups predicted phonological gain among all learners: years of formal language instruction, reported use of Spanish before the semester, reported use of Spanish outside the class-

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room during the semester (days), reported use of Spanish outside the classroom during the semester (hours), gender, entrance Oral Proficiency Interview, exit Oral Proficiency Interview, and level at which formal instruction began.

Studies in second language (L2) learning have begun to examine the role played by context of learning in the acquisition of linguistic skills (Armstrong, 1981; Brecht, 1993a, 1993b; Brecht, Davidson, & Ginsberg, 1995; Freed, 1995; Lafford, 1995; Lapkin, Hart, & Swain, 1995). Freed noted that studies examining L2 learning in study abroad (SA) contexts suggest a positive outcome for experience in the target culture. However, she also underlined the lack of consensus due to contradictory evidence.² A positive outcome generally means achieving higher levels of proficiency defined by standard measurements of oral production such as the Oral Proficiency Interview (OPI) or listening tests developed by Educational Testing Services. For instance, in a study of a program in Mexico, Armstrong maintained that learners showed a better overall performance and a more positive attitude toward Hispanic language and culture:

Gains were sufficient enough that 62 out of 71 respondents to the follow-up study were able to report their placement in advanced levels of college Spanish. The remaining nine had begun at the intermediate level. . . . Life in the target culture assures meaningful practice and serves to reinforce the learning that takes place in the academic setting. (p. 86)

These findings reinforce the belief that the only way to improve L2 proficiency is to live in a place where the L2 is spoken.

Recent research (Lord, 2000; Simões, 1996) has presented an incomplete picture about the benefits of the SA context on L2 phonology. This investigation fills that gap by examining the acquisition of segmental features (i.e., word-initial stops [p t k]; intervocalic fricatives [ð j ʃ]; word-final laterals [l], and palatal nasals [ɲ]) in a more extensive oral corpus to determine the impact of context of learning—L2 learning in a SA program versus studying in regular classrooms in an “at home” institutional setting (AH)—on L2 phonology.

CONSONANTAL PHENOMENA: AN OVERVIEW

A comparison of the consonantal segments of Spanish and English highlights potential areas of difficulty for native speakers (NSs) of English (cf. Tables 1 and 2). Some of the most common phenomena that are stressed by textbooks for teaching Spanish pronunciation are: the aspiration of voiceless stops, voiced intervocalic fricatives, the velarization of word-final [l], and the palatal nasal (Barrutia & Schwegler, 1994; Barrutia & Terrell, 1982; Dalbor, 1997; Hammond, 2001; Navarro-Tomás, 1967; Quilis & Fernández, 1979; Teschner, 2000).

Table 1. Spanish consonantal sounds

	Bilabial		Labiodental		Dental		Interdental		Alveolar		Palatal		Velar		
	-	+	-	+	-	+	-	+	-	+	-	+	-	+	
Stop	p	b			t	d								k	g
Affricate											tʃ	ʃ			
Fricative		β	f				θ	ð	s	z		j	x	ɣ	
Nasal		m		ɱ		ɲ		ɲ		n		ɲ		ŋ	
Lateral						ɭ		ɭ		l		ʎ			
Trill										r					
Flap										ɾ					

Spanish voiceless stops ([p t k]) are the first potentially problematic group. English speakers tend to produce word-initial voiceless stops with an increase of airflow or aspiration. In Spanish *papá* “father,” a native English speaker may pronounce the word-initial [p] as [p^h]. According to Harris (1969), voiced fricatives are allophones of voiced stops ([b d g]), which become fricatives by spirantization. Voiced stops occur after a nasal or pause, whereas voiced fricatives [β ð j ɣ] occur in all other contexts, and they are especially frequent in intervocalic position.³ The voiced fricatives [β j ɣ] are not present in the English inventory. English NSs have [ð] in their inventory, but they need to learn to produce it in the appropriate context. Furthermore, American English speakers should suppress the production of a flaplike variant in intervocalic position. In English, orthographic “t,” “tt,” “d,” and “dd” tend to be pronounced as a flaplike variant in intervocalic position, and this phonological process is transferred to Spanish. Spanish [ɭ] is a lateral voiced alveolar, undergoing assimilation in syllable-final position followed by a dental (e.g., *caldo* “soup”), an

Table 2. English consonantal sounds

	Bilabial		Labiodental		Interdental		Alveolar		Palatal		Velar		Glottal	
	-	+	-	+	-	+	-	+	-	+	-	+	-	+
Stop	p	b					t	d			k	g		
Affricate									tʃ	ɟʃ				
Fricative			f	v	θ	ð	s	z	ʃ	ʒ			h	
Nasal		m						n				ŋ		
Lateral												ɭ		
Trill														
Flap								r						
Approximant								l	ɹ					
Glide		w									j			

interdental (as in *dulce* “candy” in Peninsular Spanish), or a palatal (e.g., *colchón* “mattress”). English NS learners of Spanish often pronounce word-final [l] by retracting the tongue root toward the velum (i.e., the dark [ɫ]). Spanish [ɲ] is a nasal voiced palatal. In syllable-initial position the palatal nasal contrasts with the bilabial nasal (i.e., [m]) and the alveolar nasal (i.e., [n]) as in *mama* “breast,” *mana* “flow,” and *maña* “habit.” In syllable-final position, nasals do not contrast and they assimilate the point of articulation of the following consonant (e.g., *ambos* [ambos] “both”; *pongo* [pongo] “I put”). English does not have a palatal phone, which causes potential problems in Spanish.

BACKGROUND

Few studies have examined phonological acquisition in an L2 and its relationship to context of learning. After surveying well-known databases in linguistics, SLA, and the humanities, I found only two studies (Lord, 2000; Simões, 1996) in which certain aspects of L2 phonology are analyzed using limited corpora. It nevertheless would be expected that students spending a certain amount of time in a target language country would be more likely to introduce nativelike features in their speech.

The literature analyzing the acquisition of L2 phonology comprises general surveys and anthologies as well as empirical research exploring diverse factors and theoretical issues (Archibald, 1998a, 1998b; Bongaerts, van Summeren, Planken, & Schils, 1997; Flege & Eefting, 1988; González-Bueno, 1997; Leather, 1999; Lord, 2000, 2002; Major, 1998; Moyer, 1999; Piske, MacKay, & Flege, 2001; Simões, 1996). The most important findings within different perspectives are presented to place the subject matter of the present investigation in context.

Generative Approaches to L2 Phonology

Traditional Linear Approaches. Formal theoretical models help to describe patterns of SLA (see Leather, 1999). The term *traditional linear approaches* refers to research based on Chomsky and Halle’s (1968) model of phonological analysis. In this model, phonological representation consists of a horizontal sequence of segments, with each segment specified as a set of features. According to Leather, Michaels (1974) is a good example of traditional generative approach in L2 learning. Michaels used markedness to explain why NSs of Spanish tend to substitute the velar nasal [ŋ] for [n] and the palatal fricative [ʃ] for the palatal affricate [tʃ] in English. Following the principles of traditional linear and nonlinear generative models, SLA scholars have concentrated on rules that speakers formulate on the basis of L2 input. Such generative rule-based accounts explain connections between underlying and surface representations.

Natural Phonology. According to Leather (1999), studies focusing on universal constraints in SLA have benefited from theoretical proposals of natural phonology (Stampe, 1979), which considers human speech capacity. Explanations of L2 phonological acquisition concentrate on the simplification of articulatory effort and reattunement of perceptual distinctions. Natural phonology assumes that children possess universal or innate phonological processes conditioned by the input they receive, such as deletion of unstressed syllables, simplification of consonant clusters, and stopping of fricatives. These processes are the product of phonetic and perceptual forces that reflect unmarked (e.g., common, frequent patterns) and universal linguistic patterns. For L2 speakers, phonological processes have been suppressed, limited, or reordered during first language (L1) acquisition. L2 phonological development implies readjustments and the incorporation of new categories. For NSs of English, Spanish fricative sounds (i.e., β δ γ) would be more difficult to acquire because students would have to perceive a new phonetic category as well as to learn new articulatory specifications, some of which do not have phonemic status in English (i.e., β γ).

Lexical Phonology. Lexical phonology explains the differences found in the effect of phonological principles at the lexical and postlexical levels (see Mohanan, 1986). It distinguishes between phonological processes affecting morphology and individual phonemes. Leather (1999) pointed out that lexical phonology has been an important framework in accounting for the transfer of postlexical rules from the L1 to the L2. Yet, lexical rules may not always transfer. Following these generalizations, one can explain why aspiration of /p t k/, flapping of intervocalic /t/ and /d/, and final /l/ velarization are common in the speech of Americans learning Spanish as an L2, given that these processes are postlexical. However, phonological processes based on morphological conditioning would be difficult to find. For instance, Siegel (1974) placed English suffixes in two classes according to their effects on vowel lengthening and stress location (i.e., class I: *-ity*, *-al*, *-ous*; class II: *-ness*, *-hood*, *-ly*). Class I suffixes preserve the stress in the stem and shorten the stressed vowel, whereas class II suffixes are neutral for both the stress and vowel lengthening. This sort of morphophonological phenomenon would be unlikely to be transferred in the process of acquiring an L2.

Feature Geometry. Archibald (1998a) examined underlying representation in interlanguage phonology by reviewing evidence from Spanish, Polish, Hungarian, Korean, and Arabic. He explained L2 phonological acquisition by adopting a hierarchical representation with different levels such as segments, moras, and syllables. Learners transfer complex L1 structures and principles to the L2. For instance, he claimed that the acquisition of /l/ and /r/ by native Korean learners of English correlates with the acquisition of consonant clusters in onset position and that acquiring /l/ entails learning the contrast between /l/

and /r/. That is, the presence of onset clusters implies that of the contrast between /l/ and /r/ in the English speech of Korean NSs. The independent evidence from different languages as well as the tendencies found in the speech samples of his informants corroborates his claims.

Archibald (1998b) presented a comprehensive perspective emphasizing generative approaches to SLA including feature geometry, lexical phonology, and contrastive proposals such as the connectionist model. According to his viewpoint, generative phonology offers important insights in our understanding of nonnative phonological competence. Archibald maintained that, because phonological inventories vary across languages, learners must perceive and produce new sounds. A key factor for explaining “accented” speech is transfer. For instance, English speakers learning Spanish might pronounce the palatal nasal [ɲ] as an alveolar [n], the closest L1 match. Transfer is particularly more salient at the beginning stages of acquisition. It is important to mention that besides transfer there are other factors in the development of L2 phonology. Although it is out of the scope of the present paper to offer a detailed account of all factors, it can be pointed out that linguistic universal factors have been investigated (e.g., Archibald; Broselow, Chen, & Wang, 1998; Carlisle, 1998) to determine how L2 speakers develop their phonological system.

Regarding segmental acquisition, Archibald (1998b) maintained that transfer could account for much of SLA. Once learners perceive an L2 phonological distinction, they are likely to produce it. Yet, intrinsic aspects in the structure of the native phonology as well as universal patterns determine the process of learning to perceive and produce the target segments. Thus, the nonnative variants produced by Spanish learners can be explained by considering the English phonological system. For instance, in the cases of intervocalic /g/ as well as of the palatal nasal /ɲ/, English NSs learning Spanish tend to produce a voiced velar stop (i.e., [g]) and an alveolar voiced nasal (i.e., [n]) where NSs of Spanish produce a fricative voiced velar (i.e., [ɣ]) and palatal voiced nasal (i.e., [ɲ]). Still, it is expected that other linguistic and extralinguistic factors play a role in the development of new phonological categories (Suter, 1976).

Markedness. Another influential generative framework is that of markedness, which is defined in terms of simplicity or complexity following criteria that take into account universal frequencies. Crosslinguistically common sounds should be less difficult to acquire than uncommon ones. Specifically, Eckman (1987) examined markedness within the context of the Contrastive Analysis Hypothesis (CAH) by using the notion of the Markedness Differential Hypothesis (MDH). He claimed that the CAH can be completed by incorporating the principles of Universal Grammar to predict the directionality of difficulty in the process of SLA. In other words, linguistic universals would help to predict what segments or combination of segments would be more difficult to master for L2 speakers. Eckman provided as an example the acquisition of voiced and voiceless obstruents for native German learners of English. The contrast between voiced and voiceless obstruents in English occurs word

initially, medially, and finally. On the contrary, German only contrasts voiced and voiceless obstruents word initially and medially. In word-final position, only voiceless obstruents are produced. Eckman's model presents an implicational typology according to which languages can be classified taking into account whether the contrast between voiced and voiceless obstruents occurs in word-initial, -medial, or -final position. Following Eckman's proposal, native German speakers learning English would have difficulties acquiring voice contrast in the word-final position. The implicational scale predicts that voice contrasts in the syllable-final position would be more marked for NSs of German given that German only has such contrasts word initially and medially. In summary, Eckman suggested that the MDH is a useful theoretical construct for explaining the potential areas in which an L2 learner will face difficulties, as in the case of native German speakers of English.

Riney and Flege (1998) also used markedness to analyze foreign accent and /ɹ/-/l/ production in a group of Japanese learners of English. Riney and Flege assumed that /l/ is less marked than /ɹ/ because /l/ is more frequent in the languages of the world. Following that reasoning, they expected /l/ to be acquired more accurately than /ɹ/ on the basis of markedness. The results of the experiment revealed that even though the scores for /l/ were not statistically significant from those obtained for /ɹ/, there was a trend according to which the scores for /l/ in singletons and clusters were higher than the ones for /ɹ/.

Riney and Flege's (1998) study also examined how theories of production and perception account for changes in the English pronunciation of Japanese NSs. Particularly, they examined whether measures of production would mirror those of perception and vice versa. Riney and Flege did not find evidence to support the mirror-image model, according to which improvements in production should reflect improvements in perception. The authors based their proposal on models that posit a direct connection between perception and production (i.e., Best, 1995; Fowler, 1986; Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967; Liberman & Mattingly, 1985, 1989). Despite the mixed results obtained for the relationship between perception and production, crucial interconnections were found.

Carlisle (1998) also used the notion of markedness to study the acquisition of initial clusters in English by a group of Spanish NSs. Specifically, Carlisle examined implicational hierarchies in predicting the acquisition of /sp/, /sk/, /spr/, and /skr/. He based his research proposal on the Interlanguage Structural Conformity Hypothesis (ISCH), according to which universal generalizations that apply to primary languages also apply to interlanguages. Carlisle recorded 10 Spanish intermediate students of English using a reading instrument. He collected the data with a period of 10 months between times 1 and 2. Carlisle's results indicate that implicational universals operate in L2 speech, as marked clusters are more likely to be modified than unmarked ones. The meaning of implicational universals in the case of Carlisle's study assumes that short onsets are less marked than long ones. For instance, /sp/ and /sk/

are less marked than /spr/ and /skr/. It was predicted that speakers would be able to be more faithful to less marked onsets than marked ones. Following implicational hierarchies, he also assumed that marked onsets are not produced with a high degree of faithfulness until less marked ones are mastered. He claimed that the ISCH, which takes into account such implicational universals, correctly predicts the pattern in which speakers produce /spr/ and /skr/ with more accuracy when /sp/ and /sk/ are pronounced with a high degree of faithfulness.

An analysis of markedness within Optimality Theory was presented by Broselow et al. (1998). Optimality Theory is the most recent development in formal phonological theory (McCarthy & Prince, 1993, 1995; Prince & Smolensky, 1993). The notion of grammar within Optimality Theory consists of innate and universal constraints, which are ranked in different hierarchies depending on the language. Lower ranked constraints might be violated to satisfy higher ranked constraints. Universal constraints represent common crosslinguistic patterns (e.g., syllables must have onsets). Broselow et al. examined English syllable-coda simplification by NSs of Mandarin Chinese. They claimed that this simplification phenomenon is the result of universal markedness constraints. The inventory of codas in Mandarin Chinese only includes glides and the alveolar and velar nasals. This pattern in syllable codas in Mandarin makes the production of obstruent consonants in such position especially difficult. According to their results, Optimality Theory has more advantages than rule-based accounts given that it encompasses universal constraints that penalize, for instance, marked structures. They presented a theoretical analysis of vowel epenthesis, deletion, and devoicing. They proposed a ranking where WD BIN (i.e., words should consist of two syllables) is a low-ranked markedness constraint that becomes visible when the input violates the high-ranked constraint NO OBS CODA (i.e., syllable codas may not contain obstruents), in which case the faithfulness constraints DEP (V) (i.e., do not insert a vowel) and MAX (C) (i.e., do not delete consonants) are violated to satisfy WD BIN. In other words, Mandarin speakers insert a vowel, delete a coda stop, or devoice a voiced coda stop in English words containing stops in coda position as a strategy to transform an unlicensed syllable structure in their L1 into a licensed one. Broselow et al. maintained that the tendency to produce vowel epenthesis in monosyllabic words and devoicing in disyllabic words are both instances of the emergence of the unmarked, which are reflected in the ranking of phonological constraints. Broselow et al. considered those cases in which low-ranked constraints become visible as the emergence of the unmarked, so that speakers are able to use less complex structures in their speech as in the case where the constraint WD BIN turns out to be visible when faithfulness constraints are violated.

In the case of the sounds analyzed in this paper, the markedness framework can be used to predict some of the patterns found in L2 speech. For instance, following Eckman's (1987) proposal regarding the MDH, we can predict that Spanish voiced fricatives would be more marked than Spanish voice-

less stops for NSs of English. The implicational hierarchy would assume that the presence of voiced fricatives in Spanish would also indicate the presence of voiceless stops. Such a hierarchy would also define voiced fricatives as marked. This type of analysis is consistent with L1 acquisition data (Bernhardt & Stemberger, 1998; Jakobson, 1968; Stemberger & Bernhardt, 1999) in which voiceless stops are predicted to be acquired first.

Empirical Studies

This section discusses investigations examining the effect of internal and external factors as well as the role of classroom instruction in the acquisition of L2 phonology. Flege, Frieda, Walley, and Randazza's (1998) study is among those analyzing internal and external factors in L2 speech. They examined the effects of lexical factors such as text frequency, subject familiarity, cognate status, and concreteness⁴ as well as external factors such as age of acquisition in the production of /t/ in NSs of English and Spanish who learn English before or after the age of 21. The assumption behind this investigation is that sounds are perceived in the context of a particular word rather than as abstract units. Hence, there is the possibility that lexical factors might have an effect in L2 phonological acquisition. Based on evidence presented in L1 acquisition, Flege et al. suggested that the word could be the earliest phonological unit in L2 speakers. The results showed that none of the factors considered had an effect in the speech production of Spanish speakers. Flege et al. maintained that this finding indicates that sounds and phonological factors (i.e., vowel height and number of syllables) play an important role in L2 acquisition as proposed by L2 theoretical accounts. They suggested that one explanation for this outcome is to consider age-dependent variability in detecting phonetic differences in both languages, establishing new phonetic categories, establishing new realization rules, or adapting existing ones.

In other empirical studies, production and perception were examined. Flege and Eefting (1988) studied the imitation of voice onset time (VOT) by a group of English NSs and Spanish NSs, including monolingual and bilingual subjects. According to their hypothesis, L2 speakers who accurately produce English stops have established a separate phonetic category for these segments. They created a synthesized stimuli composed by 16-member continuum ranging from /da/ to /ta/. During each trial, the stimuli were presented twice. Subjects were then asked to listen to and imitate each one of them. The findings of the experiment indicated that bilingual speakers were able to imitate the stimuli presented distinguishing three categories from nonaspirated to aspirated variants (i.e., lead, short lag, and long lag). Flege and Eefting maintained that this result indicates that bilingual Spanish speakers who can distinguish between non-aspirated versus aspirated variants of /t/ have acquired a phonetic category [t^h] that is used when targeting aspirated /t/ in English.

González-Bueno (1997) studied the effect of producing aspirated variants of stop consonants such as /k/ in the perception of foreign accent in the speech of English NSs learning Spanish. She created 28 stimuli including 14 nonaspirated productions and 14 aspirated productions of the word *casa* “house.” Eighteen monolingual speakers of Spanish from Seville, Spain, listened to and classified the stimuli as foreign or native accented. The results indicated that stimuli perceived as native have VOT ranging from 15 to 35 ms. Because of the variation found in the perception of the NSs when VOT is manipulated, González-Bueno suggested that Spanish pronunciation instruction should consider using training activities to shorten VOT of stops to achieve more native-like values.

To investigate formal Spanish pronunciation training, Lord (2002) studied the effect of instruction in the attainment of nativelike VOT in the production of Spanish stops by NSs of English enrolled in a Spanish phonetics class. She included 17 NSs of English enrolled in a Spanish phonetics class, 10 NSs of Spanish, and a control group composed of 15 English NSs enrolled in the prerequisite course to the phonetics class. Students attending the phonetics course received a theoretical explanation of the articulation of voiceless stops. Class training also included oral and transcription practice. This traditional training was reinforced by introducing visualization and practice using phonetic computer software. The findings revealed that the experimental group shows a significant improvement at the end of the semester. Lord also found some improvement in the control group. She concluded that explicit instruction and increased input and output in the L2 are beneficial. These results are important because they suggest that students can improve in their pronunciation even in the scenario without explicit instruction.

Moyer (1999) examined the effect of age, motivation, and instruction in the L2 phonology of a group of American graduate students who speak German. Moyer’s study revealed that better performance in pronunciation is related to professional motivation. However, although university-level teaching was related to a more accurate speech production, it did not appear to be related to optimal production. Age of immersion as well as age of instruction were also related to pronunciation. Moyer found a significant correlation indicating that individuals exposed to German by instruction or immersion between 11 and 15 years of age were more likely to achieve a more native-like pronunciation.

Piske, MacKay, and Flege (2001) analyzed factors affecting the degree of foreign accent in the L2. Specifically, they examined the age of L2 learning, length of residence in an L2-speaking country, gender, formal instruction, motivation, language learning aptitude, and amount of L1 use in a group of 90 Italian NSs living in Canada. Their findings indicated that age of L2 learning and frequency of L1 use are significant predictors of degree of foreign accent. Piske et al. found that late bilinguals showed stronger foreign accent than early bilinguals and that speakers using their L1 more frequently also showed a stronger degree of foreign accent.

The age factor and its relationship to English L2 pronunciation were also examined by Bongaerts et al. (1997) among native Dutch speakers of English. They selected a group of late language learners to determine whether they can achieve nativelike performance in their pronunciation. It was found that some of the Dutch speakers were rated as having nativelike pronunciation by the English NS judges, which indicates that a late start in L2 does not necessarily limit ultimate attainment of nativelike pronunciation. They also pointed out that highly successful students⁵ are more likely to show better performance, which reveals that certain individual learner characteristics are related to ultimate attainment in L2 phonology.

Context-of-Learning Studies. There are two studies in which linguistic gain in the SA context has been observed. Simões (1996) examined fluency in a group of five adult learners of Spanish who participated in a SA program in Costa Rica for a period of 5 weeks. Simões (p. 87) defined *fluency* as the accurate pronunciation of syllable nuclei in sequences of words. The findings revealed that only two students out of five showed significant changes in their fluency. Specifically, Simões reported less production of centralized vowels (i.e., [ə]), less vowel lengthening, more use of linking across word boundaries, and fewer hesitations.

Lord (2000) studied the effects of the SA context in the production of voiced stops and their voiced fricative allophones in a group of eight intermediate learners of Spanish who participated in an 8-week SA program in Mexico. Lord divided students in two groups: Four students had not previously taken a Spanish phonetics and pronunciation class (control group), whereas the other four had taken such a course one to two semesters prior to going to Mexico (instruction group). The results showed that students did not have any problem with the production of voiced stops (i.e., [b d g]) in the pretest and posttest. Lord suggested that stop allophones seem to be the default value as a result of transferring the L1 voiced stop values. In the case of fricatives in the pretest, the average accuracy percentage in the control group was 3.3%, whereas the average accuracy percentage in the instruction group was 8.6%. In the posttest, the control group showed 5.8% accuracy, whereas the instruction group presented 28.7%. Although the participant groups were too small to perform a statistical evaluation, Lord concluded that studying abroad facilitates improvement in the production of the voiced fricatives allophones, especially in the case of the instruction group.

In summary, the literature review reveals several tendencies in the analysis of L2 phonology. Formal analysis within the generative framework shows how to explain L2 underlying and surface representations when learners establish new phonetic and phonological categories. Generative approaches also provide explanations regarding the emergence of universal trends in L2 speech favoring unmarked structures. Empirical studies indicate that factors such as age of L2 learning, age of immersion and instruction in the L2, and the frequency of L1 use are important predictors of better performance in L2 phonology. Studies also indicate that late learners can approximate nativelike

pronunciation. In these studies, highly successful learners who receive special pronunciation training are more likely to attain nativelike performance. Research examining the effects of SA in fluency and the pronunciation of voiced stops and their fricative counterparts reveals a trend of improvement that requires further investigation. The present study further investigates the role of context of learning (SA vs. AH) as well as factors such as years of formal instruction, time of recording, self-reported use of Spanish outside the classroom, and language proficiency. The aim of this investigation is to observe whether SA has an impact on L2 pronunciation.

The research questions are:

1. What is the effect of context of learning (SA vs. AH) in attaining nativelike pronunciation of consonantal segments in Spanish?
2. What other variables significantly predict nativelike pronunciation of consonantal segments in L2 speech?⁶

METHOD

Participants

The participants were American university students learning Spanish. Twenty were taking Spanish classes in the regular program at the University of Colorado, and 26 were part of a 10-week SA program in Alicante, Spain. Their ages ranged from 17 to 42, with most in their early 20s.

Instruments

The Language Contact Profile. All participants completed the Language Contact Profile (LCP; Freed, Segalowitz, Dewey, & Halter, this issue) before and after the program. This instrument gathered personal information such as age, L1, previous language-learning experiences as well as information regarding traveling, languages spoken at home, years of formal language instruction in Spanish and other languages, time spent speaking Spanish with NSs before and during the semester, and time spent reading books and newspapers and watching television in Spanish.

Read-Aloud Text. To analyze the two groups' speech, a short text was designed with 60 target words containing four types of segments. According to Major (1987):

Many speakers are able to correctly produce sounds and words in isolation, but in running speech they slip back into L1 patterns. This suggests that in formal style the speaker is able to suppress interference processes that will reappear in more casual speech. (p. 107)⁷

One would expect, given the results of previous L2 research, that in this formal task speakers are more likely to produce target sounds faithfully (nativelike pronunciation) than in more casual speech where the influence of L1 phonology is expected (Major, 1987; Tarone, 1982, 1983).⁸ Furthermore, this technique—widely used in mainstream experimental phonetics and phonology—facilitates pretreatment-posttreatment comparisons.

The target sounds included word-initial stops, intervocalic fricatives, word-final laterals, and palatal nasals. These sounds were chosen on the basis of content material included in Spanish pronunciation textbooks commonly used in American universities. The students read the text before and after the treatment, and the data were digitized.

Procedure for Coding

Statistical Analysis. Four dependent variables were included in this investigation. They represent segments that could present difficulties for American students of Spanish (Barrutia & Schwegler, 1994; Dalbor, 1997; Navarro-Tomás, 1967; Quilis & Fernandez, 1979). The first group consists of word-initial stops (i.e., [p t k] in words such as *para* “for,” *telas* “fabric,” and *compre* “buy”). The second group consists of fricatives in intervocalic position (i.e., [ð ʎ j] in such words as *todo* “all,” *pagar* “to pay,” *vaya* “go”). Word-final laterals are included in the third group (e.g., *el* “the,” *papel* “paper”), whereas palatal nasals are the fourth (e.g., *tamaño* “size”). Word-initial stops have two possible variants.⁹ Speakers of American English tend to produce aspirated stops (i.e., [p^h t^h k^h]) in cases where nonaspirated variants (i.e., [p t k]) should appear. Fricatives in intervocalic position have many possible variants. Intervocalic [ð] has three: (a) the fricative, interdental, voiced segment [ð], which is the native pronunciation in that context and coincides with the English pronunciation of “th” as in *then*; (b) the flaplike pronunciation [ɾ], which is the result of the influence of the L1 phonology; and (c) the stop, dental, voiced segment [d]. This last variant could be the result of producing the closest English matching segment of intervocalic [ð]. The voiced velar fricative [ʎ] has two variants according to what was observed in the speech samples: the native fricative variant [ʎ], and the voiced velar stop [g].

Word-final laterals can be produced in two ways. The nativelike variant is a lateral, alveolar, voiced segment [l], and the nonnative variant is a velarized lateral, voiced segment [ɫ], which is a result of the influence of the L1 phonology. The palatal nasal [ɲ] also has two variants in the corpus of the present investigation: the native voiced palatal nasal [ɲ] and the nonnative voiced alveolar nasal [n].

Ten independent variables were included in the analysis of all four dependent variables considered in the present study.

1. Time of recording: entrance, exit
2. Context of learning: SA, AH

3. Years of formal language instruction: 0–3 years, 4–6 years, 6+ years
4. Reported use of Spanish before the semester: never, few times, monthly, weekly
5. Reported use of Spanish outside the classroom (days per week): 0–3 days, 4–7 days
6. Reported use of Spanish outside the classroom (hours per day): 0–3 hours, 4+ hours
7. Entrance Oral Proficiency Interview (ACTFL): novice (-low, -mid, and -high), intermediate (-low, -mid, and -high), advanced (-low, -mid, and -high), superior
8. Exit Oral Proficiency Interview (ACTFL): novice (-low, -mid, and -high), intermediate (-low, -mid, and -high), advanced (-low, -mid, and -high), superior
9. Level at which formal instruction began: elementary school, junior high school, high school, university
10. Gender: female, male

Following Berdan (1996) and Young and Bayley (1996), a quantitative analysis of the dependent variables was included in this investigation. Berdan and Young and Bayley maintained that the quantitative model used in sociolinguistic studies is particularly useful for capturing the probabilistic nature of L2 development. All the sounds included in this study are considered as interlanguage variation phenomena, which allows examining such phenomena based on what has been proposed in the sociolinguistic literature (e.g., Cedergren & Sankoff, 1974; Labov, 1966, 1969). Berdan pointed out that quantitative sociolinguistics have developed the variable rule analysis model. Variable rules are studied by means of a logistic regression analysis that can be performed through VARBRUL and GoldVarb.¹⁰ “VARBRUL has . . . proven to be a powerful analytic device for identifying significant linguistic, social, and interactional factors that differentiate or condition probabilities associated with linguistic variables” (Berdan, p. 209).

The logistic regression analysis using VARBRUL or GoldVarb provides the probabilistic weight for each one of the factors included within each factor group,¹¹ which indicates the significant statistical contribution of each factor to dependent variable values. The maximum weight is 1.00 and the minimum 0.00. Values greater than .500 favor the application value (see Sankoff, 1998, for more statistical details regarding this software). The justification for including this statistical test is based on the idea that variability in the pronunciation of L2 speakers may be affected by different factors simultaneously, as with sociolinguistic variation in L1 speakers. In this sense, the logistic regression provides the tools for measuring the impact of the variables according to the order of selection and observes the statistical significance of a given variable (see Berdan, 1996, and Geeslin, 2002, for a description of logistic regressions and their application to SLA data).

The dependent variable must be binary because the logistic regression analysis can only be run by defining two variants for each dependent variable. Thus, all the different variants found for each one of the dependent variables were collapsed into binary categories. For instance, voiceless stops were divided into unaspirated versus aspirated, and voiced fricatives were categorized in terms of fricatives versus nonfricatives. The application value for each depen-

dent variable was the faithful or native variant (i.e., nonaspirated variants in the case of voiceless stops [p t k], fricative variants in the case of voiced fricatives [ð j ʝ], alveolar variants in the case of word-final laterals [l], and palatal variants in the case of the palatal nasal [ɲ]). The program measures the effect of the independent variables included in relation to the application value, determining which factors have a positive or negative impact on the production of natively like variants in the particular case of the present paper. In other words, the statistical analysis bases the results by taking as reference the application value, so the effect of each factor group (defined as an independent variable on the application value) is measured. The selection of the faithful variants as the application value enables us to observe the pattern of improvement in the speech of L2 speakers across time as entrance (pretest) and exit (posttest) recordings can be compared.

The first set of analyses examined the speech patterns found in AH and SA students before and after the treatment period. These analyses addressed the first research question. To analyze development across time, an interaction between the factor groups—context of learning and time of recording—was created. The four variants created for this interaction were as follows: SA students' pretest, SA students' posttest, AH students' pretest, and AH student's posttest. For each one of the four dependent variables examined in this study (i.e., word-initial voiceless stops, intervocalic voiced fricatives, word-final /l/, and the palatal nasal), the interactional factor group including context of learning and time of recording was submitted to a logistic regression analysis. As previously mentioned, this statistical test reveals the favoring or disfavoring tendencies of each factor regarding the dependent variables examined.

A second analysis of the data was performed to determine the effect of other factors in the acquisition of L2 phonology—formal language instruction, self-reported use of Spanish outside the classroom, and OPI.¹² This test addressed the second research question. All four dependent variables were collapsed in one factor group with two variants: faithful and unfaithful production. The application value selected was faithful production, so that a pattern of improvement could be observed. All 10 independent variables (i.e., factor groups in VARBRUL terminology) were submitted to a logistic regression analysis.

RESULTS

Word-Initial Voiceless Stops

The analysis of the pronunciation of word-initial stops was based on 3,652 tokens (see Table 3). All voiceless stops were collapsed into two variants: non-aspirated and aspirated. The recombination of the six variants into a binary distinction was done to run the logistic regression analysis. The nonaspirated variants represented 17% (621/3,652), whereas aspirated variants represented

Table 3. Results of the word-initial voiceless stops analysis

Factor group	Factor	No. of cases	%	Weight
Interaction between context of learning and time of recording	SA entrance	128/1,032	12	0.416
	SA exit	211/1,032	20	0.563
	AH entrance	108/794	13	0.442
	AH exit	174/794	21	0.585

Note. Input probability = 0.166 (621/3,652).

83% (3,031/3,652). These findings reveal that aspirated variants [p^h t^h k^h] were still predominant in the speech samples of both groups.

There was a trend of improvement in the pronunciation of both groups of students at the end of the period treatment. SA students disfavored nonaspirated variants at the beginning of the semester with a weight of 0.416. However, this tendency changed at the end of the semester when SA students showed a slightly favoring trend toward the pronunciation of nonaspirated variants. Recall that a weight above 0.500 favors the application value of the dependent variable, which in this case is the production of nonaspirated variants. The same pattern of linguistic behavior was found in AH students; at the end of the treatment period, a slightly favoring tendency was reached with a weight of 0.585. These findings suggest that receiving input in the L2 triggers development in both contexts.

Voiced Fricatives in Intervocalic Position [ð j ʝ]

In this section, the results regarding intervocalic [ð j ʝ] are presented. The quantitative analysis of voiced fricatives was based on 1,378 tokens. The general tendencies reveal that 13% of the cases were realized as fricatives (187/1,378), whereas 87% of the cases were realized as nonfricatives (1,191/1,378). Unfaithful pronunciation of fricative segments was predominant in the speech of these two groups of L2 speakers.

The logistic regression analysis did not select the interaction between context of learning and time of recording as a significant variable, which indicates that this interactional factor group has no effect in predicting the pattern of pronunciation found for voiced fricative segments in the corpus examined. In fact, there was little change over time if one compares the production of fricatives before and after the treatment period in both groups of students. The SA group used intervocalic voiced fricatives 10% of the time on the entrance test and 14% on the exit test; the AH group used intervocalic voiced fricatives 13% of the time on the entrance test and 16% on the exit test. Context of learning did not seem to have a significant effect in attaining a more nativelike pronunciation in the particular case

of voiced fricatives in intervocalic position. Following Flege et al. (1998) and Flege and Eefting (1988), one can suggest that the students have not established a different phonetic category for voiced fricative segments separating these from other sound types. Following Eckman's proposal (1987), one might suggest that voiced fricatives are more marked than voiceless stops, which could explain the lack of improvement in their production after the treatment period.

Word-Final [l]

A total of 368 tokens were analyzed in the case of word-final [l] (see Table 4). The general tendencies indicate that participants pronounced 28% of the tokens (104/368) using the native alveolar variant (i.e., [l]), whereas 72% of the tokens (264/368) were realized using the velar variant (i.e., [ɫ]). As in previous cases, an initial assessment of the distribution of the variants reveals that the non-native variant was predominant in the speech of these two groups of L2 speakers.

The tendencies reveal improvement in the production of word-final [l] in the speech of both groups of L2 students. Surprisingly, AH students showed a stronger result favoring the production of the faithful variant (i.e., alveolar [l]) than SA students with a weight of 0.687. At the end of the treatment period, SA students reached a borderline weight, slightly favoring the production of the faithful alveolar variant. Once again, these results suggest that in both contexts students were able to show equal linguistic gains.

Palatal Nasal

A total of 92 tokens were examined in the case of the palatal nasal. The distribution of palatal nasal variants is somewhat different from the patterns found for other sound segments. The native palatal was produced faithfully at 84% (77/92), whereas the alveolar productions represented 16% (15/92).

Table 4. Results of the word-final [l] analysis

Factor group	Factor	No. of cases	%	Weight
Interaction between context of learning and time of recording	SA entrance	22/104	21	0.419
	SA exit	33/104	31	0.555
	AH entrance	13/80	16	0.343
	AH exit	36/80	45	0.687

Note. Input probability = 0.271 (104/368).

The results of the logistic regression analysis reveal that the interaction between context of learning and time of recording was not statistically significant, as the variable rule analysis did not select it. Phonological gain in the case of the palatal nasal could not be predicted by considering the interaction of both variables. One could interpret this outcome as an indication that neither context of learning nor time of recording has an effect on the production of the nativelike palatal variant. Given that all speakers had already acquired the palatal nasal before the treatment, development across time and context were not relevant for these L2 speakers. The SA group used the palatal nasal 80% of the time on the entrance test and 73% on the exit test; the AH group used the palatal nasal 95% of the time on the entrance test and 90% on the exit test. Flege (1987, p. 63) claimed that statistical analysis of L2 speakers reveals that new phones are more likely to be produced with a higher rate of accuracy in comparison to phones with a similar counterpart in the L1. Following Flege's distinction between new and similar segmental units (p. 63), one might suggest that the palatal nasal is a new segment with a contrastive function in Spanish, which could explain the high rate of accuracy.

FACTORS AFFECTING PHONOLOGICAL ACQUISITION

The four dependent variables examined in the present paper were collapsed in a single variable with the purpose of measuring the effect of the 10 independent variables included in this study. A binary distinction between faithful and unfaithful variants was created to submit all independent variables to a logistic regression analysis. The application value selected was faithful variants. This way of organizing the analysis allowed one to observe what makes a positive impact on L2 speech. This second part of this analysis allowed an examination of not only the role played by context of learning but also other relevant factors that might have influenced L2 phonological acquisition.

A series of regression analyses were run to evaluate the impact of the 10 factor groups in the pronunciation of the four segmental variables included in this study (see Table 5). The order of selection indicates the degree of impact of a factor group selected on the dependent variable from more to less important. These significant factors were not the only ones incorporated in the logistic regression test. The original analysis also included several (insignificant) factors, such as time of recording and context of learning.

The factor group selected as the most significant is the interaction between context of learning and time of recording. These tendencies indicate a pattern of improvement in both AH and SA students. Both types of students were able to attain a more faithful pronunciation by the end of the treatment period. A surprising outcome that needs to be pointed out is that the trend of improvement is stronger in the exit recordings of AH students than in the exit recordings of SA students. One possible explanation for these findings is that within the group of AH students there might have been individuals with more years

Table 5. Results of the segmental faithfulness analysis

Factor group	Factor	No. of cases	%	Weight
Interaction between context of learning and time of recording	SA entrance	172/1,188	14	0.387
	SA exit	265/1,188	22	0.528
Years of formal language instruction	AH entrance	141/914	15	0.439
	AH exit	231/914	25	0.667
	0-3 years	315/1,916	16	0.415
	4-6 years	294/1,828	16	0.439
Reported use of Spanish before the semester	7 or more years	200/460	43	0.910
	Regularly	150/924	16	0.391
Reported use of Spanish outside the classroom during the semester (days)	Not regularly	659/3,280	20	0.531
	0-3 days	421/2,196	19	0.434
Reported use of Spanish outside the classroom during the semester (hours)	4-7 days	388/2,008	19	0.572
	0-3 hours	700/3,836	18	0.490
	4 or more hours	109/368	29	0.608
Gender	Female	678/2,926	23	0.610
	Male	131/1,278	10	0.264
Entrance OPI	Novice	40/636	6	0.232
	Intermediate and advanced-low	769/3,568	21	0.553
Exit OPI	Novice	14/368	3	0.065
	Intermediate and advanced-low	795/3,836	20	0.563
Level at which formal instruction began	Elementary school	120/460	26	0.667
	Junior high school	220/1,470	14	0.386
	High school	375/1,554	24	0.548
	University	94/720	13	0.523

Note. Input probability = 0.137 (809/4,204). Sample sizes per factor are enclosed in parentheses.

of formal instruction as well as individuals who began studying Spanish at an earlier stage. This is precisely what Díaz-Campos et al. (2002) and Díaz-Campos and Lazar (2003) found in an analysis of the word-initial voiceless stops using the same data. Overall, they found that students with 7 or more years of language instruction show a more nativelike pronunciation of word-initial voiceless fricatives. The second factor group selected was years of formal language instruction. Production of nativelike variants was favored by students with 7 or more years of language instruction with a very strong weight of 0.910, whereas students with 6 or fewer years of formal instruction did not favor the production of faithful variants. These results suggest that formal instruction can have an impact in attaining a nativelike pronunciation after a long period of time. The third factor in the hierarchy was reported use of Spanish before the semester. In this particular case, the results showed a pattern according to which students reporting nonregular use of the L2 before the semester show a borderline effect, whereas students reporting regular use of Spanish before the semester disfavored faithful pronunciation. Before providing a conclusive statement regarding this factor, it would be important to observe by means of other instruments whether this pattern is confirmed.

The fourth most important factor group was reported use of Spanish outside the classroom during the semester (days). The tendencies found in this case were more consistent with the pattern expected. Students who reported using Spanish from 4 to 7 days per week slightly favored the production of more nativelike variants, whereas students who reported using Spanish from 0 to 3 days per week disfavored the production of faithful variants. This result is consistent with what one might anticipate regarding the benefits of using the L2 outside the classroom. In particular, the data suggest a trend of improvement in L2 pronunciation. Consistent with the results for the previous factor group, the next factor in the hierarchy was reported use of Spanish outside the classroom during the semester (hours). In this particular case, the quantitative analysis shows strong tendencies according to which students reporting use of Spanish outside the classroom for 4 hours or more per week highly favored the production of faithful variants, whereas students using Spanish for 0–3 hours per week did not favor nativelike pronunciation. Because of the inconsistency found in the information regarding self-reported use of Spanish before the semester, I suggest that future research should address the problems related to the definition of these types of variables. It is possible that an analysis examining their statistical interaction could provide a solution. However, such an enterprise is out of the scope of the present paper. The sixth factor selected by the logistic regression analysis was gender. The findings indicate that female students favored nativelike pronunciation with a weight of 0.610, whereas male students disfavored it with a weight of 0.264. According to these results, one might speculate that these patterns of linguistic behavior resemble what has been observed in the sociolinguistic literature examining women's speech: Female students are more careful in producing the target segments, which can be interpreted as a conservative tendency (see Labov,

1972; Silva-Corvalán, 1989, 2001; Wodak & Benke, 1998, for further discussion of women's sociolinguistic behavior).

The entrance OPI was the next most important factor. Intermediate and advanced-low proficiency level students slightly favored a more nativelike pronunciation, whereas novice learners disfavored it. These findings suggest that higher OPI ratings are also reflected at the segmental level. The eighth factor group selected was exit OPI. Once again, the results reveal that intermediate and advanced-low students slightly favored the production of more nativelike variants, whereas novice students disfavored them. This is a very important outcome because the OPI ratings reflect the pattern of improvement in the speech of this group of L2 speakers at the end of the treatment period. Level at which formal instruction began was the last factor selected by the logistic regression analysis. The tendencies found reveal that students who began their formal instruction at the elementary level favored the production of faithful variants. Contrary to what one might anticipate, subjects who began their studies at the junior high level did not favor nativelike pronunciation, whereas individuals who began studying Spanish at the high school and university levels presented borderline results slightly favoring the production of faithful variants. Several factors could explain this outcome. However, further research will have to address this issue as focusing on this specific factor is outside the scope of this paper. Regarding the effect of beginning L2 instruction at the elementary school level in attaining a more nativelike pronunciation, the results reflect the tendencies found in previous studies that showed age of L2 learning as an important factor (Moyer, 1999; Piske et al., 2001).

CONCLUSION

What is the effect of context of learning (SA vs. AH) in attaining nativelike pronunciation of consonantal segments in Spanish? The results reveal that the production of word-initial stops and word-final laterals by both groups improves over time. The palatal nasal is produced faithfully in 84% of the cases before and after the treatment period. Still, the pronunciation of voiced fricatives does not show a pattern of development, which suggests that fricatives are difficult to acquire. Following formal generative approaches, fricatives may be more marked and therefore difficult to acquire. The initial motivation to examine these consonantal phenomena came from textbook descriptions that point out possible differences and areas of difficulty for nonnative speakers of Spanish. Even though the phenomena selected was a good point of departure, the results suggest that there might be other aspects in the development of an L2 phonological system that could be included to study the impact of context of learning in attaining nativelike pronunciation.

In summary, the findings reveal three different patterns for both SA and AH students: (a) equal gains in the case of voiceless stops and word-initial laterals, (b) a lack of gain in the case of intervocalic voiced fricatives, and

(c) high levels of accuracy in the production of the palatal nasal at the time of the pretest. These results are slightly puzzling in that they do not reveal striking differences between SA and AH students. What aspects of the phonology of an L2 speaker can benefit by participating in a SA program? Future studies will have to explore other segmental aspects, such as vowels and diphthongs, as well as suprasegmental phenomena, such as lexical stress and intonation, to determine what areas of the L2 phonology benefit from participating in a SA program.

The quantitative analysis also reveals that other important independent variables play a role in L2 pronunciation. Specifically, the following eight factor groups were found to be statistically significant: years of formal language instruction, reported use of Spanish before the semester, reported use of Spanish outside the classroom during the semester (days), reported use of Spanish outside the classroom during the semester (hours), gender, entrance OPI, exit OPI, and level at which formal instruction began.

NOTES

1. Throughout the article a phonetic representation of all sounds following the International Phonetic Alphabet (IPA) is presented. Phonetic (instead of phonological) representations avoid making assumptions about underlying L2 representations.

2. Freed (1995, p. 8) summarized the findings of the previous literature as follows:

What emerges from these studies is a somewhat contradictory picture of the linguistic benefits to be gained from an in-country language learning experience. The role of instruction, its comparison to and/or interaction with naturalistic SLA has been a dominant and much debated issue in SLA studies. Ellis has summarized this literature (1994, pp. 611–663) and concludes that “there is support for the claim that formal instruction helps learners to develop greater L2 proficiency, particularly if it is linked with opportunities for natural exposure (1994, p. 616). At the same time, he suggests caution in interpreting the many conflicting studies.

3. The /d/ is also a voiced stop (i.e., [d]) after a lateral (e.g., falda [faɫda] “skirt”).

4. Concreteness distinguishes mental images (e.g., *table*) and abstract concepts (e.g., *intelligence*).

5. Bongaerts et al. (1997) defined *highly successful* in terms of the nativelike abilities of some learners who do not have foreign accent and who show an easy and accelerated process of language acquisition. According to Bongaerts et al. (p. 451):

Subjects may owe their phenomenal language learning success to two factors that distinguish them from the “normal” population of language learners: an exceptional brain organization for language, evidenced by the use of a greater amount of cortex for language processing and by being less left lateralized for language. . . .

6. The term *variable* refers to the linguistic phenomena examined (dependent variables) and the possible factors (independent variables) that influence the dependent variable. It is assumed that dependent variable variants of a given phoneme have the same phonological value.

7. Style is out of the scope of the present paper, and future research should address potential differences between SA and AH students in formal and casual speech.

8. “Faithful” indicates that the learner produced a nativelike Spanish variant.

9. The variants for all phones were strictly analyzed according to realizations found in the production of the speakers. For example, in the case of the palatal nasal, only two variants were found in the pronunciation of the groups of speakers analyzed (i.e., [ɲ] and [ɲ̟]).

10. Young and Bayley (1996, p. 18) explained:

Modeling interlanguage variation can be carried out by a number of commercial statistical software packages, usually under the name of logistic regression. . . . However, in linguistics, the programs known as VARBRUL have been used most extensively because they have been deliberately designed to handle the kind of data obtained in studies of variation. They also provide heuristic tools that allow the investigator to modify his or her hypotheses and reanalyze the data easily. . . . The most widely available versions are GoldVarb for the Macintosh (Rand & Sankoff, 1990) and VARBRUL (Pintzuk, 1988) for DOS computers.

11. A factor group consists of the variants in a given linguistic and extralinguistic variable. For example, the context of learning variable consists of two variants—SA and AH students.
12. A certified tester administered the OPI in all cases.

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Learning Context Effects on the Perception of Phonemic Contrasts by Bilingual Spanish/Catalan Learners of English

The present paper reports on the results of a perception test (a minimal pair auditory discrimination task) devised to investigate the effect of two learning contexts on the ability of bilingual Spanish/Catalan advanced learners of English to perceive L2 phonemic contrasts. The subjects were tested at three times: before and after a 100 hours of formal instruction (FI) at their university (T1 and T2, respectively) and after a three-month stay-abroad term (SA) in an English speaking country (T3). The results reveal an overall significant effect of the FI and SA periods on the learners' perceptual ability to discriminate between phonemic contrasts, but such gains in perceptual ability were only statistically significant between T1 and T2, suggesting that the FI period had a greater effect on the learners' perceptual phonological competence than the SA term.

1. Introduction

Models of second language (L2) phonological acquisition¹, irrespective of their different assumptions, predictions, methods and the aspect of interlanguage phonology they focus on, represent different attempts at explaining native language (L1) phonological transfer effects on learners' interlanguage phonology by attributing L1 phonological interference to a structural mismatch between L1 and L2 categories at the phonetic, phonological or featural level of representation. A common assumption underlying these models is that the process of acquisition of a second language phonology does not only involve learning to pronounce new sounds, the foreign learner must also acquire the correct mapping between phonetic and phonemic categories in the L2, a type of knowledge that cannot be gained unless the learner is capable of perceiving the distinctive phonological features that the L2 exploits to convey differences in meaning.

The formation of phonological categories in a learner's L2 phonology is largely dependent on his/her capacity to accurately perceive (and produce) non-native sound contrasts. The successful development of this perceptual ability through time has been shown (e.g. Brown 2000) to be essentially constrained by the learner's first language (L1) phonological system, which filters out phonetic differences between L1 and L2 sounds that are not phonologically contrastive in the L1 so that non-native phonemic

contrasts are perceived through L1 phonemic categories. As argued by Flege in his Speech Learning Model, the successful formation of a phonemic category for L2 sounds depends on the perceived phonetic distance between L1 and L2 sounds (e.g. Flege and MacKay 2004).

The present paper reports on the results of a perception test designed to investigate the effect of two learning contexts on the ability of bilingual Spanish/Catalan advanced learners of English to perceive phonemic contrasts in minimal pairs. The two contexts of learning from which the data for this study were collected are (1) a six-month period of 100 hours of formal instruction (FI) in an at-home context, and (2) a three-month stay-abroad (SA) period which also included 100 hours of formal instruction. The study reported on here is part of a larger project (VALAL) that investigates SA effects on the process of acquisition of English as a foreign language at an advanced stage by measuring learners' linguistic competence at three different times (before and after FI and SA periods)². The learners' phonological competence is explored by means of two production tasks aimed at producing a number of phonetic/phonological accuracy and fluency measures (e.g. VOT, vowel reduction, linking phenomena): a reading aloud task (a 150-word passage) and a sentence repetition task; and two perception tasks consisting of two auditory discrimination tests: one on word stress and the other one, which is reported on here, on phonemic contrasts.

2. Method

The subjects taking part in the study were 25 European exchange undergraduate students at Universitat Pompeu Fabra (UPF) in Barcelona reading for a degree in Translation and Interpreting. All of them were advanced EFL students and Catalan/Spanish bilingual speakers. The data were collected at three times: upon student enrolment at the UPF (T1), after 100 hours of formal instruction at the UPF (two three-month terms) and prior to a three-month SA period (T2), and after the SA term in an English-speaking country (mostly at British universities) during which the subjects also received about 100 hours of formal instruction in English (T3)..

In order to investigate the effect of an FI and an SA period on the perception of English phonemic contrasts, an AX auditory discrimination test with 135 word pairs expressing 9 different phonemic contrasts by means of minimal pairs (MPADT) was

devised (see Appendix). The words constituting the aural stimuli for the perception test were read by a native speaker of British English in a soundproof booth and were digitally recorded. The word-pairs were read on a falling tone from the screen of a laptop computer as they appeared on Microsoft Powerpoint slides at regular intervals of one second between members of a word pair and three seconds between word pairs.

The test contained 108 minimal pairs and 27 same-word pairs (20% of the total) consisting of two realizations of the same word that functioned as distractors. The target phonemes in the minimal pairs appeared in alternating order (e.g. /fi:t/-/fit/; /sɪt/-/sit/; /rɪdʒ/-/ritʃ/; /tʃest/-/dʒest/), in a variety of phonetic environments, and the 15 word pairs per phonemic contrast (135 word pairs) were presented in randomized order.

The 9 phonemic contrasts on which the advanced EFL students were tested for degree of perceptual phonetic/phonological competence were chosen due to their relative difficulty for Spanish/Catalan bilinguals (see Table 2 below). Both Spanish and Catalan lack a tense-lax distinction for high vowels (/i:/-/ɪ/), since they both have the phoneme /i/ in this area of the vowel space. A front-back distinction for open vowels (/æ/-/ʌ/-/ɑ:/) is also lacking in Spanish and Catalan, whose only open vowel is a relatively front /a/. The phonemic contrasts 4 and 5 were selected on the basis of their acoustic similarity. Besides, whereas Catalan has /ə/ in unstressed syllables as a process of vowel reduction affecting the vowels /e/, /ɛ/ and /a/, Spanish lacks a schwa-like vowel. Neither Catalan nor Spanish, however, have falling diphthongs ending in a non-high vocalic element³. As far as consonantal contrasts are concerned, we examined three contrasts based on voicing: /t/-/d/ and /s/-/z/ were examined in word-final position only because Spanish and Catalan have no voiced obstruents in word-final position at the phonetic level, whereas /tʃ/-/dʒ/ was examined word-initially and word-finally. The contrast /d/-/ð/ was chosen because of the structural mismatch between the phonetic and phonological categories these sounds belong to in Spanish and Catalan: Spanish/Catalan speakers often realize the English voiced dental fricative as the Spanish/Catalan spirantized (approximant) realization of the voiced dentalveolar phoneme /d/ at the phonetic level, which causes its categorization at the phonemic level as /d/.

Phonemic Contrasts		Example	Word Pairs			
			Minimal Pairs	Distractors	Total	
1	/i:/-/ɪ/	tense vs. lax	<i>feet – fit</i>	12	3	15
2	/æ/-/ʌ/	front vs. central	<i>began – begun</i>	12	3	15
3	/æ/-/ɑ:/	front vs. back	<i>back – bark</i>	12	3	15
4	/ɪ/-/ə/	close front vs. central	<i>illusion – allusion</i>	12	3	15
5	/e/-/eə/	front mid vs. centring diphthong	<i>belly – barely</i>	12	3	15
6	/t/-/d/	voiceless vs. voiced (word final)	<i>card – cart</i>	12	3	15
7	/s/-/z/		<i>loose – lose</i>	12	3	15
8	/tʃ/-/dʒ/		<i>choke – joke</i>	12	3	15
9	/d/-/ð/	alveolar plosive vs. dental fricative	<i>breathing – breeding</i>	12	3	15
Total				108	27	135

Table 2: Distribution of item types according to phonemic contrast

The auditory discrimination test containing 135 word pairs was presented aurally over headphones and administered in a language lab. The instructions for the test and 6 preliminary examples were presented to the subjects in written form as well as aurally over headphones to make sure they understood the task.

MPADT: AX Discrimination Task					
Aural Stimuli: vowel and consonant contrasts				Answersheet	
1.	[sɪt] seat	← 1 sec. →	[sɪt] sit	1. S	<input type="checkbox"/> D <input checked="" type="checkbox"/>
2.	[fɪt] feet	← 1 sec. →	[fɪt] feet	2. S	<input checked="" type="checkbox"/> D <input type="checkbox"/>
3.	[rɪtʃ] rich	← 1 sec. →	[rɪdʒ] ridge	3. S	<input type="checkbox"/> D <input checked="" type="checkbox"/>
4.	[tʃeɪn] chain	← 1 sec. →	[tʃeɪn] chain	4. S	<input checked="" type="checkbox"/> D <input type="checkbox"/>
				⋮	S= same D=different

Figure 1

The word pairs were not provided in written form; the subjects were asked to put a tick in a box marked “S” for “same” or in a box marked “D” for “different” according to whether they had heard the two items in the word pair as the “same” word or as two “different” words (see Figure 1 above). The randomized 135 word pairs were grouped into 6 sections of 20-25 word pairs each, with a short break between sections to avoid subjects losing concentration from fatigue.

3. Results and discussion

A statistical analysis of the subjects' responses in the MPADT was carried out to explore the effect of a two-term period of formal instruction (test scores at T2) and a stay-abroad period (test scores at T3) on the subjects' perceptual competence in English (test scores at T1). Normality of distribution was assessed by means of the Kolmogorov-Smirnov statistic and either repeated measures ANOVAs or Friedman's tests were used accordingly to find out whether there were any significant differences among the three sets of scores (T1, T2 and T3)⁴.

The subjects' responses to the 27 same-word pairs functioning as distractors in the MPADT (3 per phonemic contrast) were not included in the statistical analysis. Such word pairs were expected to elicit "same word" responses, since they consisted of two realizations of the same word by the same speaker, but this was not always the case. In fact, 6,27% (on average) of these distractors were interpreted as real minimal pairs. This can only be accounted for by assuming that a minor phonetic difference between the two realizations of the same word was occasionally interpreted as a phonologically contrastive phonetic feature. It has been shown (e.g. Ganong 1980; Werker and Logan 1985) that subjects can use three different sound processing strategies when categorizing segments and syllable-sized sequences: they may rely on phonemic categories, phonetically relevant category boundaries or any acoustic difference between two items. Werker and Logan (1985) suggest that auditory processing is favoured by a short inter-stimulus interval, whereas phonemic processing is predominant in task conditions with long intervals between repetitions, which is more similar to the requirements of speech processing in communication. Consequently, the short one-second interval between the two realizations of a same-word pair may have caused the subjects' misinterpretation of some instances of phonetic variability as distinctive phonemic contrasts.

The results of the statistical analysis revealed an overall significant effect of the formal instruction period and the stay abroad period on the subjects' performance in the form of a steady improvement in their ability to perceive phonological contrasts in English. However, although statistically significant differences were found between the subjects' scores at T1 and T2 (after the formal instruction period), the gains the subjects obtained at T3 with respect to T2 (i.e. after the stay abroad period) turned out to be non-significant statistically. A one-way repeated measures ANOVA (see the means and

standard deviations in Table 4) revealed an overall significant effect for time (T1, T2, T3), $p = ,000$ (Wilks' Lambda = ,343; eta squared = ,657). Further paired comparisons showed a statistically significant difference between the subjects' scores at T1 and T2 ($p = ,000$). The difference between the scores at T2 and T3, however, turned out to be non-significant ($p = ,141$) despite the general improvement trend in the perception of phonemic contrasts (Figure 2).

MPADT	M (/108)	SD	M %
T1	79,92	13,38	74,00
T2*	85,64	12,23	79,30
T3	87,88	14,81	81,37

Table 4: MPADT means at T1, T2 and T3

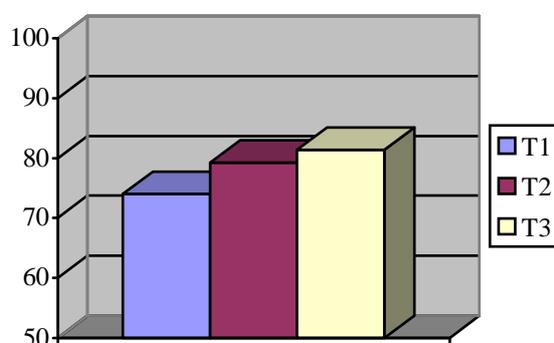


Figure 2: Percentage of correct responses in the MPADT

These results suggest that the period of formal instruction had a greater effect on the subjects' ability to perceive non-native phonemic contrasts than a three-month stay abroad period. Although similar results have been obtained for productive phonological competence (e.g. Díaz-Campos and Lazar 2003, Díaz-Campos 2004), they should be treated with extreme caution here due to the very high level of perceptual proficiency of the subjects taking part in the study. Díaz-Campos (2004), for example, found no significant differences between the gains in pronunciation accuracy measures (VOT in word-initial /p, t, k/, among others) of a stay-abroad group and an at-home group of English learners of Spanish. The at-home group showed a stronger trend of improvement, particularly in those subjects that had received 7 or more years of instruction.

The MPADT was devised to test 9 phonemic contrasts (see Table 2 above), which may be grouped into several types of phonemic contrast based on a particular phonetic property (e.g. the voicing contrast in consonants) or classified according to the segmental natural class they belong to (e.g. vowel vs. consonant contrasts).

Consequently, the analysis of the results further aims at investigating the extent to which the overall pattern of steady improvement through T2 and T3 also holds for each one of the phonological contrasts and phonological contrast types the subjects were asked to discriminate.

Phonemic Contrast (PhC)	Time	<u>M</u> (/12)	<u>SD</u>	<u>M %</u>	Phonemic Contrast (PhC)	Time	<u>M</u> (/12)	<u>SD</u>	<u>M %</u>
1	T1	8,72	2,44	72,67	6	T1	8,72	2,41	72,67
	T2*	9,80	2,54	81,67		T2*	9,56	1,87	79,67
	T3	9,80	2,86	81,67		T3	10,04	2,20	83,67
2	T1	9,28	3,23	77,33	7	T1	5,80	2,83	48,33
	T2*	9,96	2,49	83,00		T2*	6,88	3,11	57,33
	T3	10,04	2,85	83,67		T3	7,16	3,08	59,67
3	T1	11,28	1,28	94,00	8	T1	8,00	1,89	81,67
	T2	11,24	1,64	93,67		T2	8,00	1,89	85,33
	T3	11,40	1,50	95,00		T3	8,36	2,40	87,33
4	T1	11,08	1,15	92,33	9	T1	9,80	1,26	57,33
	T2*	11,56	0,77	96,33		T2	10,24	1,33	66,67
	T3	11,48	0,92	95,67		T3	10,48	1,42	69,67
5	T1	7,24	1,83	60,33	* T2 and T3 shaded rows mark statistically significant differences ($p < .05$) with respect to T1 and T2 means, respectively.				
	T2*	8,40	1,47	70,00					
	T3*	9,12	1,42	76,00					

Table 5: Means at T1, T2 and T3 according to phonemic contrast

As shown in Table 5, statistically significant differences between the mean scores were only found for 6 out of the 9 phonemic contrasts in the MPADT. Two significant generalizations stemming from the data, however, are worth highlighting. The first one is the very clear (though not exceptionless) trend of improvement in the subjects' ability to discriminate phonemic contrasts across the three times for all phonemic contrasts (see Figure 3 below).

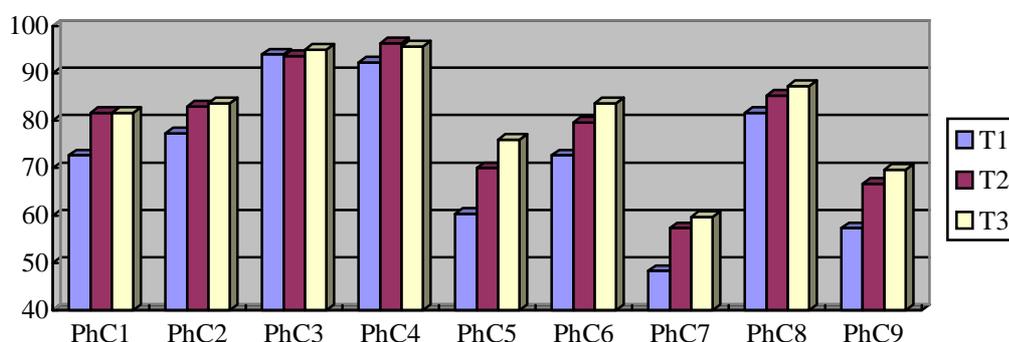


Figure 3: Percentage of correct responses per phonemic contrast

The second generalization is that, with the exception of PhC5, statistically significant differences in mean scores ($p < .05$) are only found between T1 and T2

(PhC1=,011; PhC2=,035; PhC4=,038; PhC5=,002; PhC6=,025; PhC7=,009;). These findings suggest that although some improvement in the subjects' ability to perceive phonemic contrasts may be attributed to an SA period, a statistically significant effect of this type of learning context is not observable, whereas an FI period does seem to exert a significant positive influence in the subjects' ability to discriminate phonemic contrasts⁵.

The differences in mean scores according to phonemic contrast suggested that such differences might be caused by the type of phonetic property or the segmental natural class each phonemic contrast expresses or belongs to. In order to explore this possibility we compared the means in the grouping variables identifying the main phonemic contrast types in the MPADT (see Table 6), namely: vowel contrasts (PhCs 1-5), consonant contrasts (PhCs 6-9) and voicing contrasts (PhCs 6-8).

Type of Phonemic Contrast	Time	<u>M</u>	<u>SD</u>	<u>M %</u>
Vowels (out of 60)	T1	47,60	7,85	79,33
	T2*	50,96	7,22	84,93
	T3	51,84	7,93	86,40
Consonants (out of 48)	T1	32,28	6,98	67,25
	T2*	34,68	6,39	72,25
	T3	36,04	7,97	75,08
Voicing (out of 36)	T1	22,48	6,21	62,44
	T2*	24,44	5,99	67,89
	T3	25,56	7,15	71,00
Place (/d/-/ð/) (out of 36)	T1	9,80	1,26	57,33
	T2	10,24	1,33	66,67
	T3	10,48	1,42	69,67

* T2 shaded rows mark statistically significant differences ($p < .05$) with respect to corresponding T1 means.

Table 6: Means according to type of phonemic contrast

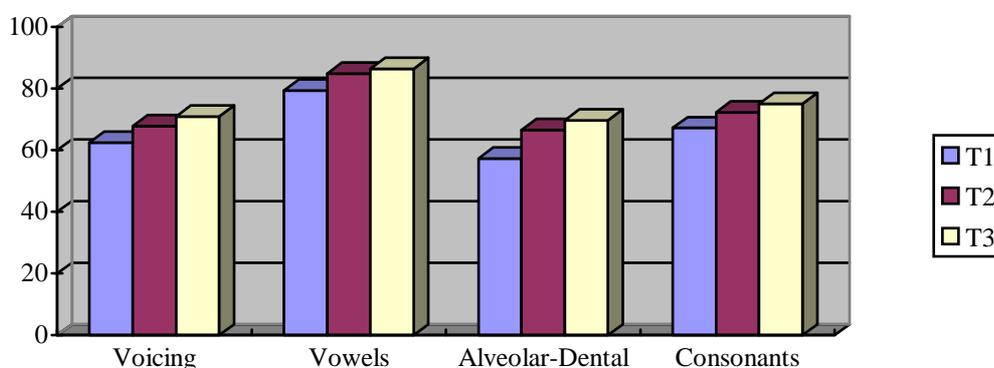


Figure 4: Percentages of correct responses according to type of phonemic contrast

Statistically significant differences ($p=,000$) were found for all types of phonemic contrast at T1, T2 and T3. In general, the voiced-voiceless phonemic distinction in PhCs 6 to 8 are more difficult to perceive than the vowel contrasts examined and the alveolar-dental place of articulation contrast in /d/-/ð/ is the most difficult type of contrast to perceive, as Figure 4 shows by means of T1-T2-T3 averages.

The significant differences between the three types of phonemic contrast can only be attributed to the relative difficulty different phonemic contrasts present for Spanish/Catalan learners of English, which will vary according to such factors as the inherent perceptual salience of a given phonemic contrast, the area of the perceptual space a given phonemic contrast occupies with respect to the learners' L1 segmental inventory, whether a particular phonetic feature functions contrastively in the learners' L1 phonology or whether a particular phonetic difference is likely to be incorrectly mapped onto a phonemic category.

A Friedman's test indicated an overall statistically significant effect of time, but further paired tests (Wilcoxon's) revealed differences were statistically significant only between T1 and T2 ($p=,001$ for vowel contrasts, $p=,000$ for consonant contrasts and $p=,002$ for voicing contrasts; no significant differences were found for the /d/-/ð/ contrast), as shown by the shaded rows in Table 6. These results reveal that differences in the ability to perceive different types of phonemic contrasts do not alter the already observed robust pattern in the data, showing that the SA period (T3) presents a smaller effect on perceptual ability than the FI period (T2).

4. Conclusions

Advanced learners' ability to auditorily discriminate between English contrastive sound units seem to improve over time as a result of the two different contexts of learning in which formal instruction took place: a two-term period in the home university and a one-term stay-abroad period. However, it is only at T2 (after a formal instruction period in the home university) that statistically significant gains are obtained. The learners' performance at T3 (after the stay-abroad period), therefore, has

relatively little effect on the overall improvement of their perceptual phonetic/phonological ability when compared to the at-home formal instruction period.

These results are consistent with the results for some of the fluency, complexity and accuracy measures obtained by Pérez-Vidal and Juan-Garau (2004) with respect to writing in a study conducted with the same group of subjects. It was expected, however, that a stay-abroad period would have a much greater effect on the subject's perceptual phonological competence than on the subjects' writing skills due to an intensive period of exposure to the spoken language in a linguistic immersion context. Contrary to the findings of the study reported on here, significant gains in perceptual ability were also expected to be greater after a stay-abroad term than after a period of formal instruction. Similar results have been obtained by research investigating the effect of context of learning on the phonological competence of foreign language learners (Díaz-Campos and Lazar 2003; Díaz-Campos 2004).

Two tentative explanations may be offered for the findings reported on in this study. One explanation is to be sought in the type of stay-abroad experience the learners took part in: a three-month term may not be a long enough period to produce significant gains in perceptual ability in advanced learners; or it may have longer term effects that are not captured by a T1-T2-T3 design. However, it may also be the case that the experimental design used was not sensitive enough to be able to reveal significant gains in perceptual ability as a result of a three-month stay-abroad period; in this sense, further research on the same subjects' production data may yield clearer insights into the phonological benefits of a stay abroad term and may be used to confirm or disconfirm the results of the analysis of the perception data of the present study.

APPENDIX

Word-Pairs in the Minimal Pair Auditory Discrimination Test

- | | |
|--|--|
| 1. distraction-destruction /dɪs'trækʃn-dɪs'trʌkʃn/ | 14. began-begun /bɪ'gæn-bɪ'gʌn/ |
| 2. accept-except /ək'sept-ɪk'sept/ | 15. blared-bled /bleəd-bled/ |
| 3. belly-barely /'beli-'beəli/ | 16. boxes-boxers /'bɒksɪz-'bɒksəz/ |
| 4. advises-advises /æd'vaɪzɪz-æd'vaɪzɪz/ | 17. breathing-breeding /'bri:ðɪŋ-'bri:ðɪŋ/ |
| 5. breed-breathe /bri:d-bri:ð/ | 18. bride-bride /braɪd-brɑɪd/ |
| 6. produces-producers /prə'dju:sɪz-prə'dju:səz/ | 19. cut-cat /kʌt-kæt/ |
| 7. brought-broad /brɔ:t-brɔ:d/ | 20. card-cart /kɑ:d-kɑ:t/ |
| 8. allusive-allusive /ə'lu:sɪv-ə'lu:sɪv/ | 21. catchers-catches /'kætʃəz-'kætʃɪz/ |
| 9. crashed-crushed /kræʃt-krʌʃt/ | 22. Dave-Dave /deɪv-deɪv/ |
| 10. assessors-assesses /ə'sesəz-ə'sesɪz/ | 23. coat-code /kəʊt-kəʊd/ |
| 11. bared-bared /beəd-beəd/ | 24. drug-drag /drʌg-dræg/ |
| 12. bathe-bayed /beɪð-beɪd/ | 25. complained-complaint /kəm'pleɪnd-kəm'pleɪnt/ |
| 13. beaten-bitten /'bi:tɪn-'bɪtɪn/ | |

26. cup-cup /kʌp-kʌp/
 27. dare-their /deə-ðeə/
 28. dead-dared /ded-deəd/
 29. den-then /den-ðen/
 30. edition-addition /ɪ'dɪʃn-ə'dɪʃn/
 31. dine-thine /dam-ðam/
 32. drank-drank /dræŋk-dræŋk/
 33. erase-arrays /ɪ'reɪz-ə'reɪz/
 34. fit-feet /fɪt-fi:t/
 35. flared-fled /fleəd-fled/
 36. float-flowed /fləʊt-fləʊd/
 37. green-grin /gri:n-grɪn/
 38. grade-grade /greɪd-greɪd/
 39. Harry-hurry /'hæri-'hʌri/
 40. head-hared /hed-heəd/
 41. heard-hurt /hɜ:d-hɜ:t/
 42. heats-heats /hi:ts-hi:ts/
 43. herring-haring /'herɪŋ-'heərɪŋ/
 44. hitting-heating /'hɪtɪŋ-'hi:tɪŋ/
 45. illusion-allusion /ɪ'lu:ʒn-ə'lu:ʒn/
 46. joint-joined /dʒɔɪnt-dʒɔɪnd/
 47. leak-lick /li:k-lik/
 48. dent-dent /dent-dent/
 49. lamp-lump /læmp-lʌmp/
 50. list-least /lɪst-li:st/
 51. effect-effect /ɪ'fekt-ɪ'fekt/
 52. litre-litter /'li:tə-'lɪtə/
 53. loathe-load /ləʊð-ləʊd/
 54. luck-lack /lʌk-læk/
 55. Mary-merry /'meəri-'meri/
 56. mend-meant /mend-ment/
 57. fillings-fillings /'fɪlɪŋz-'fɪlɪŋz/
 58. metal-medal /'metl-'medl/
 59. wed-ward /wed-weəd/
 60. thence-dense /ðens-dens/
 61. mud-mud /mʌd-mʌd/
 62. pigeon-pidgin /'pɪdʒən-'pɪdʒɪn/
 63. stared-stead /steəd-sted/
 64. tide-tithe /taɪd-taɪð/
 65. publishers-publishes /'pʌblɪʃəz-'pʌblɪʃɪz/
 66. quid-quit /kwɪd-kwɪt/
 67. reach-reach /ri:tʃ-ri:tʃ/
 68. ride-writhes /raɪd-raɪð/
 69. risen-reason /'rɪzn-'æri:zn/
 70. run-ran /rʌn-ræn/
 71. professes-professors /prə'fesɪz-prə'fesəz/
 72. said-set /sed-set/
 73. they-day /ðeɪ-deɪ/
 74. salmon-summon /'sæmən-'sʌmən/
 75. sat-sat /sæt-sæt/
 76. sauces-saucers /'səʊsɪz-'səʊsəz/
 77. seek-sick /si:k-sɪk/
 78. teethe-teed /ti:ð-ti:d/
 79. shed-shared /ʃed-ʃeəd/
 80. slip-sleep /slɪp-sli:p/
 81. spared-spared /speəd-speəd/
 82. steal-still /sti:l-stɪl/
 83. stunned-stand /stʌnd-stænd/
 84. though-though /ðəʊ-ðəʊ/
 85. threat-thread /θret-θred/
 86. Tim-team /tɪm-ti:m/
 87. uncle-ankle /'ʌŋkl-'æŋkl/
 88. vary-very /'veəri-'veri/
 89. swathe-swathe /sweɪð-sweɪð/
 90. wary-wherry /'weəri-'weri/
 91. purse-purrs /pɜ:s-pɜ:z/
 92. adder-ardour /'ædə-'ɑ:də/
 93. age-age /eɪdʒ-eɪdʒ/
 94. ants-aunts /ænts-ɑ:nts/
 95. advise-advice /əd'vaɪz-əd'vaɪs/
 96. aren't-ant /ɑ:nt-ænt/
 97. chunk-junk /tʃʌŋk-dʒʌŋk/
 98. chain-chain /tʃeɪn-tʃeɪn/
 99. chats-charts /tʃæts-tʃɑ:ts/
 100. device-devise /dɪ'vaɪs-dɪ'vaɪz/
 101. heart-heart /hɑ:t-hɑ:t/
 102. chest-jest /tʃest-tʃest/
 103. bark-back /bɑ:k-bæk/
 104. choke-joke /tʃəʊk-dʒəʊk/
 105. ham-ham /hæm-hæm/
 106. loose-lose /lu:s-lu:z/
 107. edge-etch /edʒ-etʃ/
 108. falls-false /fɔ:lz-fɔ:ls/
 109. hard-had /hɑ:d-hæd/
 110. liege-leach /li:dʒ-li:tʃ/
 111. hence-hens /hens-henz/
 112. pat-pat /pæt-pæt/
 113. jeer-cheer /dʒɪə-tʃɪə/
 114. Jews-juice /dʒu:z-dʒu:s/
 115. Joyce-choice /dʒɔɪs-tʃɔɪs/
 116. marks-Max /mɑ:ks-mæks/
 117. larch-large /lɑ:tʃ-lɑ:dʒ/
 118. rice-rise /raɪs-raɪz/
 119. lunch-lunge /lʌntʃ-lʌndʒ/
 120. dice-dice /daɪs-daɪs/
 121. march-match /mɑ:tʃ-mætʃ/
 122. pays-pays /peɪz-peɪz/
 123. matter-martyr /'mætə-'mɑ:tə/
 124. raise-race /reɪz-reɪs/
 125. chews-Jews /tʃu:z-dʒu:z/
 126. palm-Pam /pɑ:m-pæm/
 127. pens-pence /penz-pens/
 128. purge-purge /pɜ:dʒ-pɜ:dʒ/
 129. rigde-rich /rɪdʒ-rɪtʃ/
 130. scares-scarce /skeəz-skeəs/
 131. search-surge /sɜ:tʃ-sɜ:dʒ/
 132. packed-parked /pækt-pɑ:kt/
 133. spies-spies /spaɪz-spaɪz/
 134. trace-trays /treɪs-treɪz/
 135. vanish-varnish /'vænɪʃ-'vɑ:nɪʃ/

Notes

1. The Contrastive Analysis Hypothesis (CAH) (Lado 1957), the Markedness Differential Hypothesis (MDH) and the Structural Conformity Hypothesis (SCH) (Eckman 1977, 1981, 1985, 1991), the Ontogeny Model (OM) (Major 1986, 1987, 2001), the Speech Learning Model (SLM) Flege (1980, 1981, 1987a, 1987b, 1991, 1992, 1995, 1997, 2003), the Feature Competition Model (FCM) (Hancin-Bhatt 1994, 1999) and the Perceptual Assimilation Model (PAM) (Best 1994, 1995; Best, Faber and Levitt 1996; Best, McRoberts and Goodell 2001).
2. The VALAL Project (Project BBF2001-0820; funded by the Spanish Ministry of Education).
3. For a brief account of the vowel systems of Catalan and Spanish see Carbonell and Llisterra (1999) and Martínez-Celdrán et al. (2003), respectively.
4. Further T-tests and Wilcoxon signed rank tests were conducted when necessary to determine significant differences between mean scores.
5. The findings reported on in Díaz-Campos and Lazar (2003) and Díaz-Campos (2004) for productive phonological competence also point in the same direction; but see Freed (1995), Towel, Hawkins and Bazergui (1996), Freed, Segalowitz and Dewey (2004) and Segalowitz and Freed (2004) for evidence suggesting that an SA period results in significant gains in some of the measures of oral fluency they examined.

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