ACQUISITION OF CONDITIONED ALTERNATIONS IN A SECOND LANGUAGE

Christine E. Shea
University of Calgary

1. Introduction

Part of acquiring a second language involves learning how sounds in the target language are conditioned by contextual factors. In illustration, all sounds represented by the letter "t" in English are not necessarily treated alike by the perception and production systems. Alternations may be driven by positional factors (initial/medial/final position in the word or phrase), prosodic factors such as stress and immediate contextual factors such as neighboring sounds.

Speakers' selection of one positional variant over another is predictable, and may be based upon contextual information present in the speech signal and prosodic structure that is not necessarily present. For example, abstract knowledge of foot structure is required for consistent production of the flapped variant of /t/ in North American English. However, this knowledge is not explicitly available in the input.

The question examined in this paper is how adult second language learners might approach this task. Specifically, how and when does contextual information of the sort that drives flapping in English become accessible to L2 learners? I propose that the acquisition of positional variants by adult second language learners requires a grammar that can track statistical probabilities in the input: Positional information that drives alternations is predictable and regular and in order to successfully master the phonological system of the target language, adult second language learners must be able to encode this information at some point during the learning process. The knowledge emerges through exposure to the L2 input and is dependent upon frequency and co-occurrence statistics across the target language lexicon.

Evidence for this account comes from adult L1 English/L2 Spanish acquisition of the stop-approximant alternation in Spanish. In Spanish, the voiced stops /b,d/g/ and the approximants /ßð□/ alternate in a highly predictable manner. Stops occur in word-initial position stops and approximants occur in foot-medial/word-medial position. Thus, the probability of a learner encountering an approximant in word-initial position (when this coincides with the edge of a foot) is almost zero.

I predict that L1English/L2 Spanish learners will not initially produce the alternation at all and will instead produce stops across the board. This is a case of transfer from English distribution patterns, where stops are found in most positions (the obvious exception being the flapped /t/). As experience with the language increases, learners will develop more robust distributional representations. Experience with the input will reinforce the connection between segmental alternations and their conditioning factors. In the case of

Actes du congrès annuel de l'Association canadienne de linguistique 2007.
Proceedings of the 2007 annual conference of the Canadian Linguistic Association.

our L2 learners of Spanish, this means connecting the stops with foot-initial position and approximants with foot-medial position.

Furthermore, I predict that as learners increase in their experience with the language, they will demonstrate instability in their productions. Unstable, highly variable productions may result from incorrect or incomplete initial hypotheses regarding the distributional information relevant to the alternations. Learners may also rely upon an item-based learning strategy. This strategy would lead to the production of approximants in words or sequences with high lexical frequency, but not in those with low lexical frequency, where stops are expected to occur. Finally, as learners stabilize their understanding of how the stop-approximant alternation is conditioned, they will be able to extend their item-based learning strategy to novel tokens. At this stage, learners will have successfully acquired the conditioning factors that drive the stop-approximant alternations.

In the literature on second language phonological acquisition it is implicitly assumed that allophones are acquired in the same way as new segments or features found in the target language (Eckman, El Reyes, Iverson 2003; Flege 1995). On this perspective, the learning task involves a comparative analysis of the two languages' phonological system and where they differ, either in terms of segments or features, is where learning must occur. However, there are two important and related tasks involved in the acquisition of conditioned alternations: First, the learner must notice the alternations and second, realize the factors that condition it. I maintain that by focusing upon the segments rather than the context, we are missing an important piece of the puzzle: Allophones are conditioned alternations that arise in predictable contexts. The acquisition of these conditioning factors is the true learning task.

In this study I present data from two perception experiments and one production experiment. The goal is to demonstrate that more advanced learners are aware of the connection between the alternation and prosodic structure, specifically foot structure, while less advanced learners are not. Given that metrical feet are an abstraction and are not explicitly available in the input, learners must begin to associate the cues that are available in the input to the abstract metrical structure. Specifically, that stops will indicate foot-initial position and approximants will be foot medial and that stress and word position are the relevant cues to the alternation.

In sum, the broad question addressed in this paper is how adult second language learners make use of the distributional information found in the speech stream and start to acquire conditioned alternations. Based upon perception and production data collected from L1 English/L2 Spanish participants, I propose that this knowledge is emergent, dependent upon distributional information in the input and only once learners have had sufficient exposure to the target language will they begin to realize that prosodic information and word position are tightly linked to the distribution of the alternations in Spanish. The question asked herein is, over the course of gaining this experience, what type of information do learners use?

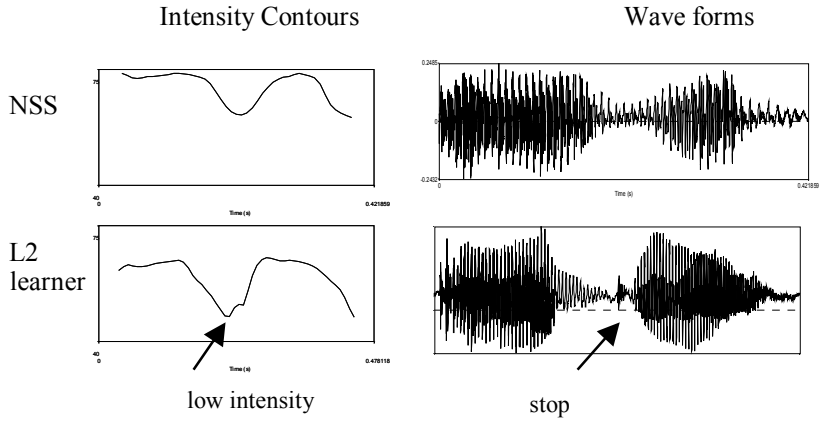
2. Stop-Approximant Alternation in Spanish

In this section I will outline the basic phonetic and phonological facts regarding the stop-approximant alternation in Spanish.

2.1 Phonetic Description

Figure 1 shows the production of the word *agua* 'water' by a native Mexican-Spanish speaker and a beginner L1 English/L2 Spanish speaker. In this token, the target segment occurs in intervocalic, foot medial position, the expected context for an approximant [□]. The native Spanish speaker's intensity contour clearly undergoes less of a drop at the onset of the second syllable than the L2 learner's contour. At the onset of the second syllable, where the approximant occurs in the native speaker's production, the L2 learner is producing a segment that is closer to a stop, both in terms of intensity and in terms of the burst that can be seen in the right hand panel. This burst is not present in the native Spanish speaker's production. As can be seen, stops have less formant structure and are less sonorous than approximants. Given this, approximants also higher intensity values than their stop counterparts.

(1) Figure 1: Native speaker and L2 learner productions of *agua* 'water'



2.1 Phonological Description

In general, phonological descriptions (Mascaró 1983; Harris 1968) state that the stop is underlying and the approximant is the allophone. Stops surface after nasals and the alveolar stop surfaces after the lateral /l/. Hualde (2005) states that traditional analyses have characterized the alternation in terms of feature spreading. The feature [+cont] spreads from the adjacent vowels to the [-cont] stops, rendering them as an approximant. The problem investigators quickly encountered with this analysis was how to account for the [-cont] nature of /d/ next to the lateral. Face (2003) gives a phonetic and phonological account that is based in the similarity of place of articulation between the lateral and the

alveolar stop. This, according to the author, is why the stop has a strong release. Other researchers have proposed that the /l/ phoneme in Spanish is underspecified for [cont] as an explanation.

From an OT perspective, Piñeros (2001) analysed the alternation in terms of the LAZY (Kirchner 1998) constraint family. Allophones surface because of a drive towards minimizing articulatory effort on the part of the speaker. While this approach does capture the idea of aligning stops with the edges of a prosodic unit, it remains vague in terms of how "effort" is quantified. In the present context, it does not explain why our native speakers of English actually seem to prefer to make more of an effort than necessary when speaking by producing stops across the board. In addition, this approach has a difficult time explaining the acquisition of the alternations.

In summary, the phonetic and phonological explanations proposed in the literature have a difficult time accounting for how learners acquire this alternation and also how the phonetics might play into the process itself.

In the next section, I present the data from two perception experiments demonstrating that learners of Spanish as a second language are in fact aware of the distributional information that drives the alternation.

3. Experiment 1: Crossing distributional information

3.1 Methodology

The objective of this first perception experiment is to find out whether L2 learners of Spanish have started to link stops with stressed syllables and approximants with foot-medial, unstressed position. This experiment represents a first attempt at determining the role of consonant onsets and stress information carried on the vowel in the perception of stress in Spanish as a second language. The task involved listening to CVCV sequences which were crossed for stop/approximant onsets and stressed/unstressed vowel. Listeners had to decide which syllable they perceived as stressed.

The prediction is that a monolingual English control group will perceive stress as conditioned uniquely by the vowel. The onset consonant will not influence their decision at all, following their experience with the distributional information present in the speech stream of English. On the other hand, our L2 Spanish learners will have started to realize the distributional relationship between stops and stressed vowels on the one hand, and approximants and unstressed, foot-medial vowels on the other. Thus, the perception of stressed syllables will be differentiated for these participants, based upon the syllable onset.

3.1.1. Participants

Participants were ten monolingual English speakers, thirteen low intermediate L1 English/L2 Spanish learners. All were recruited from the University of Calgary. Participants received either course credit or were paid ten dollars. The L1 English/L2 Spanish learners completed a questionnaire regarding their level of Spanish and number of years they had been studying the language and finally, whether they had ever lived in a Spanish speaking country. Data from

three participants was discarded because they had lived in a Spanish-speaking country for more than three months. This gave our total of ten participants in each group.

3.1.2. Stimuli

The stimuli were CVCV nonwords, created from naturalistic speech produced by a female native speaker of Mexican Spanish. The consonants alternated between the stop and the approximant, with consistent place of articulation across the two onsets. The vowel alternated between a stressed and unstressed token of [a]. Stimuli were created by splicing the onsets onto the vowels. A quarter of the syllables followed the prosodic information that is consistent with Spanish while another quarter contradicted this information. The same division occurred for positional information. For example, the sequence [**ba**ßa] follows the expected distributional information found in Spanish while [ßa**ba**] contradicts positional expectations. The onset segments and the two prosodically distinct versions of /a/ were crossed, yielding a set of 32 stimuli.

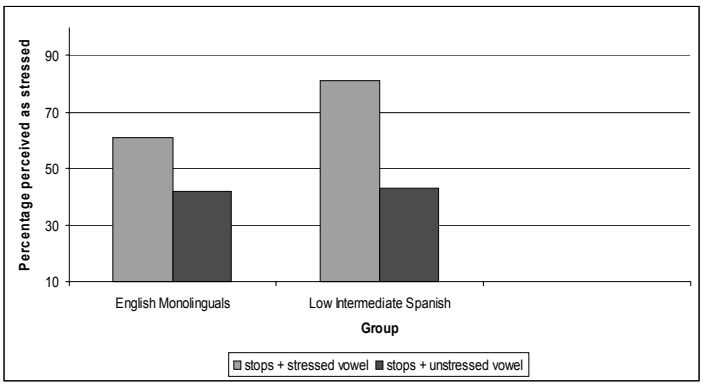
3.1.3. Procedure

Participants were seated in front of a Macintosh computer in a quiet room and given instructions via the computer screen. They were instructed to press the red key (left hand side of the keyboard, button with a red sticker on it) if they perceived the first syllable as stressed and the green key (right hand side of the keyboard, button with a green sticker on it). Stimuli were presented by means of Psyscope experimental program. Participants were given four practice trials, with feedback, after which the experimental trials began.

3.2 Results

Figure 2 presents the results from Experiment 1 for the perception of stop-initial syllables. Responses were tallied and calculated in terms of the percentage for each syllable that was considered stressed. As can be seen, the monolingual English group detects stress on the syllable with the stressed vowel. The L2 Spanish group also detects stress on the syllable with the stressed vowel, but the difference in percentages between the stops and stressed syllables and the stops and unstressed syllables is greater for our L2 learners than for the monolingual English speakers. In other words, our L2 learners are making a greater distinction between stops and stressed vowels and stops and unstressed vowels. This indicates that these learners have started to associate stops with syllable stress, consistent with the distributional information found in Spanish. However, we still do not have a completely clear picture of the consonant as an important factor in driving stress perception. To confirm this, we conducted Experiment 2 in which the vowel was maintained steady.

(2) Figure 2: Experiment 1 - Crossing distributional information



4. Experiment 2: Steady vowel – consonant alternation

4.1 Methodology

In Experiment 2, we maintained the vowel steady in order to determine if our participants use the information carried by the consonant to indicate stress. If L2 Spanish learners have started to realize the link between stops and stress, they will still select the stop-initial syllables as stressed, even without the stress information carried by the vowel. Our monolingual group should be close to chance in terms of their perception of stress.

4.1.2. Participants
Same as Experiment 1.

4.1.3. Stimuli
The stimuli were again CVCV sequences, with consonants alternating between stops and approximants. A natural token of a stressed [a] was modified using the PRAAT phonetics program (Boersma & Weenink 2007) to create a vowel with intensity, duration and amplitude values that fell in the middle of stressed/unstressed vowel continuum. The respective stops and approximants were spliced onto this vowel. This procedure yielded 6 bisyllabic words. Participants heard each word three times.

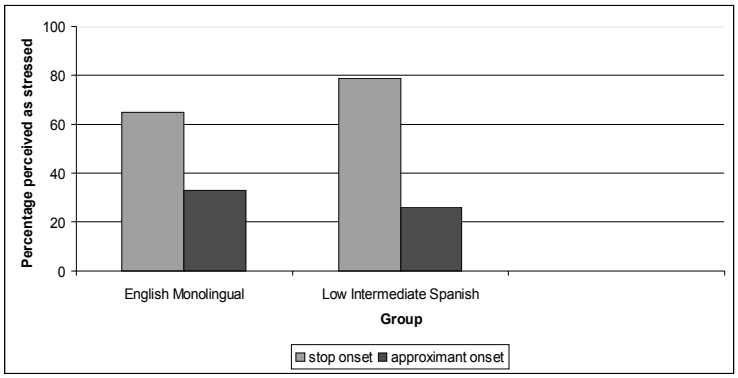
4.1.2. Procedure
Same as Experiment 1.

4.2. Results

The results from Experiment 2 show a similar pattern to Experiment 1. The two experimental groups are more likely to perceive stress on the syllables with stop-initial segments. However, the Low Intermediate group demonstrates a more robust distinction between the two types of onsets than that found in

Experiment 1. It appears that this group of learners is starting to associate stress with stop onsets.

(3) Figure 3: Experiment 2 - Steady vowel/consonant alternation results



4.3. Discussion: Experiments 1 and 2

The results of the perception experiments suggest that with experience, learners of Spanish begin to associate the stop-approximant alternation with stress information carried on the vowel. While both groups seemed to prefer stops to approximants in onset position, this may be a result of either innate preferences or reflect the distribution found in English. They could be transferring this knowledge to Spanish. However, evidence in favour of our hypotheses came from the greater difference in percentages between the stop and approximant onsets in the Low Intermediate Spanish L2 learners. If it were uniquely a matter of transfer, these differences should not have been as great.

In the next section we investigate whether the same predictions hold for production patterns as well.

5. Experiment 3: Production

In Experiment 3, we examined how learners are actually producing the alternations. Our goal was to determine if the productions also reflected increasing knowledge of the distributional information found in the speech stream. Recall that our predictions for this experiment were that low-level learners will be producing stops across the board while intermediate learners will have started to recognize the distributions that characterize the stop-approximant alternation. However, these learners will not have stabilized their distributional knowledge and will demonstrate inconsistencies and perhaps even word frequency effects.

5.1. Methodology

5.1.1. Participants

Participants were 5 low level L1 English/L2 Spanish learners, 5 intermediate level learners and 5 advanced learners. Our control group was composed of 5 native Mexican Spanish speakers.

5.1.2. Procedure

Participants read a list of 60 real and nonce words containing the target segments and the five vowels of Spanish. Each sound with each vowel occurred in all four possible positions. Participants read the list twice and the second set of tokens was used for analysis. Recording was carried out using Audacity sound editing program and data was recorded directly onto a laptop computer.

5.1.3. Analysis of tokens

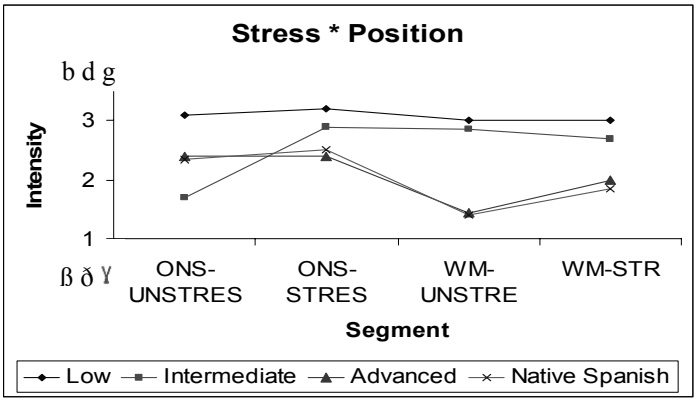
Stops are lower in intensity values than approximants, which have visible formant structure and higher amplitude. Thus, in order to distinguish between stops and approximants, root mean square intensity values were taken for each segment and subsequently the entire word. These values were then converted to decibels. The target segment intensity value was subtracted from the word intensity value to give an overall intensity ratio value for the realization of the segment (Lavoie 2001).

The lower the intensity ration value, the more "approximant-like" the segment (the target segment intensity is close to or greater than the intensity of the word reference). Higher values are expected for more "stop-like" segments (target segment intensity is highly different from the word reference).

5.2. Results

Figure 3 presents the results from Experiment 3. The vertical axis represents the values for the intensity ratios. Higher values mean more stop-like intensity measurements while lower values mean the consonant was closer to the word intensity, yielding more approximant-like characteristics. The horizontal axis depicts the position in the word. As predicted, low level learners had very high ratio values for all tokens, with little differentiation across positions or prosodic contexts.

(2) Figure 3: Results from Experiment 3 production



However, the low intermediate group shows an interesting pattern in that they are using more sonorous approximant-like tokens in foot-initial contexts, in word initial position. This follows neither the advanced group nor the native speaker patterns and requires further investigation. The advanced group patterns very closely to the native speakers, as predicted by our hypotheses.

5.3. Discussion: Experiment 3

As stated, the low intermediate group demonstrated the greatest variability in their productions, consistent with the hypotheses. It appears that learners with more language experience are acquiring the correct distribution of these alternations.

6. General Discussion: Experiments 1, 2 and 3

The results from the three experiments demonstrate that increasing language experience leads to a concomitant awareness of the stop-approximant alternation and the distributional information that drives it. In other words, this experience means that learners are aware of the alternations and can produce them.

In terms of perception, the low intermediate Spanish learners detected stress on the stop syllables at levels greater than chance (Experiments 1 and 2). In production, our lowest level learners are producing stops across the board. They appear to be unaware of the alternation. Our intermediate level learners are starting to produce the alternations, but their productions are highly variable and unstable.

There are, however, explanations other than distribution-based learning that could account for these results. Our participants could be relying upon functionally-based perceptual preferences for stops in onsets (Smith 2003; Gordon 2005). Acoustically, stops make the "best" onsets because of their low sonority. When followed by high sonority vowels, the auditory system must adapt to the abrupt shift in intensity, forcing auditory neural adaptation. Thus, stops can be seen as the ideal onsets because they force the auditory system to adapt and acoustically mark the prosodic boundary more efficiently than the low-sonority approximants. Following this explanation, the functionally unmarked position for stops would be phonetically strong positions such as released consonants and stressed syllables and also in psycholinguistically strong positions such as word-initial syllables and morphological roots. This would account for the preference our participants had for stops in stressed syllable onsets (Experiment 1). However, these results could also be due to transfer from English. Our participants could simply prefer stops in onsets across the board because that is the distribution found in their native language. To explore this explanation, we must turn to the results from Experiment 2.

Recall that in Experiment 2, our monolingual English group perceived a higher percentage of stop onset syllables as stressed even though the vowel was neither stressed nor unstressed. Thus, the difference in percentage between the stop-initial syllables perceived as stressed and the approximant-initial syllables

perceived as stressed cannot be attributed to any information carried on the vowel. According to functionally-based analyses, listeners should prefer stops in stress-position because of the neural adaptation provided by the abrupt intensity shift. However, in English, the only contrast that exists between stops and approximants conditioned by stress is the flapped /t/ in words such as 'water'. Thus, our monolingual English learners have had experience with one specific stop-approximant alternation in their L1. The occurrence of the flapped /t/ in English has a more limited type distribution than the approximant [ð] in Spanish which also means that they will have had less experience with this alternation.

I suggest that the monolingual English participants could be relying upon the distributional information in English when approaching this task and associating stops as better onsets in *general*, not as better onsets for stressed syllables. Because their instructions were to listen for *stressed syllables*, participants chose the ideal syllables for them, which are stop-initial, not approximant initial, independent of stress considerations. One way to correct for this possible effect would be to instruct listeners to detect unstressed syllables. If the monolingual English speakers still prefer stop onsets for unstressed syllables, then they the conclusion can be made that in general, stops are the ideal onset for this group. In other words, if our participants maintained their preference for stops in onset, regardless of the instructions to detect stressed or unstressed syllables, this would potentially indicate a transfer from English.

In sum, I would argue that while functionally-based explanation may play a role at a basic level of language acquisition where neurological biases initially enter the acquisition process, these biases can be mediated by experience with the language being acquired. Similar explanations have been proposed for the acquisition VOT values in Spanish, where the voiced-voiceless boundary that is linguistically relevant actually crosses an innate perceptual boundary. Nevertheless, Spanish-learning infants shift their VOT boundaries to the language-relevant value at an early age.

Any explanation for how learners acquire conditioned alternations must consider the cues that exist in the speech stream and how L2 learners eventually become sensitive to these cues. The cues, at least at the initial stages, are phonetically based. This means that learners must be storing this phonetic information in some form in order to acquire the alternations they cue. Thus, L2 learners must create representations that can change over the course of acquisition and are sensitive to the accumulation of examples in the input. These representations must be capable of storing the rich information that exists in the speech stream and cues the alternations. I propose that exemplar-type representations best fulfill these requirements. Our learners are storing phonetic information in their developing representations and using this to acquire the alternations. Evidence for this comes from the inconsistency observed in the productions of our Low Intermediate learners. These learners may not be aware of the distributional information that drives the alternations, but they are nonetheless aware that they occur. This leads to initially unstable representations which begin to gain robustness as more exemplars are

accumulated. Exemplar-type representations would also account for the differences observed across the two groups in perception.

Exemplar representations encode position and prosodic information about each linguistic unit encountered. Over time, the system begins to extract this information and the relationship between variants emerges. Once this happens, access to the information is available to the phonology and reflected in production patterns of L2 learners.

7. Conclusions

Learning predictable, contextually conditioned alternations in a second language requires awareness of the target language distributional information. As learners accumulate experience with a language, they begin to produce the alternations and perceive their conditioning factors. Storing information in the lexicon facilitates the acquisition of phonological alternations.

References

Cohen John.D., Brian MacWhinney, M. Flatt and John Provost. 1993. PsyScope: A new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, and Computers*, 25: 257-271

Face, Timothy L. 2002. Disentangling the necessarily entangled: The phonology and phonetics of Spanish spirantization. *Southwest Journal of Linguistics* 21:56-71.

Gordon, Matthew. 2005. A perceptually-driven account of onset-sensitive stress. *Natural Language and Linguistic Theory* 23:595-643.

Harris, John. 1969. *Spanish Phonology*. Cambridge, MA: MIT Press.

Hualde, José Ignacio. 2005. The Sounds of Spanish. Cambridge, UK: Cambridge University Press.

Lavoie, Lisa. 2001. *Consonant Strength: Phonological Patterns and Phonetic manifestations*. NY: Routledge Press.

Kirchner, Robert. 1997. Geminate Inalterability and Lenition. *Language* 76:509-545.

Martínez-Celdran, Eugenio. 1991. Sobre la naturaleza fonética de los alófonos de /b,d,g/ en español y sus distintas denominaciones. *Verba* 18:235-253.

Mascaró, Joan. 1991. Iberain spriantization and continuant spreading.In *Catalan working papers in linguistics 1991*, eds Branchadell, Palmada. Quer. Roca and Solá, 167-179. Barcelona: Universitat Autónoma de Barcelona.

Piñeros, Carlos-Eduardo. 2002. Markedness and laziness in Spanish obstruents. *Lingua* 112:379-413.

Smith, Jennifer L. 2002. *Phonological Augmentation in Prominent Positions*. PhD dissertation, University of Massachusetts, Amherst.