Learning Allophonic Alternations in a Second Language: Phonetics, Phonology and Grammatical Change

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1. Introduction

Of the most widely recognized characteristics of Spanish phonology is the way in which the voiced obstruents and approximants alternate in certain contexts. Considerable research has been carried out on the phonological distribution of these segments (Harris, 1969; Mascaró, 1984, among others), their phonetic characteristics (González, 2006) and their sociolinguistic cross-dialectal realizations (Amastae, 1995; González, 2002). Cole, Hualde and Izkarous (1999) and Lavoie (2001) demonstrated that the stop-approximant alternation is not only dependent upon the immediate phonetic context but also governed by prosodic context and word position. Specifically, the degree of sonorization characteristic of the approximants is conditioned by the position of the segment in the word (initial or medial) and its position relative to stress (onset of a stressed or unstressed syllable). Thus, the stop-approximant alternation in Spanish represents an interesting problem for theories of adult second language phonological acquisition: How do learners acquire alternations that are dependent upon positional factors? The framework of Optimality Theory (OT) affords a potential answer to this question, given its assumption of a universal set of constraints that are present in all grammars, including constraints that target strong and weak positions. Languages differ as to how these universal constraints are ranked, which means that not every constraint will play a crucial role in each language (Broselow, Chen & Wang, 1998). The initial state of adult second language phonological acquisition is assumed to be the L1 constraint ranking and the input triggers re-ranking for some of these constraints, leading to a final state that can range from fossilized knowledge to near-native competence.

Positions which have an advantage perceptually due to phonetic or psycholinguistic prominence are privileged with respect to certain phonological processes (Beckman, 1998; Steriade, 1993). Stressed syllables, syllable onsets and word–initial syllables have been shown to have special licensing properties that allow them to assume perceptual prominence and remain impervious to neutralization effects that occur in weak positions. Within OT, researchers have argued in favour of positional constraints that can capture this asymmetry between strong and weak positions. These constraints lend themselves well to the analysis of the Spanish voiced stop-approximant alternation: strong positions license stops and weak positions license approximants.

We argue that the task facing English speakers when learning the Spanish stop-approximant alternation is to arrive at the same output forms in the most feasible and economic manner, in order to function efficiently as quickly as possible in the target language. This may imply that L2 learners never acquire rankings identical to those of native Spanish speakers with respect to positional requirements or it may entail distinct inputs to the inputs to the phonological computational system for native and non-native speakers. Based upon data collected from native English speakers of various proficiency levels acquiring Spanish, we propose that L2 learners do not necessarily require representational input identical to that of native speakers; different constraint rankings can lead to the same surface forms. However, because L2 learners are not using the same input forms as native speakers, their output will inevitably be less stable and more prone to errors in production.

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We argue that speakers of Spanish whose variety manifests stop-approximant alternations will have approximants as their underlying representation. Positional markedness constraints (Smith, 2005; deLacy, 2000) militate against output with approximants in strong positions, meaning that for these speakers, the alternations result from a process of lessening the sonority of syllable onset segments. On the other hand, English speakers will initially have voiced obstruents as their underlying representations and they will need to "desonorize" in the correct position. Therefore, the learning task involves re-ranking L1 constraints in such a way that the positional alternation of the L2 can surface and the same surface pattern emerges through a different grammar.

2. The Acquisition of Allophones

Learning the phonological system of a second language requires an awareness of how the target language sounds pattern together and condition one another. Specifically, second language learners must detect and acquire changes to underlying forms conditioned by contextual factors in the input. Allophones are the conditioned variants that result from this contextual variability. The acquisition of allophones, whether in a first language or a second language, is the result of two computational processes: first, the learner must compute how phonologically *similar* two segments are, either in terms of phonological features or orthographic correspondence; second, the learner must compute how *dissimilar* the two segments are, based upon separate distributions in the input. If there are no contexts of co-occurrence, the learner will postulate an alternation conditioned by a factor in the input. Complementary distribution without phonological similarity will not lead to the postulation of allophonic alternations, nor will phonological similarity without complementary distribution. In the case of first language acquisition, these computational processes are carried out implicitly and occur within the first year of life (Maye, Gerken & Werker, 2003; Werker & Curtin, 2005); in the case of adults learning allophones in a second language, the process requires more time and the learner often never reaches the end-state of native speaker competence. This may be due to previous perceptual or articulatory learning or it may be related to the way in which the target language phonological input is processed by adult second language learners.

The acquisition of allophones by adults learning a second language can potentially lead to one of three final states:

1. The learner acquires the correct representation in all contexts and successfully reproduces the target language allophones;
2. The learner assumes that the allophones are in fact phonemes and creates independent representations for each of them;
3. The learner acquires the incorrect representation, employs a mistaken grammar, but nonetheless arrives at the correct surface output.

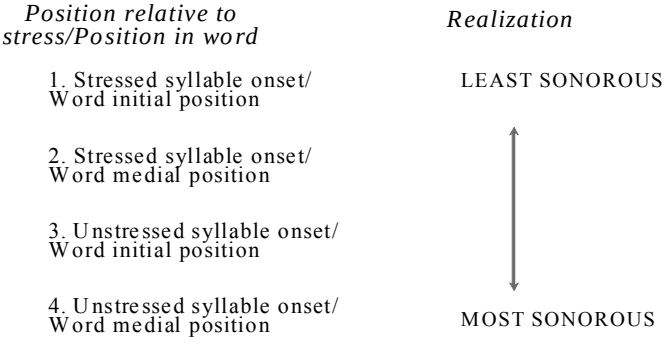
In terms of actual output, 1) and 2) will lead to the same surface forms in most contexts. The difference lies in the postulated input and the final state. Specifically, under 1), the learner's final state is equivalent to L2 native speaker competence, which rarely, if ever, occurs. In the case of option 2), we must assume that learners are somehow incapable of acquiring allophones in their second language. Given the orthographic and featural similarity between the stops and approximants, this scenario is highly unlikely in the present case. Therefore, we propose that native speakers and learners of different proficiency levels may have different underlying representations that feed into their output, or 3). We hypothesize that lower proficiency learners will use underlying representations that are faithful to their L1 forms, causing the production of stops in all contexts, without allophonic alternations while more advanced learners will change their URs but not necessarily arrive at native-Spanish speaker inputs.

3. Characterizing Stops and Approximants in Spanish

The Spanish voiced stop-approximant alternations exhibit variability within a given dialect and even within an idiolect. They are best characterized in terms of contexts that tend to favour one or the other form instead of an obligatory, categorical phonological rule (Mascaró, 1984). Acoustic analyses reveal that the approximant allophones have low amplitude energy and visible formant structure not

present in the stops, which are less sonorous than the approximants. Articulatorily, the approximants manifest weaker vocal tract stricture and the stops have stronger onsets and offsets. Cole et al (1999) undertook a small-scale analysis of how prosodic structure and immediate phonetic context can account for the degree of sonorization in the stops and approximants. They had native Castilian Spanish speakers produce a list of 59 words all containing intervocalic /g/, balanced for the location of stress and varying in the quality of thee vowels preceding and following /g/: either front vowels /i,e/, back vowels /u,o/ or back vowel /a/. Their results showed that tokens of /g/ in post-stress position have more energy than those in pre-stress position, revealing a significant effect for prosodic context.

When the flanking vowels were the non-low back vowels /u,o/, there was also a higher degree of energy detected. The lowest degrees of energy were found in stressed syllable onset position and with flanking /i,e,or a/ vowels. Based upon this data, we predict the following continuum of sonorization for native Spanish speakers:



dado > **d**ijiste > a**d**apto> a**d**ecuar

In Section 5 we will look at data from non-native speakers of Spanish and determine whether these predictions hold for their productions as well.

4. Methodology

4.1 Participants

Twelve native speakers of Western Canadian English were recruited from Spanish as a second language classes at the University of Calgary. Four were from the low–intermediate level, four from high–intermediate level and four were highly proficient non-native speakers of Spanish, either professors of Spanish or non-native speakers who had lived at least five years in a Spanish speaking country. All four high proficiency learners spoke Spanish on a daily basis. Their ages ranged from 19–39, ten females and two males in the participant group. The control group consisted of two male speakers of Mexican Spanish, one from the Yucatan Peninsula and the other from Mexico City.

4.2 Materials

Participants read a list of real and nonce words. Words consisted of one syllable (73%) or two. Each word had the target segment in one of the four possible prosodic/word positions and was followed by one of the five vowels in Spanish: /i,e,a,o,u/. Crossing these requirements gave us the 60 words, randomized.

4.3 Procedure

Speakers were recorded directly onto a Macintosh computer. Speech was sampled at 16kHz and the recordings were segmented using PRAAT (Boersma & Weernink, 2006) phonetics program. Participants read the word list three times and the third recording was used for subsequent analysis. Segmentation was based upon formant transitions (particularly F2, for C offset and vowel onset), spectrogram and waveform information.

Stops can be distinguished from approximants by means of the intensity, or energy, present upon their articulation. Stops are low intensity segments while approximants are closer to vowels in their energy levels. To quantify intensity, we took Root Mean Square (RMS) amplitude values of the target segment and the word in which it appeared. We then converted the RMS values into decibels to normalize for gender and interspeaker variations in amplitude and created ratios between the overall intensity of the target word and the target segment. Because decibels are on a logarithmic scale, we subtracted the decibel values to arrive at the final ratio: Target Word Intensity dB – Target Consonant Intensity dB = INTENSITY RATIO VALUE. If the target consonant has lower intensity than the word, the ratio values will be high, as in the case of stops. If the target consonant has high intensity, these values will be low, as in the case of approximants.

5. Results

The results showed that indeed the lower proficiency group produced more stop-like segments across all contexts. They are not exhibiting any alternations. In contrast, our low–intermediate learners' productions appear to be highly inconsistent. There was considerable variability in individual speaker tokens and also across participants.

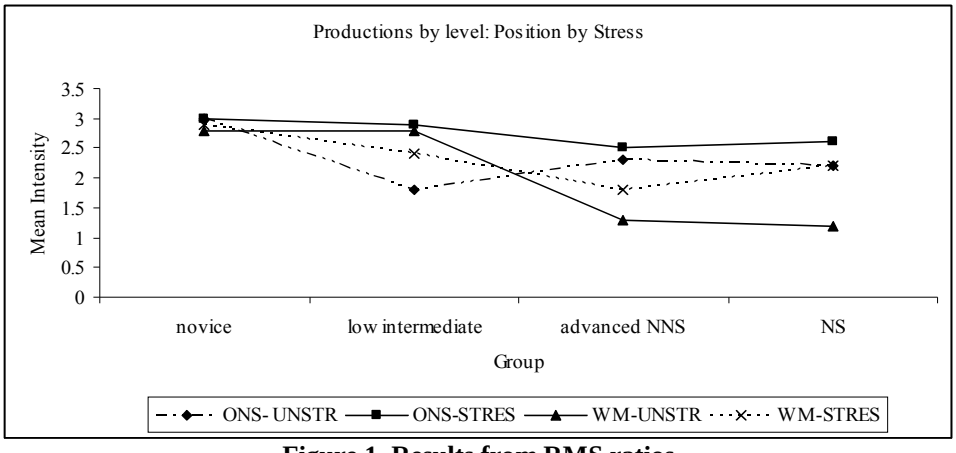


Figure 1. Results from RMS ratios

The advanced learners deviated from native speaker measurements in two ways: unstressed syllable onsets were produced with less sonorization (i.e., more stop–like) and the stressed syllable onsets were produced with greater sonorization (i.e., more approximant–like) than the native Spanish speakers. Their data show a tendency towards less extreme production values when compared to the native speakers. Interestingly, our native Spanish speakers are producing equivalent intensity values for the onset unstressed and word medial stressed. This seems to indicate that word position plays a key role in the production of these tokens.

In summary, there are clear differences between the three native English speaker groups. The lower proficiency level speakers are directly transferring from their L1 phonology: voiced stops emerge in all contexts, with no evidence of allophonic alternation. Higher proficiency participants exhibit alternations that correspond closely to those of native speaker norms. It is clear that progression occurs across the different proficiency levels but what exactly these changes entail for learners' phonological representations remains to be determined. We will address that issue in the following section.

6. Theoretical Implications

We propose that the approximants are the "elsewhere" segments in Spanish (following Bakovic, 1994; Barlow, 2003). Their distribution is less predictable than the voiced stops and they occur in the non-prominent positions across the dialects of Spanish: /βaβa/ → [báβa]. Constraint rankings must

reflect these positional preferences for stops in strong positions (stress syllable onsets and word initial positions) and maintain faithfulness to approximants in all other positions.

Positional constraints (Beckman, 1998; Smith, 2005) are constraints relativized to strong positions that can exhibit special feature licensing abilities. For example, phonetically strong positions tend to have released consonants, long vowels (Beckman, 1997) and stress. There are also strong positions such as morphological roots and word initial syllables which play a key role in psycholinguistic processes and license certain features that weak positions do not.

In terms of OT constraints, de Lacy (2000) and Smith (2005) model these preferences by means of the *MARGIN/X subhierarchy (Prince & Smolensky 1993), based in turn upon the sonority scale. The constraint with the most sonorous margin is highest ranked. Smith (2005) relativizes these constraints to onset positions and assumes a positionally sensitive *ONSET/X subhierarchy. Using such functionally grounded positional markedness constraints, it is possible to characterize the voiced stop-approximant allophonic alternations in Spanish. By further specifying that the constraints must refer to stressed syllable onsets only, i.e. *ONSET σ'/ approximant, we arrive at the correct constraint set for Spanish native speakers:

*ONSETσ' / approximant >> *ONSET/approximant >> *approximant
relativized positional markedness >> positional markedness >> general markedness

In order to maintain faithfulness to the underlying approximant, the following faithfulness constraint is active:

IDENT(cont)/ V_V (adapted from Steriade, 1998): a consonant and its input correspondent must have equivalent continuant specifications

This constraint guarantees that the approximant will surface in word medial position.

Tableau 1: Native Spanish speaker

/ βaβa/	*onsσ'/app	ID(cont)/ V_V	IDENT
a. 'βaβa	*!		
b. 'βaba	*!	*	*
c. 'baba		*!	**
d.☛'baβa			*

The positional markedness constraints are ranked highest, militating against approximants in the onset position of stressed syllables. These are followed by the ID (cont)/ V_V ensuring faithfulness to the underlying approximant. By positing the approximants as input, native Spanish speakers must move down the sonority scale and desonorize the onset position of stressed syllables. In other words, this is process of fortition.

For native English speakers, the positional markedness constraints relativized to strong positions will be ranked very low for voiced stops. The learning task for native English speakers acquiring Spanish will involve sonorizing in the appropriate contexts: unstressed syllable onsets and word medial position onsets. In other words, learners must realize that the stop-approximant allophonic alternations in Spanish are positionally conditioned:

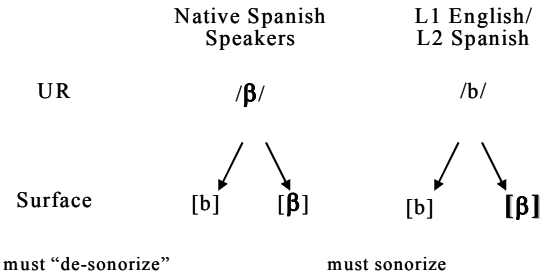


Figure 2. Underlying forms

We propose that L1 English learners of Spanish initially posit voiced stops underlyingly and as evidence from the input accumulates, learners adjust these representations and conform to their new hypotheses. If, on the other hand, our native English speakers were to posit approximant segments as underlying initially (i.e., the same UR as native Spanish speakers), they would need to "desonorize" and then subsequently "re-sonorize" the same segments again in order to follow the learning path depicted in our data. Therefore, we contend that our native English learners of Spanish are using a different grammar which favors more effortful productions in weak positions. Their learning task is to sonorize in weak positions and remain faithful to stops in strong positions. In other words, this is a process of lenition. Kirchner (1998) proposes a set of LAZY markedness constraints that militate against effortful productions and seek to reduce muscular exertion in the articulation of voiced stops. Abstract effort units serve to quantify the amount of force required to produce segments in certain contexts and LAZY constraints will prevent the high ranking of effortful productions. For example, it is more demanding in terms of articulatory control to produce a full closure between two vowels than at the beginning of a word or a syllable.

The following constraints are active in native English speaker phonology:

> LAZY (STOP)/V-V (adapted from Kirchner, 1998): reduce muscular effort in the articulation of voiced stops
> IDENT (cont) (Steriade, 1998): a consonant and its input correspondent must have identical Manner specifications

These constraints combine to give us the rankings which follow. Tableau 2 corresponds to the L2 initial state, representative of novice learners:

Tableau 2: English L2 initial state

/baba/	IDENT (cont)	LAZY (stop)/V-V	*onsσ'/app
a. ' βaβa	* *!		*
b. ' βaba	*!	*!	*
c. ☞ 'baba		*	
d. 'baβa	*!		

In the L2 initial state, learners are producing stops in all contexts and there is a direct transfer from the L1 phonology. There are no allophonic alternations occurring in the productions of these novice learners and their underlying representations are consistent with those of English. The L2 learners are being faithful to the underlying representation and the lower ranked markedness constraint and the positional markedness constraint does not play a role in determining the output.

In contrast, our third year Spanish students are producing the stop-approximant alternations but they are inconsistent in their realizations. They will accurately produce the appropriate surface realization in the case of a weakening in an unstressed syllable (Tableau 3), but they will also produce an approximate in a non-initial, stressed syllable onset (Tableau 4). The ranking has changed with LAZY now ranked above IDENT, which suggests that these learners are still using the stops as the

underlying form for the allophonic alternation, but they have re-ranked the markedness and faithfulness constraints to give the correct output.

Tableau 3: L2 intermediate level

/baba/	LAZY (stop)/V-V	IDENT (cont)	*onsσ'/app
a. 'βaβa		* *!	*
b. ' βaba	*!	*	*
c. 'baba	*!		
d. ☞'baβa		*	

Here, these learners are still positing the voiced stops as the underlying form for the allophonic alternation, but unlike the less experienced learners they have re-ranked the markedness constraint LAZY and the faithfulness constraint IDENT. Thus, the correct output is selected in the case of the intervocalic stop in an unstressed syllable. However, this ranking will not allow for the emergence of stops in word medial stressed syllable position, which is characteristic of native speaker and more advanced non-native speaker productions:

Tableau 4: L2 intermediate level word medial stress input (1)

/baba/	LAZY (stop)/V-V	Ident (cont)	*onsσ'/app
a. βa'βa		*! *	*
b. βa' ba	*!	*	
c. ba'ba	*!		
d. 💣☞ ba'βa		*	*

This ranking, with the stop input of our native English speakers, has the onset of the stressed syllable surfacing as an approximant, which was not produced by any of our participants or native speaker controls. It is at this point that the ranking changes once again. The positional markedness constraint is now ranked above IDENT, yet it is not crucially ranked with respect to LAZY. The learner has acquired knowledge from the input that suggests LAZY does not operate across the board and the grammar shows that there are contexts in which the LAZY is violated in order to preserve continuancy in stressed syllable onsets.

Tableau 5: L2 Intermediate level word medial stress input (2)

/baba/	LAZY (stop)/V-V	*onsσ'/app	Ident (cont)
a. βa'βa		*	*!
b. βa' ba	*		*!
c. ☞ba'ba	*		
d. ba'βa		*	*!

With this ranking, the stop surfaces in the stressed, word-medial syllable even though it occurs between two vowels. In the case of initially stressed words, the correct output is also selected with this ranking.

Tableau 6: L2 Intermediate level word initial stress input

/baba/	LAZY (stop)/V-V	*onsσ'/app	Ident (cont)
a. 'βaβa		* !	**
b. 'βaba	*(!)	*(!)	*
c. 'baba	*!		
d. ☞ 'baβa			*

Gradually the grammar will settle on a final ranking where the positional markedness constraint is strictly ranked above LAZY, a ranking which our data suggests has yet to be attained by our L2

Spanish learners. Importantly, the highly proficient L2 learners are arriving at the correct surface outputs in spite of the fact that neither their grammar nor their URs are the same as native Spanish speakers.

7. Conclusions

We propose that as adults are acquiring the phonology of their second language they will pass through various stages, each of which has distinct implications for L2 phonological representations. In their final state, L2 learners do not necessarily posit equivalent input representations as native speakers, even though they may arrive at the same output. These representational discrepancies will affect their productions and possibly lead to non-native-like performance. However, while they may not have the same underlying representations or the same phonological grammar, L2 learners can produce the appropriate surface outputs. Thus, native-like attainment need not mean acquiring the target language native grammar. Native speakers of a language benefit from extensive input allowing them to build the distributions necessary for phoneme categories to emerge; non-native speakers do not receive the same type of input nor do they receive the same amount of input to their computational system. Often in L2 classroom learning situations students are introduced to the written system which likely influences what is posited as the underlying phoneme. Since allophones are conditioned alternations dependent upon factors in the input, adult L2 learners may be impervious to the cues that indicate them.

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