Perceiving and Processing Dialectal Variation in Spanish: An Exemplar Theory Approach

Amanda Boomershine
The University of North Carolina, Wilmington

1. Introduction

The current studies on perception and processing of variable input in Spanish look at how native speakers of a given dialect process input that is different from their own dialect, or what they have stored in their lexicon. The stimuli for these studies are Spanish words and nonwords produced by native speakers of Mexican and Puerto Rican Spanish. These dialects were chosen because they exhibit significant phonological variation, and the variables chosen have been shown to be dialect indicators or markers by speakers of other dialects. These dialects differ in the realization of word-final /n/, syllable-final /ɾ/, and syllable-final /s/.

These differences are tested in three psycholinguistic studies on perception and processing. The results of these studies are easily modeled and accounted for within an exemplar-based approach. A listener's linguistic experience is stored as exemplars in the lexicon that are connected to other linguistic and extra-linguistic information that the listener has experienced. This way, input is stored as detailed exemplars, which activate, and in turn are activated by, other categories such as stereotypes (e.g., age, gender, dialect, etc.) and phonological generalizations (e.g., word-final nasals are velar). The findings of the current study add to the growing literature on the effects of linguistic experience on the perception of variable input, as well as to the growing literature on exemplar-based models of perception and production.

2. Previous accounts

Processing and perception of variable input, or talker variability, has been researched by a number of linguists, especially in the late 1990's. There are two main views on how variable input is processed and stored. One view, which is more traditional, argues for a simple representation of the input, usually as phonemes, with a complex mapping of acoustic information onto these phonemes. This view is often referred to as the mental dictionary assumption, which states that the lexicon is comprised of one representation of each word that the listener has heard and uttered. This representation has been stripped of all phonetic and speaker variation and information, and only retains the contrastive elements of speech (i.e., phonemes).

The other view, which is considered to be somewhat radical, is the view that will be adopted in this research. Supporters of this view have argued that the representation of input and output is not simple, but rather a complex unit that stores information about the talker's voice, his speaking rate, and any variation in the speech signal. Therefore, the mapping from this input onto the stored units in the lexicon, or exemplars, is simple. This dichotomy will be discussed below, including findings of recent studies on perception and processing of variation, as well as models of each of these views.

2.1 Traditional approaches

The traditional view that input is stored as a very simple representation in the lexicon has been supported by many for years. In fact, it is the basis for most traditional phonological theories. One point of evidence is that listeners receive input that is extremely variable, yet have very little difficulty processing it. They argue that this variable input undergoes a process of normalization, which

© 2006 Amanda Boomershine. Selected Proceedings of the 8th Hispanic Linguistics Symposium, ed. Timothy L. Face and Carol A. Klee, 58-72. Somerville, MA: Cascadilla Proceedings Project.

eliminates any contextual- or talker-specific information in the input. The result, then, is a string of segments, or phonemes, which is void of details and particulars about the talker and the context in which that sequence was uttered. Each time the listener hears variable or complex input, it is stripped down to a string of phonemes, and stored with the entry in the lexicon containing that same string of phonemes.

This view of speech processing has been represented most often with the TRACE model (Elman & McClelland 1986). This is a neural network model in which processing occurs through connections among numerous processing units, called nodes. Distinctive features, phonemes, and words constitute nodes, which represent different levels of processing. Each of these nodes has three levels: a resting level, a threshold, and an activation level. These nodes are connected, and if a given node is activated, it may activate other nodes that it is connected to. This activation across nodes can lower activation or raise activation of connected nodes. For instance, given the input <Pam> [p^hæm], the phoneme nodes for /p/, /æ/, and /m/ would be activated. By activating these phoneme nodes, other phoneme nodes representing competing sounds, such as /b/ or /d/ for the first phoneme, would have lower activation levels. This activation would then activate word nodes containing these phonemes.

The TRACE model of word recognition requires that all detailing be removed from the input in order to match a string of phonemes that is stored in the lexicon. This view, as mentioned earlier, contrasts with that which allows detailed phonetic and talker/contextual information to be stored in the lexicon. This outlook will be discussed below.

2.2 Usage-based approaches

Exemplar Theory, or exemplar-based models of speech perception and processing, is a framework that allows for detailed representation of input to be stored in the lexicon. This theory or model is used by several linguistics, including Pisoni (1990, 1992, 1997), Pisoni et al. (1985), Johnson (1990, 1997), Goldinger (1990, 1996, 1997), and Goldinger et al. (1991). Within this framework, detailed information from the speech signal is processed by the listener and becomes part of the stored representation in the lexicon. Therefore, listeners encode this very specific, detailed information rather than discard it.

Pisoni has conducted research on talker processing, where he looks at how talkers affect listeners' perception and processing. In one such experiment, he presented one subject group with stimuli spoken by only one talker, and the other subject group with stimuli presented by 15 different talkers. The subjects' task was to identify the words that they heard. This identification performance was significantly better for words produced by a single talker (Pisoni 1992). In another experiment, he tested the reaction time in naming these words, both produced by a single talker and produced by multiple talkers. The results showed that when the listeners were presented with multiple talkers, they responded much more slowly and produced more errors.

If the speech processing system were organized as others have claimed, where the input is void of all talker and context variability, these results would be impossible to interpret. Within that model, listeners should have no difficulty in processing speech by various talkers, as their process of normalization would convert that variable input into strings of phonemes. However, within an exemplar-based model of speech perception and processing, these findings are easily explainable. The listener is storing this talker-specific information in the lexicon, with each exemplar being encoded with this information. Therefore, when a listener is presented with input from a specific talker, that talker's category is activated, along with the category of exemplars that matches the input phonetically. An example of such an activation, based on Johnson's XMOD, is given below, in Figure 1.

In this figure, the speech input is the word 'sosa'. Exemplars in the lexicon are activated according to their phonetic similarity to the input. Exemplars retain auditory and phonetic details of the talker. These activated exemplars in turn activate categories such as talkers (María vs. José) and lexical categories, which in this case are words. The weight of the line corresponds to the amount of activation for each item. Therefore, in the figure below, the second exemplar has the highest activation based on the input. The talker with the highest activation level is José, as the talker-specific details in the input best match those stored for José. Then, the category that has the highest activation level is the word 'sosa'. It should be noted that this is a rough simulation of how XMOD works.

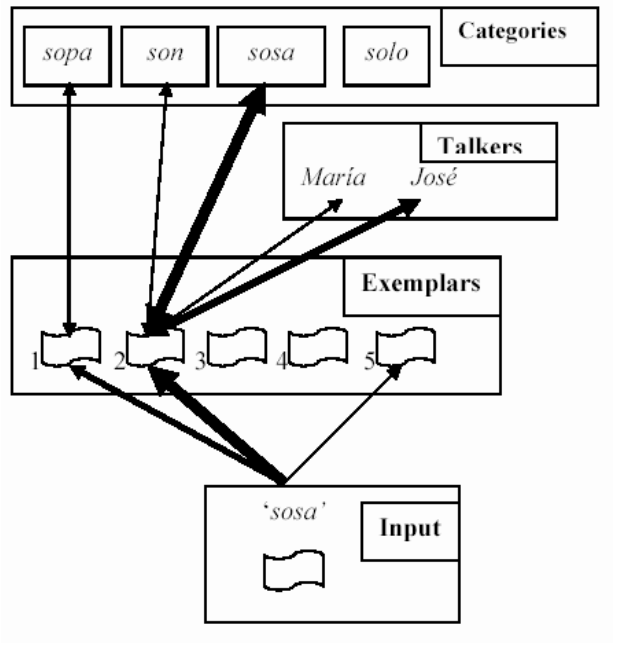

Figure 1: Johnson Model of Exemplar Theory (2004)

In exemplar-based approaches to speech perception and processing, such as XMOD, the item to be stored (i.e., the input) is compared to all existing exemplars in the lexicon. If it is very similar to an item already stored, then it will be stored as an instance of that exemplar. If it is dissimilar enough, then it will be stored as its own exemplar. The auditory properties of the input are compared with the auditory properties of the exemplars in the lexicon. The similarity between the input and the exemplars' auditory properties determines the activation level of each exemplar. If a given exemplar receives a very high activation level, then the input will be stored as part of that exemplar. The predictions of this model for the current study are discussed in § 4.1.

3. Language background

In this study, three phonological variables in two dialects of American Spanish are used to determine the effects of dialectal variation and linguistic experience on speech perception and processing. The two dialects being studied are Puerto Rican Spanish (San Juan area) and Mexican Spanish (Morelos area). These dialects were chosen because they exhibit significant phonological variation, as well as syntactic and prosodic variation, and were therefore considered to be dialects that could be easily distinguished by naïve speakers of Spanish. The three variables in question are word-final /n/, syllable-final /s/, and syllable-final /ɾ/. The following sections will provide a brief overview of the three variables within each dialect that are being studied in this research project. The presentation and discussion of the variables should not be taken to mean that the rules or processes mentioned below are representative of the author's views of phonological theory, but are merely being used to describe the data and dialectal differences.

3.1 Mexican Spanish

3.1.1 Phonological variable /n/

Mexican Spanish, like other dialects of Spanish, has a non-variable nasal assimilation rule that applies to nasals preceding consonants. This assimilation rule requires the coda nasal to assimilate or 'take on' the place specification of the following consonant. While all dialects of Spanish have a nasal assimilation rule for coda nasals, there is also a word-final neutralization rule in effect in all dialects of Spanish. In the dialect of Mexican Spanish being discussed here, this word-final neutralization rule

results in word-final alveolar nasals preceding a pause or a vowel (in the cases of word-final nasals preceding consonants, the nasal assimilation rule mentioned above applies). This notion of contextual word-final neutralization to alveolar, rather than to velar or bilabial, is a crucial difference between the dialects being studied here. It should be noted that other regions in Mexico have a neutralization process that results in bilabial nasals rather than alveolar nasals word finally. For instance, the Spanish spoken in the Yucatan Peninsula is known for word-final bilabial neutralization.

3.1.2 Phonological variable /ɾ/

All dialects of Spanish have the flap phoneme /ɾ/, or the *vibrante simple* in Spanish. In many dialects of Spanish, this rhotic is realized as a flap (i.e., does not undergo any phonological changes). This is the case for the dialect of Mexican Spanish being studied here. It is not, however, the case for Puerto Rican Spanish, and this difference will be discussed below.

3.1.3 Phonological variable /s/

The voiceless sibilant fricative /s/ has several realizations in Spanish. The fricative /s/ can undergo deletion, aspiration, voicing, or can be retained as /s/. In Spanish, there is a general voicing assimilation rule where the fricative /s/ is voiced before a voiced consonant. The processes of deletion and aspiration, mentioned above, do not occur in the dialect of Mexican Spanish discussed here. These processes do, however, occur in many dialects of Spanish, including Puerto Rican Spanish, and will be discussed below.

3.2 Puerto Rican Spanish

3.2.1 Phonological variable /n/

The nasal assimilation rule discussed in §3.1.1 above applies in Puerto Rican Spanish for most speakers. Unlike in Mexican Spanish, in Puerto Rican Spanish word-final nasals before pauses and vowels are velarized. This is a crucial difference between Puerto Rican Spanish and this dialect of Mexican Spanish, where in the former nasals neutralize to a velar place of articulation, and in the latter they neutralize to an alveolar place of articulation.

3.2.2 Phonological variable /ɾ/

In Puerto Rico, syllable-final /ɾ/ is realized as a flap [ɾ] or is lateralized to [l]. This process of lateralization has been noted for decades, and was described by Navarro Tomás in 1948. Lipski reports that lateralization occurs with 50% of the pre-consonantal and pre-pausal flaps in Puerto Rican Spanish (cf. Lipski 1994).

3.2.3 Phonological variable /s/

As noted earlier, there are several realizations of coda /s/. Puerto Rican Spanish speakers retain, aspirate, and delete syllable-final /s/. Both aspirated and deleted /s/ are widespread throughout the island, and Lipski states that elision of /s/ has its origins in the capital (San Juan) and appears to be spreading outward (cf. Lipski 1994). Both aspiration and elision span socio-economic classes and age categories, and neither are specific to one group of speakers. In fact, the speakers that participated in the production study for this experiment produced both aspirated and deleted /s/.

4. Current study

In order to measure the effect of native dialect on speech perception and processing, three experiments were conducted on native Spanish speakers from Mexico and from Puerto Rico.[1] For the first two tasks, a naming task and a lexical decision task, native dialect effect is considered to be correlated with reaction time. In the third task, the actual response is taken to represent the native dialect effect. Words containing the phonological variables discussed in Section 3 were used as the stimuli for the tasks.

4.1 Stimuli

The same stimulus set is used for experiments 1, 2, and 3. Experiments 1 and 3 use only the real words from the stimulus set, while experiment 2 uses both the real words and nonwords from the stimulus set. While all three experiments use stimuli from the same stimulus set, the experimental task differs from experiment to experiment. The first experiment consists of a naming task in which the participants must repeat the word that they hear as quickly as possible. The second experiment involves a lexical decision task in which the participants must decide, as quickly as possible, whether the word they hear is a real word or a nonword. The final experiment is an identification task in which the participants have to determine whether the word they heard was produced by a speaker of their own dialect or another dialect.

The stimuli in these experiments exhibit possible phonological variation in the two dialects being studied. The three variables that are being examined are syllable-final /s/, word-final /n/, and syllable-final /ɾ/. These three phonemes have variable realizations depending on many factors, one of which is dialectal region. The stimulus set also contained non-variable words, which were used as fillers in the experiments. Figure 2 provides examples of the stimuli for the experiments.

variables	word	gloss	Mexico	Puerto Rico
/s/	astro	‘astro’	[astɾo]	[ahtɾo], [atɾo]
/n/	canción	‘song’	[kansjon]	[kansjoŋ]
/ɾ/	porque	‘because’	[poɾke]	[polke]
filler	oso	‘bear’	[oso]	[oso]
nonword	cuande	---	[kwan̪de]	[kwan̪de]

Figure 2: Example stimuli for experiments 1, 2, and 3

There are 45 test words arranged into three groups of fifteen based on the variable they contain (/s/, /n/, or /ɾ/). There are 21 filler words that do not exhibit variation of the three variables being studied in the two dialects in question. There are 32 nonwords that were used only in the lexical decision task. The complete stimulus set contains 98 words, all of which are bisyllabic. The stimuli are further described in the following sections: Section 4.1.1 describes the test words; Section 4.1.2 describes the nonwords; while Section 4.1.3 describes the filler words. Section 4.1.4 describes the production of the stimuli.

4.1.1 Test words

As mentioned above, the test words can be divided into three groups depending on the type of phonological variation that they exhibit. The first group contains fifteen words that have a word-final nasal. In this phonological context, word-final nasals are neutralized either as alveolars [n] or velars [ŋ]. In most of Mexico, including the region under study here, word-final nasals that are followed by a vowel or a pause are realized as alveolars. In most of Puerto Rico, and in the area related to this study,

[1] This research project was generously funded by an OSU Alumni Grant for Graduate Research and Scholarship and an OSU College of Humanities Small Grant.

word-final nasals followed by a vowel or a pause are realized as velars. Therefore, the word *pan* ‘bread’ is produced as [pan] by a Mexican Spanish speaker and as [paŋ] by a Puerto Rican Spanish speaker. It should be noted that in some areas of Mexico, in particular the Yucatan Peninsula, word-final nasals are realized as bilabial nasals rather than alveolar nasals. Speakers from this region did not participate in the study.

The second set of test words contains fifteen words with an underlying syllable-final /ɾ/. In coda position, /ɾ/ is realized as /ɾ/ or undergoes lateralization, resulting in /l/. Lateralization of /ɾ/ is frequent in the Caribbean, and is very common in Puerto Rico, especially among younger, less educated speakers. Coda /ɾ/ is usually realized as /ɾ/ in Mexico. Therefore, *Gilberto* ‘Gilbert’ is pronounced as [xilβeɾto] in Mexico but as [hilβelto] in Puerto Rico. It should be noted here that syllable-final rhotics are often produced as trills in Mexico, but never as laterals. Therefore, the contrast here is between rhotics and laterals, and not taps and trills.

Fifteen words containing syllable-final /s/ comprise the final set of test words. There are several realizations of syllable-final /s/ in Spanish. Coda /s/ is voiced [z] when followed by a voiced consonant. It is a voiceless alveolar fricative [s] in all other cases in many dialects of Spanish, including Central Mexican Spanish. Coda /s/ can be aspirated [h] or deleted in other dialects of Spanish, including Caribbean Spanish. Therefore, the final set of test words was either produced with a voiceless alveolar fricative [s] by the Mexican Spanish speakers or with an aspirated or deleted /s/ by the Puerto Rican Spanish speakers. For example, the word *este* ‘this, east’ is pronounced as [este] in Mexico but as either [ehte] or [ete] in Puerto Rico.

4.1.2 Filler words

In addition to the three groups of test words, there is also a group of filler words in the stimulus set. The words in this group were chosen because they do not exhibit variation in word-final /n/, coda /s/, or coda /ɾ/. They were intended to be non-variable forms, or nearly non-variable forms. For instance, *oso* ‘bear’ was chosen because it is pronounced as [oso] in both Mexico and Puerto Rico. Another such non-variable word that was used as a filler is *obra* ‘play, work’, which is pronounced as [oβɾa] in both Mexican and Puerto Rican Spanish. This group of filler words, like all fillers, was used to distract the participants from the task at hand.

4.1.3 Nonwords

In Experiment 2, the stimulus set not only included the three test groups and the filler group described above, but also a group of nonwords. The nonwords were used only in the second experiment because that task was a lexical decision task. In that session, the participants were asked to listen to a word and determine whether it was a word that existed in Spanish or not. Therefore, nonwords were a necessary component of the stimulus set in order for the task to be completed.

There were 32 nonwords in the stimulus set. The nonwords were constructed from 32 real words in Spanish. These real words were divided into four sets of eight words. In the first set of words, the onset consonant in the penultimate syllable was changed to a consonant that resulted in a nonword in Spanish. An example of a change in the penultimate onset consonant is the nonword *sindo*, which was originally *lindo* ‘cute’. In this example, the onset [l] was changed to [s]. The second set of nonwords was constructed by changing the vowel in the penultimate syllable. The nonword *dido* originated from *dedo* ‘finger’, in which the penultimate vowel was changed from [e] to [i]. In the third set, the nonwords were created by changing the onset of the last syllable, as in the nonword *cuanes*. This nonword was created from *cuales* ‘which (pl.)’ by changing the onset [l] to [n]. The final set of nonwords was produced by changing the vowel of the last syllable. Thus, the word *queso* ‘cheese’ was converted into the nonword *quesa* by changing the final vowel from [o] to [a].

4.1.4 Production of stimuli

The stimuli that were used in the experiments were produced by ten native Spanish speakers. Five participants were native Spanish speakers from Puerto Rico who were studying at the Ohio State

University. The other five participants were native Spanish speakers from Mexico who were studying at the Ohio State University. All of the participants were born and raised in either Mexico or Puerto Rico and had been in Ohio for less than four years. They all reported Spanish as their native language and English as their second (non-dominant) language. The participants were paid $10 for their participation in a 20-minute production session. The participants were recruited by an advertisement distributed by email and by word of mouth (i.e., from contacts in the community). The stimuli were spliced into individual tokens, and the amplitude was equalized using a Praat script in order to insure equal peak amplitude across all ten speakers for all stimulus items.

4.2 Participants

Thirty-three participants took part in the experiment. Thirteen (8 females and 5 males) of the participants were native Spanish speakers from Puerto Rico who studied or worked at the Universidad de Puerto Rico – Río Piedras. The remaining twenty participants (9 males and 11 females) were native Spanish speakers from Morelos, Mexico who taught at the Comunidad Educativa de Cemanahuac, or who were relatives or friends of teachers at Cemanahuac. The data from one of the twenty participants from Mexico was not used. It should be noted that the desired number of participants was twenty from each region. However, due to the unpredictable occurrence of Hurricane Frances while in Puerto Rico, only thirteen participants from Puerto Rico took part in the study. All of the participants reported normal hearing and no history of speech or hearing trouble. The participants were paid $10 (or $100 pesos) for their participation in a 30-45 minute session. The participants were recruited by an advertisement posted at each of the respective schools and by word of mouth (i.e., from other participants).

4.3 Procedure

There were three tasks in the experiment: a naming task, a lexical decision task, and an identification task. The participants took part in all three of these tasks, in the order listed above. For all of the participants and for all of the tasks, a Dell Inspiron 1000 laptop computer and a 5-button Serial Response Box were used to conduct the experiment. The experiment was run using E-Prime software. All of the participants used a head-mounted microphone headset for all of the tasks. After completing these tasks, the participants completed a one page, double-sided post-experiment questionnaire.

4.3.1 Naming task

The first task, a naming task, investigates whether a speaker's native dialect affects their naming or repetition time of words from both their dialect and another dialect. In this task, two independent variables were manipulated. The first variable is the dialect of the speaker who is producing the stimulus token. As mentioned earlier, the stimuli were produced by five female speakers of Mexican Spanish and five female speakers of Puerto Rican Spanish. The second variable is the phonological variable found in the test words in the stimulus set. The three phonological variables being manipulated are the realization of syllable-final /s/, the realization of word-final /n/, and the realization of syllable-final /ɾ/. This variable is directly related to the first variable in that the realization of these variables is correlated with the native dialect of the speaker.

In the naming task, participants were instructed that they would hear a word in Spanish, and that they were to repeat or name that word as quickly and accurately as possible. They were to repeat the word as loudly as possible into the head-mounted microphone that was attached to their headphones. They were told that after each repetition, their response time (in milliseconds) would appear on the screen, and their goal was to keep the reaction times as low as possible (i.e., respond as quickly as possible), while maintaining accuracy.

After the spoken instructions from the researcher and after reading the instructions on the computer screen, they completed five practice trials in which they named filler words (i.e., non-variable words). During the practice block, the participants were given the opportunity to ask questions

or ask for clarification. The researcher also used this time to adjust the microphone position and sensitivity. Once the participants and the researcher felt comfortable with the task, they were reminded of the instructions and then were able to start the test block, which consisted of 76 trials.

The participants in Puerto Rico were seated at a rectangular table with the researcher, in a reading room on the second floor of the main library at the University of Puerto Rico. The participants in Mexico were seated at a circular table with the researcher, in a private classroom at the Cemanahuac Language Institute. The trials were conducted on a Dell Inspiron 1000 laptop, using E-Prime experiment software, a five-button serial response (SRS) box, and a head-mounted headphone – microphone set. The researcher sat at the table with the participants to monitor progress and to be able to answer any questions or problems that arose during the experiment. The participants were able to partially control the presentation rate. Participants were told to press the #1 button on the SRS box in order to continue with the experiment between test blocks. The participants were tested individually, and this task took participants fifteen minutes on average.

4.3.2 Lexical decision task

The lexical decision task investigates whether a speaker's native dialect affects their ability to determine whether a word produced by a speaker from their dialect and another dialect is a word or a nonword in Spanish. In the lexical decision task, participants were instructed that they would hear a word, and that they were to determine whether what they heard was a real word or a nonword in Spanish. If the word existed in Spanish, they were told to press button #1 on the button box. If the word did not exist in Spanish, they were told to press button #2 on the button box. They were to press the button as quickly as possible after having heard the stimuli. They were told that after each response, their response time (in milliseconds) would appear on the screen, and their goal was to keep the reaction times as low as possible (i.e., respond as quickly as possible), while maintaining accuracy in their responses.

After the spoken instructions from the researcher and after reading the instructions on the computer screen, they completed five practice trials in which they determined whether five words existed in Spanish or not. All five words used in the practice trial were non-variable pronunciations of real words in Spanish (e.g., *gato* 'cat', *oso* 'bear', etc.) During the practice block, the participants were given the opportunity to ask questions or ask for clarification. Once the participants and the researcher felt comfortable with the task, they were reminded of the instructions and then were able to start the test block, which consisted of 100 trials.

4.3.3 Identification task

The final task that was conducted was an identification task, in which the participants were asked to determine whether the word they heard was produced by a speaker of their dialect or another dialect. In the identification task, participants were instructed that they would hear a word, and that they were to determine whether that word was produced by a speaker of their dialect or another dialect. If the word was produced by a speaker of their own dialect, they were told to press button #1 on the button box. If the word was produced by a speaker of another dialect, they were told to press button #2 on the button box. They were told to take their time responding, as their reaction time was not being calculated, only their actual response.

For this task, there was no practice block, only a test block, which consisted of 24 of the real words from the stimulus set. One half of the words were produced by speakers of Mexican Spanish, and the other half were produced by speakers of Puerto Rican Spanish. A third of the set of 24 words used in this task contained the phonological variable /n/, another third the variable /s/, and the remaining third the variable /ɾ/. Thus, half of the words containing /n/ were produced by Mexican Spanish speakers, and the other half by Puerto Rican Spanish speakers, etc.

4.3.4 Post-experiment questionnaire

The final task in which the listeners participated was a post-experiment questionnaire. The goal of the questionnaire was to determine the amount of dialect exposure they had, and also the amount of time they had lived outside of their region. The questionnaire was also used to determine extra-linguistic factors such as age, education background, and travel experience. The purpose of the final portion of the questionnaire was to tap into their insights regarding the purpose of the experiment, as well as to find any problems with the tasks that they participated in.

5. Results

5.1 Naming task results

Using SPSS software, a repeated-measures analysis of variance (ANOVA) was conducted on the reaction time data, with the two factors "phonological variable" (word-final /n/, syllable-final /ɾ/, and syllable-final /s/) and "speaker dialect" (Mexican or Puerto Rican). There was a significant main effect of phonological variable [$F(2, 2) = 37.387$; $p < 0.05$]. The stimuli containing a syllable-final /ɾ/ resulted in the shortest reaction times, while the stimuli containing syllable-final /s/ resulted in the longest reaction times. This main effect for phonological variable is shown below in Figure 3.

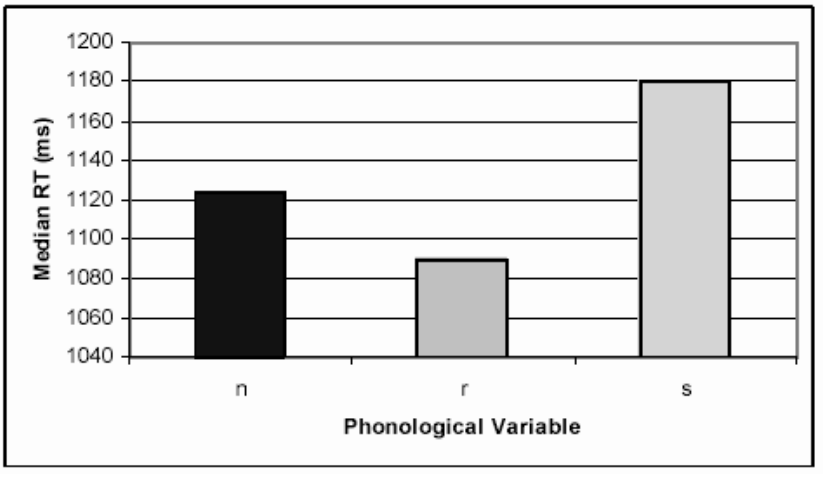

Figure 3: Significant main effect for phonological variable for naming RT data

5.2 Lexical decision task results

The lexical decision task is a choice reaction time experiment that requires participants to choose between two possible responses as quickly as possible. Therefore, in the lexical decision task, both the reaction time and the response were recorded for each participant. The reaction time data represent a measure of perceptual processing difficulty, while the accuracy responses are meant to determine whether the variation in the input affects the perceptual processing of stored exemplars in the lexicon.

A repeated-measures analysis of variance (ANOVA) was conducted on the lexical decision task reaction time data, with the two factors "phonological variable" (word-final /n/, syllable-final /ɾ/, and syllable-final /s/) and "speaker dialect" (Mexican or Puerto Rican). There was a significant main effect for phonological variable [$F(2, 2) = 36.64$; $p < 0.05$]. The stimulus items containing syllable-final /s/ resulted in slower reaction times compared to those items containing word-final /n/ and syllable-final /ɾ/. Overall, those items containing syllable-final /ɾ/ resulted in the fastest reaction times. This main effect for phonological variable is shown below.

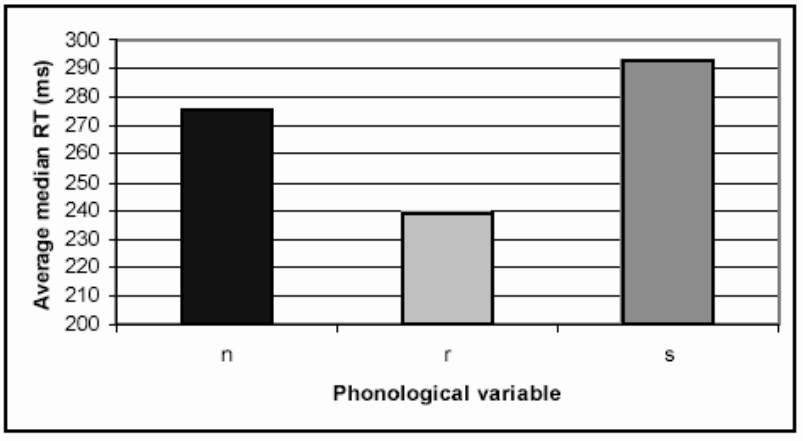

Figure 4: Significant main effect for phonological variable for lexical decision RT data

Along with the reaction times, the responses to the lexical decision task were analyzed. To determine if the native dialect of the speaker affected the response accuracy, a repeated-measures analysis of variance (ANOVA) was conducted on the accuracy data, with the factor "speaker dialect" (Mexican or Puerto Rican). These results contain the responses to both the words and the nonwords. One significant main effect was found from the results. There was a significant main effect of speaker dialect [$F(1, 3) = 14.813$; $p < 0.05$]. Regardless of the dialect of the listener, the participants were most accurate overall at responding to input produced by Puerto Rican speakers. This is shown below.

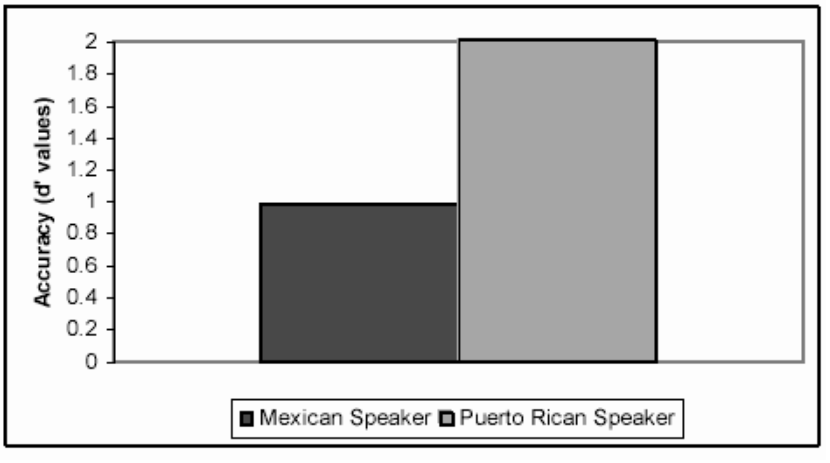

Figure 5: Significant main effect for speaker dialect for the lexical decision accuracy data

The lexical decision accuracy results are presented as d' scores in order to eliminate any bias in response. However, when we look at the number of hits (correct responses to words) and the number of false alarms (incorrect responses to words) individually, we see that both Mexican and Puerto Rican listeners responded correctly to words more often when those words were produced by Mexican speakers. Both Mexican and Puerto Rican listeners had an overall bias to push 'word' when they heard nonwords produced by Mexican speakers as compared to nonword stimuli produced by Puerto Rican speakers. These differences in hits and false alarms are shown below.

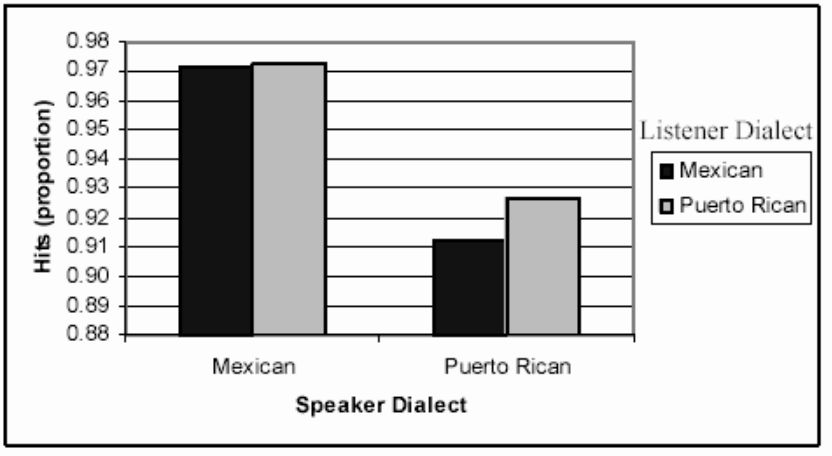

Figure 6: Proportion of hits for speaker dialect by listener dialect

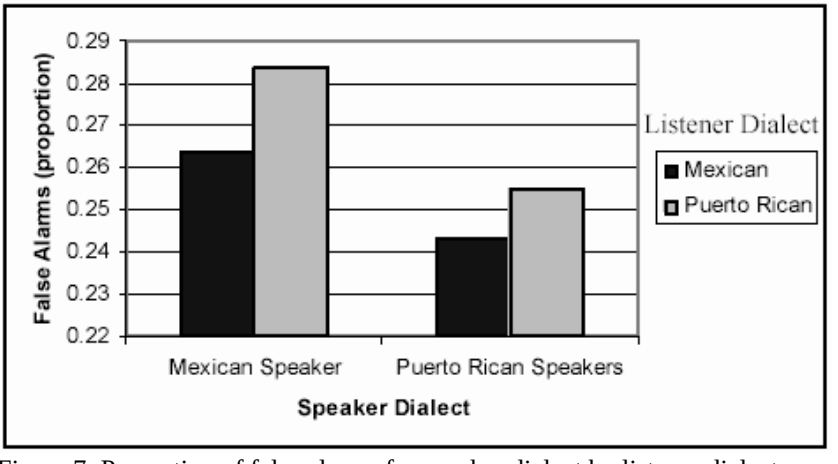

Figure 7: Proportion of false alarms for speaker dialect by listener dialect

5.3 Dialect identification task results

A repeated-measures analysis of variance (ANOVA) was conducted on the dialect identification accuracy data, with the two factors 'phonological variable' (word-final /n/, coda /ɾ/ and coda /s/) and 'speaker dialect' (Mexican or Puerto Rican). There was a significant main effect of phonological variable [$F(2, 28) = 3.528$; $p < 0.01$]. Regardless of speaker and listener dialect, the participants were most accurate at identifying a speaker's dialect when the stimuli contained a coda /s/. They were least accurate at identifying a speaker's dialect when the stimuli contained a coda /ɾ/. This main effect of phonological variable tells us what variables are most salient across dialects, and will be discussed in more detail later. The main effect for phonological variable is shown below.

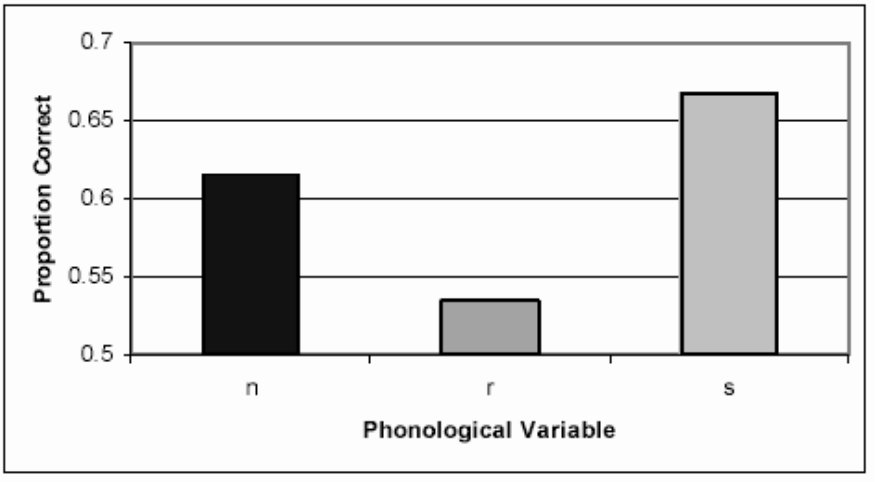

Figure 8: Significant main effect for phonological variable for dialect identification data

Several significant interactions were also found. The first significant interaction that was found was an interaction between speaker dialect and listener dialect [$F(1, 29) = 32.049$; $p < 0.01$]. The Mexican listeners were nearly 90% accurate at identifying their own dialect, but only about 57% accurate at identifying Puerto Rican input as not being Mexican. The Puerto Rican listeners were almost 70% accurate at identifying their own dialect, but only about 32% accurate at identifying Mexican input as being not Puerto Rican. This difference in accuracy among Mexican and Puerto Rican listeners can be explained by their amount of exposure to the variable input in the stimuli, and will be discussed in a later section. This interaction between speaker and listener dialect is shown below.

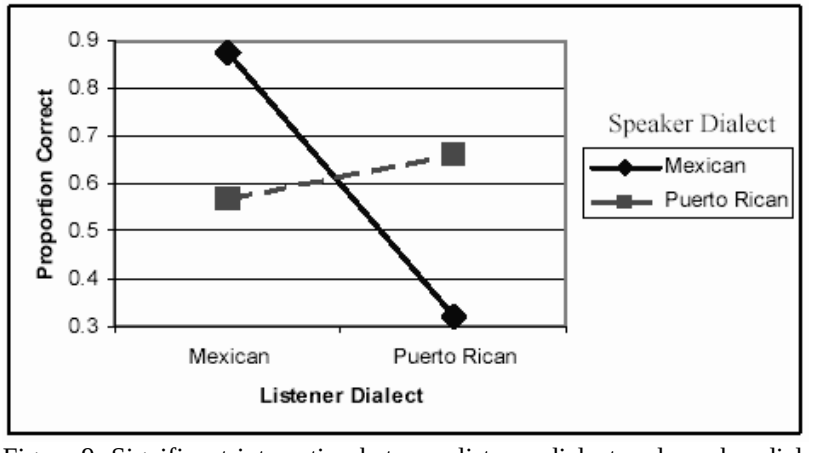

Figure 9: Significant interaction between listener dialect and speaker dialect for dialect identification data

The second significant interaction that was found for the dialect identification task was an interaction between listener dialect and phonological variable [$F(2, 28) = 15.426$; $p < 0.01$]. For input containing the phonological variable word-final /n/, there was no real difference for the Mexican and Puerto Rican listeners. However, for input containing coda /ɾ/, the Mexican listeners were considerably more accurate than the Puerto Rican listeners. The Puerto Rican listeners identified some of the stimuli produced by Mexicans as being produced by Puerto Ricans, and vice-versa. The same is true to a lesser extent for stimuli containing coda /s/. The Mexican listeners were over 80% accurate at identifying their own dialect when the stimuli contained coda /s/, while the Puerto Ricans were only about 50% accurate. The reason for this difference will be discussed in a later section, and can be

attributed to the amount of experience with variable input in the two dialects. The interaction between listener dialect and variable is shown below.

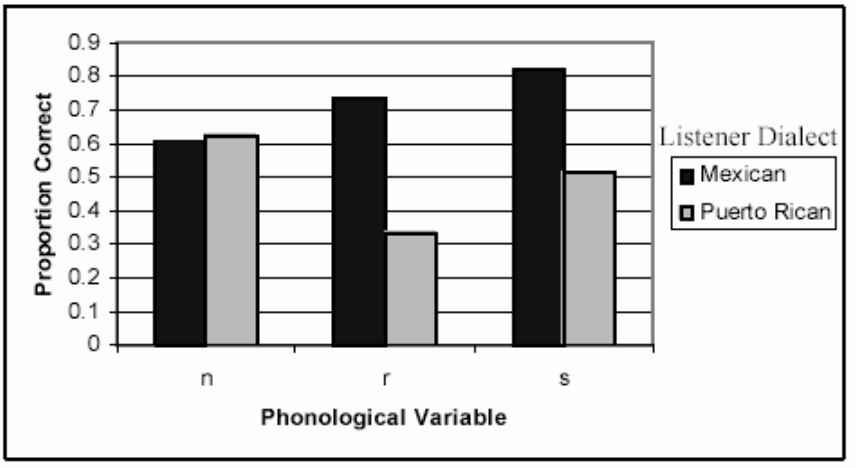

Figure 10: Significant interaction between listener dialect and phonological variable for dialect identification data

5.4 Summary of results

The participants' performance on the speeded naming task suggests that a listener's native dialect and their amount of exposure to other dialects have an effect on their ability to perceive variable input, and that the phonological variables that vary across dialects affect listeners at different rates. The listeners' performance on the lexical decision task also suggests that not all phonological variables should be considered as equal factors in the perception of variable input, as the listeners responded most slowly to stimulus items containing coda /s/ and most quickly to those items containing coda /ɾ/ for both the naming and lexical decision tasks. This finding suggests that there was a delay in the processing of items containing coda /s/ for Mexican listeners because they are not accustomed to variation in the production of coda /s/. The Puerto Rican listeners most likely had delayed processing for items containing coda /s/ precisely because of the amount of variation available in the pronunciation of coda /s/ in Puerto Rican Spanish. Processing input that is variable, such as items containing coda /s/, will delay processing because listeners will get activation in the lexicon's phonological grammar of all three variants of this variable, among other items.

The results from the lexical decision task also suggest that both Mexican and Puerto Rican Spanish listeners were more likely to respond positively (i.e., word) when the input was Mexican, but that overall they were most accurate at responding to Puerto Rican input. The bias to respond 'word' to both words and nonwords produced by Mexican speakers suggests that both groups of listeners consider Mexican Spanish to be more word-like than Puerto Rican Spanish, perhaps due to the variation in the input or stereotypes that speakers have toward 'consonant-weakening' dialects. The listeners' performance on the identification task showed marked differences for the two groups of listeners. The Mexican listeners were very good at identifying their own dialect (almost 90% accurate), while the Puerto Rican listeners were not quite as good at identifying their own dialect (almost 70% accurate). The results suggest that the Puerto Rican listeners were labeling the Mexican input as being Puerto Rican, which is expected since they are exposed to Mexican and Mexican-like Spanish on a daily basis (e.g., television, radio, formal addresses) and because Mexican-like Spanish is spoken in Puerto Rico by Puerto Ricans, though not typically in colloquial speech. Mexican-like Spanish refers to Spanish that is consonant preserving. In other words, Puerto Ricans are accustomed to variable pronunciation of syllable-final /s/, where the sibilant is retained in formal situations. They are also accustomed to syllable-final /ɾ/ that is not lateralized, as this variant is also used in certain styles of Puerto Rican Spanish.

The results from the identification task mirror those found for the other two tasks in that the pattern of phonological variables is identical in all three tasks. In this task, the dialect of the speakers producing words containing coda /s/ was most accurately identified, while those words containing coda /ɾ/ resulted in the lowest accuracy scores for the identification of the speaker's dialect. This is also expected because lateralization of coda /ɾ/ is a variable phenomenon in Puerto Rican Spanish, so Puerto Rican listeners are accustomed to hearing both realizations of coda /ɾ/ (i.e., [ɾ] and [l]). In all dialects of Spanish, both laterals and rhotics are found syllable-finally, so the lateralized pronunciation of syllable-final /ɾ/ is not a new sound or sound pattern for the Mexican Spanish speakers. Also, it follows that words containing coda /s/ would have the highest accuracy level, as the variable realizations of coda /s/ in Puerto Rico are not found in this dialect of Mexican Spanish. In other words, speakers of this dialect of Mexican Spanish are not accustomed to hearing speech containing aspirated or deleted /s/, whereas the speakers of this dialect of Puerto Rican Spanish are accustomed to variation in the realization of /s/.

6. Discussion and conclusion

The experiments described in this paper provide new findings for the study of the perceptual processing of variable input in general, and for dialect variation in Spanish. First, a speeded naming task was used to measure the effects of variable input on speech perception in Mexican and Puerto Rican Spanish. There were several significant findings, including an effect for phonological variable and an interaction between phonological variable and speaker dialect. Second, a lexical decision task was used to measure the effects of variable input on the perceptual processing of words in Spanish. There was an overall response bias for the listeners for 'word' for the Mexican input. There was again a significant effect for phonological variable. Third, a dialect identification task was used to measure the perceptual similarity of the two dialects being studied. There were many significant findings from this task, including an interaction between speaker dialect and listener dialect.

Perhaps the most significant finding from the three perception experiments is that the phonological variables patterned in the same way regardless of the experimental task. For both the naming and lexical decision tasks, the participants responded most slowly to stimuli containing syllable-final /s/, and in the dialect identification task, they were most accurate at identifying the dialect of the speaker when she produced a word containing this phonological variable. Thus, the realization of syllable-final /s/ seems to be a distinguishing marker of these two dialects of Spanish.

This finding is easily modeled within an exemplar-based model of speech perception and processing, where the input is stored with detailed phonetic information, as an exemplar. This exemplar activates other categories, such as talker, voice, stereotypes, and semantics. To account for the finding mentioned above, the exemplars containing a deleted or aspirated syllable-final /s/ would activate notions such as 'Puerto Rico' and 'young' in the stereotypes category, and also any talkers that match those stereotypes. Exemplars containing the retained syllable-final /s/ would activate stereotypes such as 'formal speech' and 'Mexico'. They would also activate 'Puerto Rico', because in Puerto Rican Spanish it is possible to get a syllable-final /s/ that is retained (cf. Boomershine 2005).

These findings have implications for the fields of dialectology and phonology. They show that perception experiments can and should be used in the classification of dialects, as they allow researchers to tap into the listeners' perceptual space to help determine the saliency of certain dialect markers. More specifically, the results of the current study suggest that both Mexican and Puerto Rican listeners consider the realization of syllable-final /s/ to be a strong dialect indicator for these two dialects. The findings are also significant for the field of phonology, as the findings are best modeled within an exemplar-based approach, rather than a traditional approach (cf. Boomershine 2005). Overall, this research is an important addition to the growing body of literature on exemplar-based models of perception and production, as well as laboratory approaches to phonology.

References

Boomershine, Amanda. 2005. The perceptual processing of variable input in Spanish: An exemplar-based approach to speech perception. Columbus, OH: Ohio State University dissertation.

Elman, Jeffrey, and James McClelland. 1986. The TRACE model of speech perception. Cognitive Psychology 18.1-86.

Goldinger, Stephen. 1990. Effects of talker variability on self-paced serial recall. Research on speech perception. Bloomington: Indiana University Press.

Goldinger, Stephen. 1996. Words and voices: episodic traces in spoken word identification and recognition memory. Journal of Experimental Psychology: Learning, Memory, and Cognition 22.1166-83.

Goldinger, Stephen. 1997. Perception and production in an episodic lexicon. Talker variability in speech processing, ed. by Keith Johnson and John W. Mullennix, 33-66. New York: Academic Press.

Goldinger, Stephen; David Pisoni; and John S. Logan. 1991. On the nature of talker variability effects on serial recall of spoken word lists. Journal of Experimental Psychology: Learning, Memory, and Cognition 17.152-62.

Johnson, Keith. 1990. Contrast and normalization in vowel perception. Journal of Phonetics 18.229-54.

Johnson, Keith. 1997. Speech perception without speaker normalization: an exemplar model. Talker variability in speech processing, ed. by Keith Johnson and John W. Mullennix, 145-66. California: Academic Press.

Johnson, Keith. 2004. Class notes on XMOD and Exemplar Theory. Linguistics 825, Seminar in advanced phonetics: exemplar modeling. Winter quarter, 2004. The Ohio State University.

Lipski, John. 1994. Latin American Spanish. New York: Longman.

Pisoni, David. 1990. Effects of talker variability on speech perception: implications for current research and theory. Proceedings of the 1990 International Conference on Spoken Language Processing, Kobe, Japan, 1399-407. Tokyo: The Acoustical Society of Japan.

Pisoni, David. 1992. Some comments on invariance, variability and perceptual normalization in speech perception. Proceedings of the 1992 International Conference on Spoken Language Processing, Banff, Canada, 587-90. Edmonton: University of Alberta.

Pisoni, David. 1997. Some thoughts on ‘normalization’ in speech perception. Talker variability in speech processing, ed. by Keith Johnson and John W. Mullennix, 9-32. New York: Academic Press.

Pisoni, David; Howard Nusbaum; Paul Luce; and Louisa Slowiaczek. 1985. Speech perception, word recognition and the structure of the lexicon. Speech Communication 4.75-95.

Selected Proceedings of the 8th Hispanic Linguistics Symposium

edited by Timothy L. Face and Carol A. Klee

Cascadilla Proceedings Project Somerville, MA 2006

Copyright information

Selected Proceedings of the 8th Hispanic Linguistics Symposium
© 2006 Cascadilla Proceedings Project, Somerville, MA. All rights reserved

ISBN 1-57473-408-3 library binding

A copyright notice for each paper is located at the bottom of the first page of the paper.
Reprints for course packs can be authorized by Cascadilla Proceedings Project.

Ordering information

Orders for the library binding edition are handled by Cascadilla Press.
To place an order, go to www.lingref.com or contact:

Cascadilla Press, P.O. Box 440355, Somerville, MA 02144, USA
phone: 1-617-776-2370, fax: 1-617-776-2271, e-mail: sales@cascadilla.com

Web access and citation information

This entire proceedings can also be viewed on the web at www.lingref.com. Each paper has a unique document # which can be added to citations to facilitate access. The document # should not replace the full citation.

This paper can be cited as:

Boomershine, Amanda. 2006. Perceiving and Processing Dialectal Variation in Spanish: An Exemplar Theory Approach. In *Selected Proceedings of the 8th Hispanic Linguistics Symposium*, ed. Timothy L. Face and Carol A. Klee, 58-72. Somerville, MA: Cascadilla Proceedings Project.

or:

Boomershine, Amanda. 2006. Perceiving and Processing Dialectal Variation in Spanish: An Exemplar Theory Approach. In *Selected Proceedings of the 8th Hispanic Linguistics Symposium*, ed. Timothy L. Face and Carol A. Klee, 58-72. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #1255.