1 Laboratory Approaches to Sound Variation and Change[1]

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1 What is a laboratory approach to sound variation and change?

Given the importance that sociolinguistics has placed on gathering different speech styles and collecting vernacular speech, a laboratory approach to sound variation and change may be seen as an attempt to undermine the sociolinguistic enterprise. However, I will show here that, especially in recent years, laboratory approaches have contributed to sociolinguistics both methodologically and theoretically, whereas sociolinguistics has had an impact on the way experimental studies are designed.

As a starting point then, it is necessary to clarify what a laboratory or an experimental approach to sound variation and change is. Although defining the scope of any field is never a simple task, I will start by invoking a distinction used by Ohala (1974: 353) between "nature-made controls" and "man-made controls." As an example of the former, he presents the case of a scientist interested in testing the hypothesis that TV-watching is inversely correlated with birth rate. Testing this hypothesis in the lab may pose serious ethical issues. This hypothesis, however, can be tested historically by comparing the birth rates nine months after a large blackout, as the one that occurred in 2003. According to Ohala, nature has offered good examples of manipulation of specific variables to test historical hypotheses. This should also be the case for sociolinguistics. For example, if we are interested in determining whether a sound change is the result of contact, it is very unlikely that we will be able to reproduce the conditions in an experiment, but it is usually possible to find two similar communities that were not affected equally by contact to test a given hypothesis. Thus, in this chapter, although I will be using the term "laboratory approaches," I will summarize studies within the

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experimental phonology and laboratory phonology paradigm.[2] In addition, I will focus on both, the contributions made by laboratory studies *stricto sensu* and sociolinguistic studies that incorporate an experimental approach. In any case, when presenting a specific study, I will focus on its goals, discussing investigations that had the theorization and characterization of sound variation as a main goal.

A final remark may be necessary before getting into the specifics of this chapter. A "laboratory approach" can and has been interpreted in the literature on Spanish in a broad or a narrow sense. In a broad sense, a laboratory approach involves the use of any experimental technique to treat data, which mostly includes the acoustic analysis of data gathered using a sociolinguistic methodology. In a narrow sense, an experimental approach refers to the way in which a study is conceived from the formulation of the hypotheses to the development of the methodology and the analysis of the results. Given that the discipline is rather new and both interpretations have been given to the term, I will include studies representing both approaches, even though it is my belief that the latter definition should be emphasized. The rest of the chapter is structured as follows. I start by discussing the connection between laboratory approaches and sociophonetics (Section 2). Then, I proceed to discuss the specific studies, covering cases of segmental and prosodic variation (Section 3). I conclude in Section 4, summarizing the contributions of this line of research and suggesting areas for future work.

2 Laboratory approaches and sociophonetics

It would not be fair to say that laboratory approaches to the study of sound variation and change started with the recent advent of sociophonetics, which combines the methodologies used in sociolinguistics and phonetics. Indeed, experimental approaches date as far back as dialectology. The *Atlas lingüístico de la Península Ibérica* (ALPI, CSIC 1962) was coordinated by one of the most well known Spanish phoneticians, Navarro Tomás. Several descriptions of Spanish varieties such as Abeille (1900) or Malmberg (1950) used not only spectrographic analysis to show the different segmental variants but also included fundamental frequency contours to illustrate intonational differences. Sociolinguistics continued this tradition. Labov, from his very early studies (e.g. Labov et al. 1972), has always included acoustic analysis, formant analysis in particular, to support his proposal of different sound changes in the vocalic system of American English. Thus, a laboratory approach involves the use of any experimental paradigm to address issues concerning the inception or transmission of a sound change or any phenomenon of phonetic variation.

Then, if sociolinguistics has always considered experimental techniques to be important, why this recent interest in the development of a new area of research? First, not all sociolinguists have used experimental methods to support their analyses. This is particularly the case in the Spanish tradition, where most variationist studies rely only on phonetic transcriptions. Second, there has been an increase in the use of experimental methods largely due to the availability of free software for

acoustic analysis (e.g. PRAAT, Speech Analyzer, Wavesurfer) and an expansion in the range of topics covered. Finally, there has been an emphasis on modeling the link between variation and categorization by using exemplar theory (see Jannedy and Hay 2006). The combination of this research practice and theoretical interest may have motivated the emergence of sociophonetics, which "refers to variable aspects of phonetic or phonological structure in which alternative forms correlate with social factors" (Foulkes and Docherty 2006: 411).

Even if researchers are not equally confident in the future of sociophonetics as a discipline (see Labov (2006) and Thomas (2002) for different points of view), the dialogue between phonetics and sociolinguistics has led to positive developments in both disciplines. As concerns sociolinguistics, the incorporation of experimental methods from phonetics has and should contribute to promote more accurate characterizations of different phonological processes and should further our understanding of how universal and language-specific patterns shape a specific sound change. In the next section, I will exemplify these claims by providing evidence from a variety of studies on segmental and suprasegmental phenomena taking place in different Spanish varieties.

3 Laboratory studies on sound variation and change in Spanish

Laboratory studies on sound variation and change in Spanish have had two main characteristics. First, as it will be illustrated below, researchers have focused on a wide variety of phenomena, including vowels, consonants, and intonation. Second, there is a continuum between research on laboratory phonology and that on sociophonetics, as evidenced by the fact that many researchers work in both areas. In the remainder of this section, I will summarize the main findings concerning segmental (Section 3.1) and prosodic variation (Section 3.2).

3.1 Segmental variation

Segmental variation has been the focus of most studies. In particular, as it is the case for sociophonetics more generally (Thomas 2002), most researchers working on Spanish have analyzed variation in production, as inferred mainly from acoustic studies. Articulatory and perception studies are scarce. Finally, most studies focus on one variety and large-scale cross-dialectal analyses still need to be developed.

3.1.1 Vowels When compared to other languages like English, studies dealing with variation in the vocalic system are very few in number, with the notable exception of attention paid to the vocalic system of Eastern Andalusian where changes in quality are reported in the context of /s/ deletion (see Hualde 2005b: 130 and references therein; cf. also Section 3.1.2.3). This is due in part to the fact

that Spanish has a small vocalic inventory and it is generally assumed that there is very little variation in the realization of the five phonemic vowels (for a discussion cf. Willis 2005). However, some studies (Guitart 1985) have suggested that differences are larger than previously assumed. Although so far no conclusive evidence has been obtained through experimental studies (see Morrison and Escudero 2007), the topic deserves further exploration.[3]

Vowel sequences, instead, have received a great deal of attention, especially in the last few years (see in particular Aguilar 1997, 1999). In terms of scope, Garrido's (2008) dissertation is the largest cross-dialectal study (México D.F. and Bogotá) on diphthongization of non-high vowels, a phenomenon exemplified in (1). By using a variety of data collection methods (such as interviews and syllabification intuitions), acoustic analysis and traditional sociolinguistic statistical analyses, the author concluded that diphthongization is phonetically motivated but social factors play a role in determining the different rates of diphthongization of each of the sequences studied.

(1) lí[ne.a] > lí[nja] *línea* 'line'
[to.a]lla > [twa]lla *toalla* 'towel'

Inspired by Hualde and Prieto's (2002) work on the realization and acoustic characteristics of rising vowel sequences in diphthongs and hiatuses (cf. also Chitoran and Hualde 2007), other studies have compared the realization of such sequences in different varieties of Peninsular and Latin American Spanish. As for the former, Cabré and Prieto (2006) administered a survey with 246 words and compared the self-reported syllabification patterns of the so-called exceptional hiatuses (e.g. Hualde 1999, 2005a), as in (2), across different Peninsular varieties.[4] They concluded that the tendency towards diphthongization was increasing in these varieties, independently of the specific phonetic conditions that might favor the maintenance of the hiatus.

(2) [pi.a]no *piano* 'piano'
con[fi.aɾ] *confiar* 'to trust'

MacLeod (2007) analyzed the acoustic realization of rising vocalic sequences in Peninsular, Costa Rican and Buenos Aires Spanish, and demonstrated that (a) varieties differed in their rate of diphthongization; (b) the phonetic contrast between diphthongs and hiatuses was larger in Buenos Aires and Costa Rican Spanish than in Peninsular Spanish; and (c) diphthongs in all varieties displayed more acoustic variation than hiatuses. Colantoni and Limanni (forthcoming) arrived at a similar conclusion when comparing Argentine contact (Spanish-Guaraní) against non-contact varieties. They also showed that these varieties differed not only in the rate of diphthongization of rising vocalic sequences but also in the way diphthongs were realized. In particular, the authors suggested that diphthongization involved a shortening of the first vowel in the sequences and more coarticulation with the second vowel, as illustrated in Figures 1.1 and 1.2.

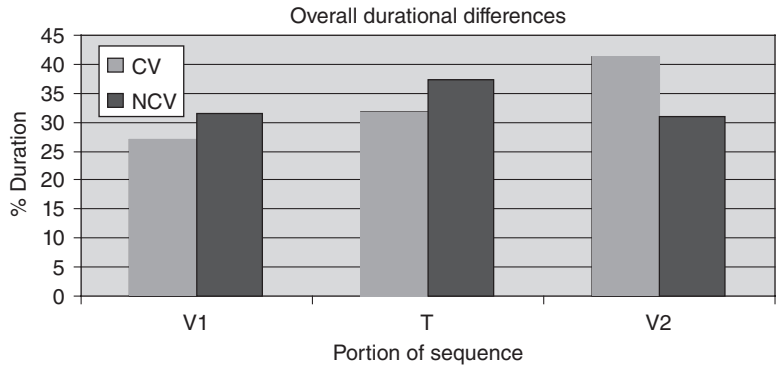

Figure 1.1 Duration of each part of the diphthong (measured as a proportion of the whole sequence) in contact (CV) and non-contact varieties (NCV). V1 = first vowel in the sequence; T = transition; V2 = second vowel in the sequence.

Source: Colantoni, Laura and Anna Limanni (2010). Where are hiatuses left? A comparative study of vocalic sequences in Argentine Spanish. In Karlos Arregi, Zsuzsanna Fagyal, Silvina Montrul and Annie Tremblay (eds), *Romance Linguistics 2008: Interactions in Romance,* 23–38. Amsterdam: John Benjamins.

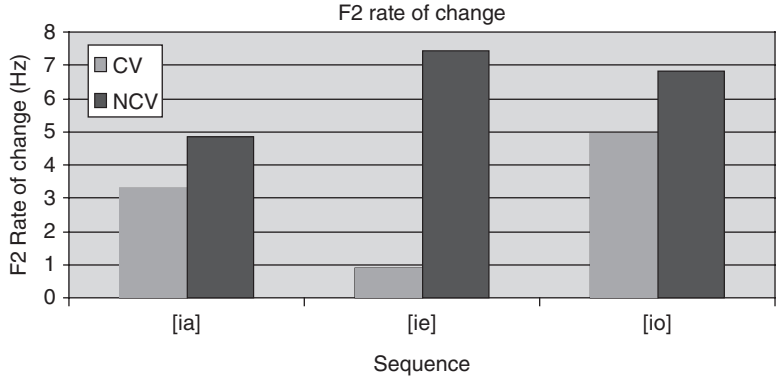

Figure 1.2 F2 rate of change (Hz per ms) in the transition in contact (CV) and non-contact varieties (NCV).

Source: Colantoni, Laura and Anna Limanni (2010). Where are hiatuses left? A comparative study of vocalic sequences in Argentine Spanish. In Karlos Arregi, Zsuzsanna Fagyal, Silvina Montrul and Annie Tremblay (eds), *Romance Linguistics 2008: Interactions in Romance*, 23–38. Amsterdam: John Benjamins.

Although most studies have dealt with the characterization of sequences within the word, a few researchers have discussed the realization of sequences across words, and, in particular the different strategies employed for hiatus resolution (e.g. Jenkins 1999; Aguilar 2005; Alba 2006; Hualde et al. 2008). Jenkins (1999) analyzed acoustically a subset of the data obtained through sociolinguistic interviews

with New Mexican Spanish speakers in order to determine whether there were differences in duration even when a single vowel was perceived in the output. The differences observed, especially when the second vowel is stressed, allowed the author to motivate a metrical analysis in which single vowels in the output were treated metrically as two vowels.

In spite of receiving a great deal of attention within Spanish dialectology and sociolinguistics (e.g. Serrano 2006), a less studied aspect within the laboratory framework is vowel devoicing. Delforge (2008) is the only experimental study demonstrating that in Spanish in contact with Quechua, vowel devoicing does not involve vowel reduction. Delforge, through the analyses of more than 16,000 unstressed vowels produced by 16 speakers, who were selected on the basis of the relatively high rate of devoicing in sociolinguistic interviews, showed that devoicing occurred in approximately 10% of the sample but did not involve a change in the vowel quality.

In summary, studies analyzing the realization of Spanish vowels are still scarce, and more studies are needed on both the realization of singleton vowels and of vocalic sequences. In particular, most studies analyzing sequences have dealt with rising front diphthongs. Rising diphthongs whose first component is a high back vowel (e.g. [we, wi]) have received less attention (cf. Limanni 2008), as it is also the case of the relative degree of diphthongization of sequences, such as [ea, eo, oa, oe, ae], across Spanish varieties. Given that Garrido (2008) has shown that diphthongization does not apply equally to some of these sequences, and that social factors play a role in blocking the process, this constitutes a promising area for future sociophonetic research.

3.1.2 Consonants Variation in the realization of Spanish consonants has been the most productive area of research. Although the variable realization of /s/ in codas has been the topic that has received most of the attention in sociolinguistic and dialectological studies, laboratory research has mostly concentrated on two areas: rhotics and the lenition of voiced stops. As such, I will first summarize the results concerning these consonant types (Sections 3.1.2.1 and 3.1.2.2, respectively). In Section 3.1.2.3, I will discuss studies on fricatives, and I will devote the last section to less-studied consonants, such as nasals and affricates.

3.1.2.1 Laterals and rhotics Spanish rhotics have received considerable attention over the last few years. This includes the realization of trills and the tap-trill contrast (e.g. Willis 2006; Bradley 2006; Willis and Bradley 2008), the social stratification of the trill realization (Díaz-Campos 2008) and a sound change from an assibilated rhotic to an approximant realization in Argentine Spanish (Colantoni 2001, 2006a, 2006b).

All these studies, in spite of the different varieties and phonetic contexts studied, coincide in showing that the variation in rhotic realization in Spanish is larger than what previous auditory descriptions had reported. Moreover, findings obtained via experimental investigations have allowed researchers to challenge

previous analyses and/or to make testable hypotheses about sound changes involving rhotics. For example, Willis (2006) and Willis and Bradley (2008) discussed the claim that the tap-trill contrast is neutralized in Dominican Spanish and showed that the contrast is still maintained although the phonetic realization varies vis-à-vis other Spanish dialects. As Willis and Bradley demonstrated, the contrast in Santo Domingo Spanish relied on duration (as expected, taps were shorter than trills) and on the pre-aspiration of the trill vs. the absence of pre-aspiration in the tap. As concerns hypotheses on sound change, Colantoni (2006b) showed that in Argentine Spanish the change from an assibilated rhotic to a non-assibilated rhotic did not have a trill as its endpoint, as it had been suggested for other Spanish dialects (e.g. Peruvian Spanish – De los Heros Diez Canseco 1997) but an approximant rhotic. This finding indeed is consistent with results from articulatory studies (e.g. Solé 2002), which revealed that the alternation between a fricative rhotic and an approximant is aerodynamically motivated, whereas the alternation between a fricative rhotic and a trill is not. Moreover, this study showed that in the event of variation speakers attempt to approximate a new acoustic target (in this case, the trill) by using different articulatory techniques when compared to speakers of other varieties that had that sound.

It has always been difficult to separate the study of laterals and of rhotics because phonological processes often affect both types of consonants. This is exemplified in a well-documented phenomenon in Spanish dialectology and sociolinguistics, such as liquid neutralization, which could be sub-classified into rhotacism (e.g.[se *ɾ*.ka] > [sel.ka], *cerca* 'close') or lambdacism (e.g. [kal.do] > [ka *ɾ*.ðo], *caldo* 'broth').

A recent experimental study has challenged the existence of liquid neutralization in Puerto Rican Spanish. Simonet et al. (2008) investigated the production of rhotics in word-internal codas in the speech of four Puerto Rican Spanish speakers. After analyzing duration and the trajectory of the first three formants, the authors concluded that the differences between the underlying rhotics and laterals relied on the trajectory of the third formant, which suggested that laterals and rhotics differed in the overall tongue configuration. However, not all the speakers behaved consistently; although one of the speakers showed neutralization, this was clearly not the case for the other three.

Laterals alone have received slightly less attention than rhotics. Experimental studies on Argentine varieties where the palatal lateral is still maintained (Colantoni 2001, 2004), as illustrated in (3), have revealed that delateralization involves a smaller degree of constriction of the lateral articulation, as signaled by a higher F1, and a maintenance of the glide that was already present in the consonant-vowel articulation, as shown in Figure 1.3.

(3) *ca*[ʎ]*ó* vs. *ca*[d ʝ]*ó calló* 'he/she stopped talking' vs. *cayó* 'he/she fell down'

This finding allowed the author to hypothesize that delateralization, a widespread change in Romance languages, affects the degree of constriction of the segment but not its duration, since palatal laterals seem to have similar duration across Spanish varieties (Colantoni 2004: 92).

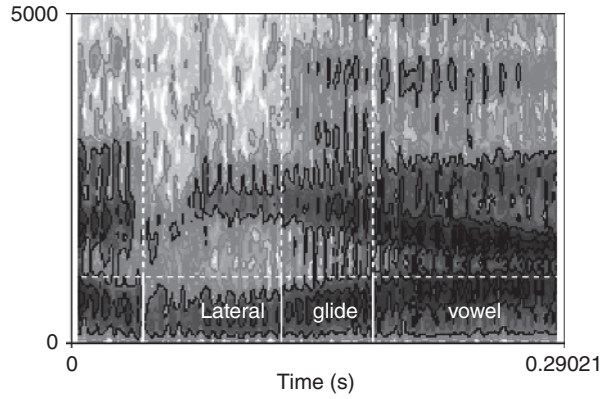

Figure 1.3 Spectrogram of the sequence [aʎa], extracted from the word *rallada* 'shredded' (feminine, singular.) (Bella Vista, female speaker). Vertical lines approximately indicate the lateral, the transition, and a vowel.
Source: Colantoni, Laura. 2004. Reinterpreting the CV transition. Emergence of the glide as an allophone of the palatal lateral. In Julie Auger, J. Clancy Clements, and Barbara Vance (eds), Contemporary approaches to Romance linguistics, 83–102. Amsterdam: John Benjamins.

Finally, a recent sociophonetic study analyzed the realization of onset and coda /l/ in Catalan-Spanish contact varieties (Simonet 2008), in order to determine whether contact has influenced the production of both Catalan and Spanish laterals. As a reminder, whereas Spanish laterals are alveolar, Catalan laterals show different degrees of velarization. As concerns the results of the Spanish-dominant participants, Simonet showed that there was no evidence of a change in progress in Spanish laterals due to contact with Catalan.

In sum, experimental studies on laterals and rhotics have greatly contributed to the re-analysis of some traditional classifications and to making hypotheses about different sound changes. First, studies have shown that (a) rhotics differ widely in their phonetic realization across varieties (see also Hammond 1999; Blecua 2001); (b) liquid neutralization deserves further study; and (c) hypotheses about sound changes having trills as the endpoint may need to be revised.

3.1.2.2 Stops Research on variation involving stops mostly deals with weakening processes, although as we will show below, some studies on place alternations have been conducted.

Two comprehensive studies should be highlighted here either for the cross-dialectal coverage (Lewis 2001) or for the variety of techniques used (Lavoie 2001). Lewis compared the realization of both voiceless and voiced stop in two Spanish varieties (Peninsular and Colombian) and three styles (conversational, reading of a text and a word list). He measured five acoustic parameters (closure duration, relative intensity, VOT, closure voicing and presence of burst) and took into account four independent variables (speech style, stress, place of articulation

and position in the word). Crucially, he showed that both varieties exhibited weakening of both series but Peninsular Spanish displayed more advanced signs of lenition.[5] Lavoie (2001) analyzed weakening processes in Mexican Spanish by combining acoustic and articulatory techniques. The articulatory study revealed that velars had the lowest degree of contact, but it was the acoustic study that allowed for a more systematic comparison between the weakening of voiceless and voiced stops. In particular, the author showed that duration was a reliable cue to weakening and so was the relative consonant-vowel intensity-ratio. Lavoie's results slightly differed from Lewis's, who did not observe place effects in the rate of lenition. Moreover, against Lewis, Lavoie concluded that, although voiceless stops weakened they did not lenite to the same degree as voiced stops. Among voiced stops, coronals lenited the most. These results were confirmed for the most part in a recent study on Argentine Spanish (Colantoni and Marinescu 2010), where voiced stops exhibited a high rate of lenition but voiceless stops did not. The authors suggested that their results presented evidence against a chain-shift type of analysis, where the weakening of voiced stops allowed for the weakening of voiceless stops (e.g. Lloyd 1993). They also argued that the evidence gathered so far does not support effort-based models of lenition either (see Kingston 2008), but seems to indicate that lenition is motivated for the most part by specific tongue-coarticulation patterns.

Although several other factors favor lenition, such as position in the word, stress (e.g. Cole et al. 1999; Ortega-Llebaria 2004) and vowel context (Cole et al. 1999; Ortega-Llebaria 2004), it is interesting to observe that place asymmetries in lenition have been repeatedly reported (e.g. Lewis 2001; Lavoie 2001; Recasens 2002; Colantoni and Marinescu 2010). These asymmetries are particularly clear in deletion patterns; namely /d/ deletes the most (e.g. Bybee 2001). Pérez (2007) showed that in Chilean Spanish different weakening patterns of voiced stops functioned as sociolinguistic indicators of speech style. In particular, /d/ deletion was an indicator of spontaneous speech, whereas weakening of either /b/ or /g/ was not a clear indicator of different speech styles. These results coincide with Mazzaro's (forthcoming) analysis of the alternation between labial and velar approximants in Corrientes Spanish. The author, via a combination of sociolinguistic interviews, a picture naming task and a perception study, showed that although the alternation of labial and velar fricatives (see Section 3.1.2.3) is associated with the speech of illiterate speakers, all social groups behaved similarly in the rate of alternations between labial and velar approximants, illustrated in (4):

(4) a[βwe]lo > a[ɣwe]lo abuelo 'grandfather'

In summary, experimental research shows that Spanish varieties differ in the degree of lenition of voiced and voiceless stops.[6] It also suggests that, as concerns the weakening of voiced stops in particular, the different degrees of deletion across places of articulation may have different sociolinguistic statuses. Thus, evidence gathered so far calls for a more detailed sociophonetic analysis of deletion and place-alternations in voiced stops across dialects.

3.1.2.3 Fricatives It is almost impossible to think of sound variation and change in Spanish without discussing variation in the realization of /s/, in particular in syllable final position. The variable (s) was the object of the first sociolinguistic studies on Spanish (e.g. Ma and Herasimchuk 1971; Poplack 1980), and since then, it has been the topic that has received most of the attention in Spanish sociolinguistics. There is a surprising disproportion, however, between the number of classic variationist studies and that of laboratory studies. For the most part, laboratory studies have focused on the acoustic characterization of the different realizations in codas (e.g. Valdivieso et al. 1991; Fox 2006; File-Muriel and Brown 2009). Articulatory studies are almost absent (Romero 1995) and perception studies are scarce. An exception to this tendency is Widdison (1997), who argues for the importance of speech perception in explaining aspiration patterns. Widdison hypothesized that a change in the phonation of the vowel that results from the presence of /s/ induces the percept of aspiration. In order to test his hypothesis, he manipulated stimuli of the type *pesco* by deleting the /s/. Then, participants were asked to listen to *peco* 'I sin' or *pesco* 'I fish' (with the deleted /s/) and identify the token. Crucially, stimuli of the type *pe(s)co* induced a high number of errors in participants, who perceived it as containing an aspirated /s/ and consequently chose *pesco*. Gerfen (2002) also demonstrated how /s/ aspiration affects not only the preceding vowel but also the length of the following consonant in Eastern Andalusian. Figure 1.4 shows how the vowel in s-aspiration contexts is longer across speakers, if the aspirated portion is taken into account. Figure 1.5 illustrates how the medial-stop closure is longer in those contexts. Indeed, Gerfen reported that overall stop-closure was a more reliable correlate of s-aspiration, but that there were also trade-off relationships between vowel and stop duration, when individual speakers were analyzed. As a matter of fact, vowel duration constituted a less reliable correlate for those speakers who had longer closure duration (Gerfen 2002: 265).[7]

Other fricatives have received less attention than /s/, but consonantization in palatals, as shown in (5), and devoicing of post-alveolar consonants, as in (6), are probably the second most-studied topics involving fricatives.

(5) [jo] > [ʒo] *yo* 'I'
(6) [ʒo] > [ʃo] *yo* 'I'

As for the former, there are two basic approaches. First, some researchers used laboratory studies to test phonological analyses in order to determine whether underlying high vocoids and palatals had the same status in different dialects (e.g. Whitley 1995; Colantoni forthcoming). Of those studies, Whitley constitutes an interesting example of a solid experimental methodology, which does not involve instrumental work. In order to test whether the initial sound in words like

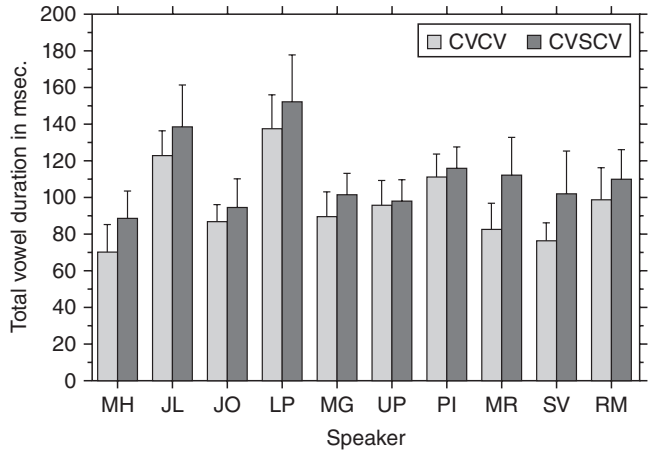

Figure 1.4 Total vowel duration by speaker and context.
Source: Gerfen, Chip. 2002. Andalusian codas. *Probus* 14. 247–277.

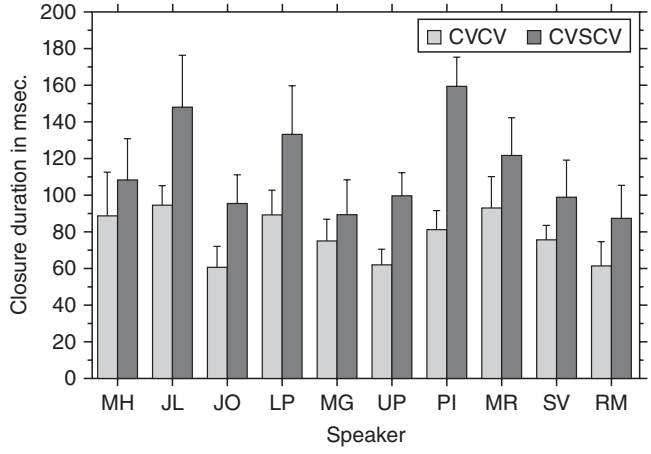

Figure 1.5 Medial stop-closure by word-type and speaker.
Source: Gerfen, Chip. 2002. Andalusian codas. *Probus* 14. 247–277.

hielo ('ice') or *ión* ('ion') is either a vowel or a consonant, he gave participants representing different Spanish varieties two nouns and asked them to coordinate them by choosing either *y* or *e*, and, as in (7).

(7) padres e hijos vs. padres y hijos 'parents and children'

The choice of a given allomorph would indicate whether participants considered the first sound in a given word a vowel (by choosing *e*) or a consonant, by

choosing *y*. Results showed that, first, participants did not behave categorically; second, that, in spite of that, choices were influenced by the nature of the following vowel, by spelling (0% alternations in words spelled with <y>), and by the frequency of the word (higher percentage of *e* before less frequent words).

Second, researchers have used experimental techniques to study glide strengthening and post-alveolar devoicing (Colantoni 2001, 2006a, b). As shown by Díaz-Campos and Morgan (2002), Spanish palatals range from vowel-like segments to fricatives. In the varieties of Spanish analyzed by Colantoni (2001, 2005, 2006) the underlying realization is a palatal glide, but assibilated variants are spreading. The author argued that this change, which is phonetically motivated, was accelerated by contact with Buenos Aires Spanish, where assibilated post-alveolars are the norm. Indeed, the tendency to fricate the glide is a universal one, especially in onset position (e.g. Ohala 1997), and this is also the case with Spanish, where high vocoids in absolute word-initial position show an increasing degree of constriction (e.g. Borzone de Manrique 1976). The evidence that contact with Buenos Aires Spanish was accelerating the change came from correlation analyses between the rate of assibilation and the distance (in km) to Buenos Aires. Results showed that locations that are closer to the Argentine capital exhibited a higher rate of assibilation (Colantoni 2005: 331), although some degree of assibilation was present in all the locations under study (see also Colantoni 2006b).

Assibilated post-alveolars in Buenos Aires Spanish have attracted the attention of sociolinguists (Wolf and Jimenez 1979; Wolf 1984), and have been the object of one of the few real-time studies on Spanish consonants (Wolf 1984). These studies documented an increasing rate of devoicing of post-alveolars in Buenos Aires Spanish led by young women. Interestingly, Wolf (1984) showed that what seemed to be a sound change in their 1979 study, looked more like stable variation when real-time data were analyzed. Indeed, the upper-middle class pre-adolescents who devoiced in 1979 reversed that tendency in 1984. Thus, evidence indicates that devoicing is a change that has not reached the upper classes and it is used as a social marker in Buenos Aires Spanish, a phenomenon which I believe is still true today. However, it has been only very recently that sociophonetic studies have reassessed the situation (Chang 2008; Rohena Madrazo 2008), arriving at apparently different conclusions. Chang (2008) found a very small proportion of voiced variants and concluded that devoicing was a change in progress, since there was a higher rate of devoicing among the younger generations. However, he included 11 speakers, but none of them reported to have grown up or lived in the traditional upper-middle class neighborhoods of Buenos Aires. Rohena Madrazo (2008), on the other hand, obtained a larger data set and a socially stratified sample. Although he concludes that among younger middle and lower middle class devoicing is the norm, the change has not yet reached the upper class. Results suggested that devoicing has increased among young upper-middle class speakers but the rate of voiced variants was still similar to that observed by Wolf and Jimenez (1979) and Wolf (1984).

Experimental studies could contribute to the understanding of the status of devoicing in several ways. For example, the use of articulatory studies may shed

light on changes in place of articulation, which may be accompanying changes in voicing. Indeed, upper-middle class porteños may be exhibiting a change in place (a more fronted articulation) to enhance the acoustic distance between the voiceless and voiced variants. The use of perception tests, such as standard discrimination tests, may also indicate whether speakers of different ages and social classes are equally capable of distinguishing voiced from voiceless variants. This would allow us to make inferences about the social status of the variants. It may perfectly be the case that upper middle classes have a perception grammar that does not completely coincide with their production grammar (see Colantoni 2008).

One last topic, that has been reported in rural speech in many Spanish varieties (e.g. Lipski 1994: 9), and has only been the object of some experimental analysis recently, is the labio-velar alternation exemplified in (8) (Mazzaro 2008).

(8) [fwer]za > [hwer]za *fuerza* 'strength'

Mazzaro, working within Ohala's (1989) theory of sound change, suggested that this alternation, particularly in the context of back diphthongs, as in (8), is perceptually motivated. Although in her perception study of Corrientes Spanish, she observed identification errors in participants of different social classes, the error rate was higher among illiterate speakers. This confusion in perception was matched by alternations in production as evidenced in a picture-naming task and in sociolinguistic interviews. These alternations in production are only observed among illiterate speakers, suggesting that velarization in fricatives is socially stratified, as opposed to velarization in approximants, which is not (see Section 3.1.2.2).

3.1.2.4 Less studied classes: nasals and affricates Laboratory studies on sound variation and change involving Spanish nasals have not attracted for the most part the attention that nasals have received in phonological and dialectological studies. In Spanish phonology, nasal assimilation is one of the most well-described phenomena (e.g. Harris 1984; Piñeros 2006). In Spanish dialectology, the realization of nasals, particularly in word-final codas, has been used as a parameter to define dialectal areas (e.g. Resnick 1975). Instrumental studies on Spanish nasals are scarce (e.g. Solé 1994) and experimental studies on variation in nasals are almost non-existent (e.g. Simone Lederer 2003). In part, the scarcity of experimental studies may be related to the fact that nasals, and place of articulation in nasals in particular, are difficult to characterize acoustically. Other techniques that would allow for a better description of nasals, such as nasal airflow or EPG studies, require laboratory settings, making it difficult to study larger populations in a more natural setting. In spite of these difficulties, the use of laboratory techniques to the study of sound variation in nasals has interesting applications to some ongoing phenomena such as depalatalization, illustrated in (9), or differences in place neutralization in word-final codas across Spanish dialects.

If studies on nasals are scarce, experimental research on variation in affricate production across Spanish dialects is almost non-existent. Even if variation in

deaffrication of the post-alveolar affricates (exemplified in (10)) is common across Spanish varieties, so are other processes through which affricates emerge, such as the assibilated realization of voiceless stop-rhotic clusters. The only exception, to my knowledge, is the study reported in Quilis (1993) on affricate realization in Puerto Rican Spanish, where Quilis identified six acoustic variants, ranging from an affricate with a clear occlusion to fricatives, showing frication periods with different degrees of intensity.

(9)	pesta[ɲa] ~ pesta[nja]	*pestaña*	'eyelash'
(10)	[t͡ʃ]ico ~ [ʃ]ico	*chico*	'small, boy'

3.2 Prosodic variation

Although research on Spanish has greatly contributed to sociophonetic research by extending the empirical coverage of phenomena, it is in the study of intonation that investigation on Spanish is taking a leading role. In particular, research on Spanish has made a significant contribution to both contact-induced changes and sociolinguistic variation in intonation.

Studies on the intonation of Spanish in contact with several languages, such as Catalan (Simonet 2008), Italian (Colantoni and Gurlekian 2004; Gabriel 2006), English (Alvord 2006), Quechua (O'Rourke 2004), and Basque (Elordieta 2003), have confirmed that transfer of intonational patterns is a frequent phenomenon. Among the features susceptible to be affected by transfer, the most frequently reported is a change in peak alignment in prenuclear accents in broad focus declaratives. In non-contact varieties, early peak alignment is only reported in a contrastive focus environment (e.g. Face 2001), whereas the default pattern in broad focus declaratives is a peak in the posttonic syllable. Early peak alignment in non-contrastive contexts has repeatedly been reported for Spanish in contact with Italian, Quechua, and Basque. Although it is not clear how similar these peak alignment patterns are (see Hualde and Schwegler 2008 for a discussion), they attest to the influence that contact has in defining the intonational contours of a given variety.

The second factor that has been attributed to contact is the shape of nuclear contours, both in interrogatives and declaratives. Alvord (2006) noticed that final contours of absolute interrogatives in Miami Cuban Spanish differed in the three generations analyzed. Whereas the first and third generations favored a Cuban-style falling intonation, the second generation used rising contours at a higher frequency. As concerns declaratives, it has been repeatedly observed that Buenos Aires Spanish has a long and deep fall at the end of declaratives (Kaisse 2001; Colantoni and Gurlekian 2004), which resembles the contours observed in different Italian varieties. Simonet (2008) described a falling contour in the broad-focus declaratives of young female Spanish-dominant speakers, which is similar to the one observed in the Catalan spoken in the area. Indeed, Simonet concluded that young females have one nuclear contour in Spanish and Catalan, whereas older males have different contours in each language, as illustrated in Figure 1.6.

As such, Simonet's study shows that intonation, as segmental phenomena, may be socially stratified. This social stratification of intonational contours is clearly

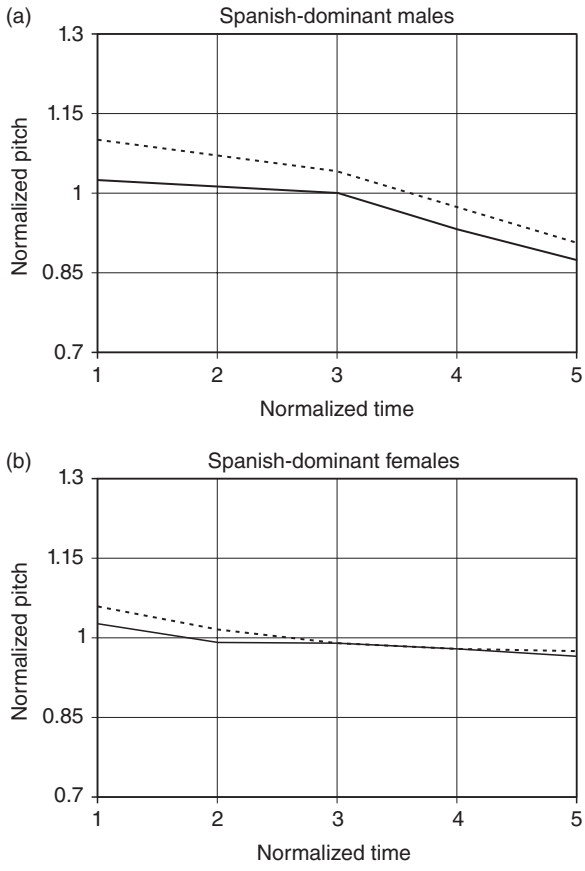

Figure 1.6 Average contours read by 10 Spanish-dominant subjects as a function of mode or language used (Spanish [L1] vs. Catalan [L2]) and gender. In each panel, solid lines represent average contours for L1 sentences and dashed lines represent average contours for L2 sentences.

Source: Simonet, Miquel. 2008. Language contact in Majorca. An experimental sociophonetic approach. University of Illinois at Urbana-Champaign dissertation.

documented in a series of studies (e.g. Enbe and Tobin 2008; Enbe 2009), which show that declaratives, wh-interrogatives and exhortatives vary according to the variables of gender and age. Researchers have always noticed that intonation varies across dialects, but this is the first large scale project designed to answer the question of whether gender and age play a role in accounting for the choice of the intonational contour. In order to tackle this question, Enbe and colleagues tested 132 Buenos Aires speakers divided into three age groups (5–8; 18–50; 51–75) with an equal number of female and male participants in each group. The experiment consisted of a shadowing task in which participants had to repeat three different types of sentences. Results first showed that not all sentence types vary equally: declaratives are more

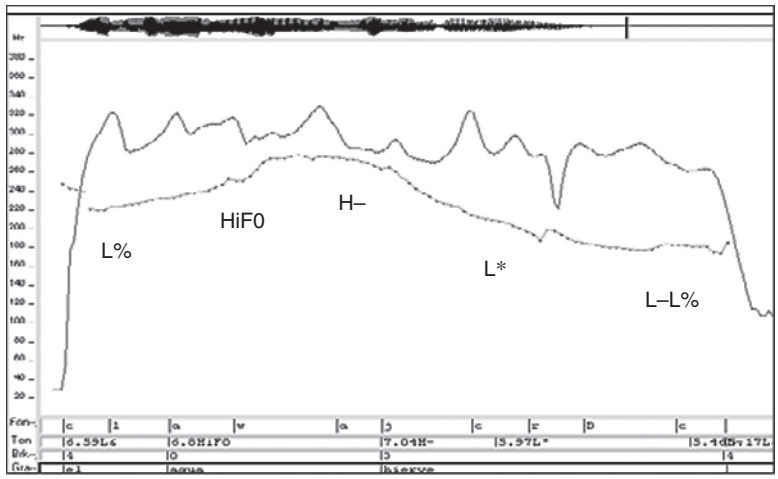

Figure 1.7 Female (21): declarative sentence *El agua hierve* ('the water boils'). High-rising-falling contour.

Source: Enbe, Claudia and Yishai Tobin. 2008. Sociolinguistic variation in the prosody of Buenos Aires Spanish according to the theory of phonology as human behavior. In Laura Colantoni and Jeffrey Steele (eds), Selected proceedings of the third conference on laboratory approaches to Spanish phonology, 140–154. Somerville, MA: Cascadilla Press.

variable than exhortatives, which, in turn, are more variable than Wh-questions. As concerns declaratives, women favored high-rising falling contours (Figure 1.7). Males showed a similar overall pattern, but differed in the magnitude of the rise (Figure 1.8), and in the variety of patterns used. Interestingly, male children used the same patterns and in the same proportions as young women (Enbe and Tobin 2008).

Although Spanish experimental research has contributed to new areas within intonational phonology, numerous studies have characterized different Spanish varieties, including Peninsular (e.g. De la Mota 1995; Face 2001), Mexican (e.g. Prieto et al. 1995, Martín-Butragueño 2004), Dominican (e.g. Willis 2003), Peruvian (e.g. O'Rourke 2004), and Argentine (Toledo 2000). It is important to highlight the existence of few comprehensive and comparative studies, in particular Sosa (1999), but also Beckman et al. (2002). Moreover, there is an increasing interest in coming up with a Pan-Hispanic description of intonational contours. Results of a recent workshop on Spanish intonation organized by Pilar Prieto will soon be published and recordings of different sentence types obtained with a similar methodology are available at: http://prosodia.uab.cat/atlasentonacio/index.html.

Research on other prosodic components, such as duration, has not grown in parallel to the study of intonation. Although some of the intonational differences between varieties, such as the long fall in Buenos Aires Spanish (Kaisse 2001) or the realization of pitch accents in Argentine varieties (e.g. Fontanella de Weinberg 1980), have been attributed to durational differences, these claims have to be further tested experimentally.

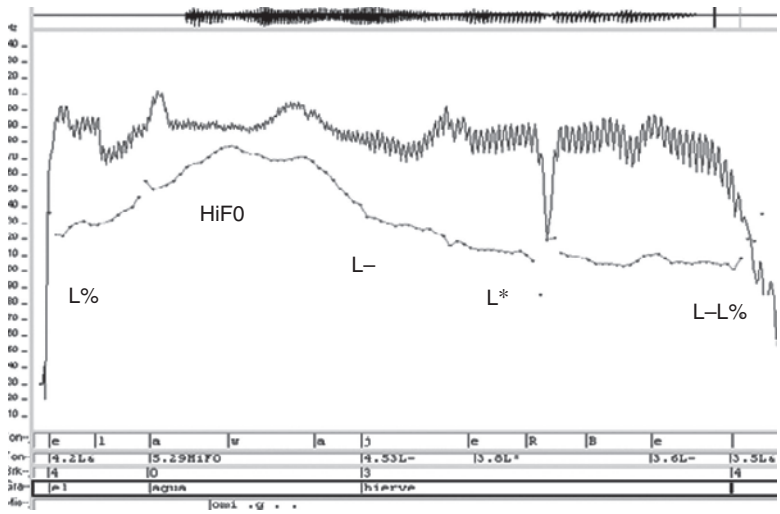

Figure 1.8 Male (19): declarative sentence *El agua hierve* ('the water boils'). Rising-falling contour.

Source: Enbe, Claudia and Yishai Tobin. 2008. Sociolinguistic variation in the prosody of Buenos Aires Spanish according to the theory of phonology as human behavior. In Laura Colantoni and Jeffrey Steele (eds), Selected proceedings of the third conference on laboratory approaches to Spanish phonology, 140–154. Somerville, MA: Cascadilla Press.

4 Previous research and future directions of experimental approaches to the study of sound variation in Spanish

4.1 Laboratory approaches and the analysis of spontaneous speech

For a long time, laboratory approaches have resisted the analysis of spontaneous speech for several reasons. Spontaneous speech is intrinsically more variable; variables, such as the segmental and prosodic contexts are difficult to control, and recording spontaneous speech or semi-spontaneous speech at the lab is not an easy task. Sociolinguistics, and more recently sociophonetics, have demonstrated the importance of analyzing natural speech, particularly in the cases of studies of changes from above (Labov 1994). Thus, the challenge for sociophonetic research continues to be the development of methodologies that would allow us to treat spontaneous speech as laboratory speech. In doing so, it is important to revisit Ohala's (1974) distinction, quoted at the beginning of this chapter, between man-made controls and nature-made controls. In particular, careful cross-dialectal as well as cross-linguistic comparisons, especially within the Romance family, would allow us to test hypotheses regarding sound change,

such as the divergent development of rhotics or the similarities in processes such as depalatalization or delateralization.

Extending the use of experimental approaches to spontaneous speech will always be easier for segmental than for suprasegmental variation mainly for one reason; in the study of suprasegmentals, meaning is always involved. This is particularly true in the study of intonational contours, where it is difficult to determine whether we may be dealing with two (or more) variants of the same variables or with two different variables. As such, the application of experimental methods to the analysis of suprasegmentals in spontaneous speech faces parallel challenges to those experienced when sociolinguistic analysis was being extended from phonological to morphosyntactic variation (e.g. Lavandera 1978; Labov 1978). It is not surprising that the vast majority of comparative studies available are based on read speech, which may obscure many of the differences across varieties. A possible way of extending the analysis of suprasegmentals to spontaneous speech is by combining the experimental research on intonation and on information structure. This latter field of research has developed a detailed methodology for spontaneous speech corpus analyses (e.g. Prince 1981), which allows for the identification of a specific information structure (e.g. new information). This information structure can be associated with intonational contours (e.g. van Donzel and Koopmans-van Beninum 2000), which, in turn can be compared across varieties.

4.2 Empirical coverage

For the most part, experimental research on sound variation in Spanish has been determined by the availability of free acoustic software (e.g. PRAAT, Wavesurfer, Speech Analyzer), which has allowed for the characterization of a wide range of phenomena. As Thomas (2002) reminds us, it is important to keep in mind that not all phenomena are equally suitable to experimental analysis. It is also important to remember that in experimental approaches, hypotheses come first (e.g. Ohala 1974), and they dictate the methodology to be chosen and the specific parameters to be measured.

Having said so, it is crucially important to extend the empirical coverage by analyzing a wider variety of phenomena, and by including processes as well as isolated segments. There is a need for studies of assimilatory and dissimilatory processes, and of coarticulation, more generally. In line with studies such as Gerfen (2002) and Torreira (2006, 2007), it is important to look at the consequences that phenomena, such as aspiration or deletion (not only of /s/), have on neighboring segments. Changes of vowel quality have been reported for varieties with high rates of aspiration and deletion, such as Eastern Andalusian (e.g. Hualde 2005b: 130). Nasalization also affects the perception of vowel quality (e.g. Ohala 1974). Thus, it is also likely that varieties that have different processes affecting nasals (e.g. higher rates of velarization) also differ in the phonetic characteristics of the vocalic system. As mentioned in Section 3.2, there is also a need to expand our knowledge of suprasegmental variation, not only of intonation but also of duration.

Great progress has been made in the variety of elicitation techniques, which include not only the traditional sociolinguistic interview but also picture naming tasks and story-telling (e.g. Mazzaro 2008; Willis and Bradley 2008), map tasks (e.g. Aguilar 1999; Henriksen 2009), and a variety of games designed to elicit specific target words (e.g. Ortega-Llebaria 2004).

In terms of the methods used, it is important to diversify on all fronts, that is both in the methods used and in the parameters measured. Perception experiments have not been widely applied to the study of sound variation and change, and neither have articulatory techniques. For example, Recasens and Espinosa's (2007) comparative analysis of fricatives and affricates in two Catalan varieties constitutes an interesting model for a comparison across Spanish varieties. As for acoustic analyses, a variety of methods is necessary. Most studies so far have dealt with formant frequencies, duration, and intensity. Very few studies have analyzed place differences (e.g. Colantoni 2006a, b; Simonet 2008) as well as differences in periodicity, which are crucial to test hypotheses about phenomena such as devoicing. In summary, the use of laboratory techniques in the analysis of sound variation in Spanish is just starting, and as such, there is a promising future as long as more variation is introduced into the study of variation.

4.3 Laboratory approaches and theories of sound change

Studies on sound variation and change in Spanish continue to grow. However, it is important that in the future our research be more and more dictated by the need to test theories about variation and change, which, as Labov (2006) reminds us, should be the goal of sociolinguistic theory.

It is crucial to go back to the data collected, as well as to gather more data on a variety of phenomena in order to address the classic questions about the origin and transmission of sound change. Is sound change articulatorily or perceptually motivated? Does it apply regularly? If there are exceptions, what are they? How is a change transmitted in a given community? What are the differences in the way a sound change is implemented in different communities? So far, very few studies have addressed these issues when analyzing the data, and even fewer have been designed to answer these questions.

Thus, if we start from the hypothesis that sound change is perceptually driven (e.g. Ohala 1989), it is important to incorporate perception tests (e.g. Widdison 1997; Mazzaro 2008, forthcoming). This, in turn, may allow us to tease apart universal trends from sociolinguistic patterns. For example, if all groups confuse two sounds at similar rates in a perception experiment using nonsense words but behave differently in production, we may be able to attribute those differences to the specific sociolinguistic status of a given sound in a given community (see Mazzaro 2008, 2010).

On the other hand, if we start with the classic Neogrammarian hypothesis in mind, there is a need to look more closely at different weakening (e.g. approximantization,

/s/ deletion, delateralization, diphthongization) and strengthening processes (assibilation, glide strengthening) as well as other processes such as dissimilation, metathesis, and epenthesis. In any event, it is necessary to start from the hypotheses independently of the type of speech analyzed (e.g. laboratory or semi-spontaneous), and it is crucial to re-conduct our findings to current research on sound variation and change.

4.4 Sound variation and categorization

To conclude, the study of sound variation and change should be intimately tied to the problem of categorization (i.e. the development of abstract categories from variable input), and should not stop at the description of variation per se. When exposed to any type of variation, a speaker of a given language faces a problem of categorization, that is of deciding whether to classify the form that s/he is exposed to as belonging to an existent category or to a new category. Ultimately, sound change involves re-categorization (Blevins 2004), even if it is only for an individual speaker (see Ohala 1989). As Pierrehumbert et al. (2000) suggest, variation is a major motivation of abstract categories, and constantly poses a challenge to the way our theories are formalized (Hinskens at al. 1997; Pierrehumbert et al. 2000).

In spite of being a central aspect of language, variation has been systematically excluded from theoretical linguistics until not that long ago (e.g. Labov 1994; Durand and Laks 2002), and one of the main contributions of sociolinguistics has been to remind linguists not only of the importance but also of the systematicity of variation. As such, if laboratory approaches want to contribute to the sociolinguistic enterprise, and crucially to linguistic theory, it will be important to constantly remind ourselves that our goal is to account for how speakers and listeners build up categories confronted with variable input (e.g. Pierrehumbert 1999; Bybee 2001). Spanish has gone a long way in the description of variation but much more needs to be done about the problem of categorization, if as Labov says (2006: 508), we want to "demonstrate to colleagues engaged in more abstract analyses that their search for the invariant core of the language faculty will fail if they do not take social variation into account."

NOTES

1 Thanks to José Ignacio Hualde and the three anonymous reviewers for their generous comments on earlier versions of the manuscript. Thanks also to my students who have always pushed me to clarify my thoughts and to make my opinions explicit.

2 Indeed, the terms "laboratory" and "experimental approaches" are not synonyms. Laboratory approaches are associated with the framework presented in Pierrehumbert et al. (2000), whereas experimental approaches have a longer and broader tradition.

3 Willis (2005) reports differences in the quality of /a o u/ in the Spanish of the Southwest.

4 According to standard Spanish syllabification rules, a sequence of an unstressed high-vowel followed by another vowel constitutes a diphthong. There is, however, a subset of words with rising sequences that do not follow this rule, and thus, are called "exceptional hiatuses."
5 Similar results were obtained by Carrasco (2008), who showed that Costa Rica and Madrid Spanish differed in the degree of lenition of post-consonantal voiced stops. Voicing of voiceless stops in other Peninsular varieties, such as the Spanish spoken in the Canary Islands, was documented in Oftedal's (1985) pioneer study.
6 Dialectal differences are also documented for voice-onset-time patterns (e.g. Williams 1977; Rosner et al. 2000).
7 See also Torreira (2006, 2007) for a series of studies on the consequences of /s/ aspiration for the articulation of the following consonant in Andalusian Spanish.

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