Chapter 3

The Phonology of Spanish Liquids

Spanish is a language of interest in this study because it uses a system of three liquid consonants which display some interesting distributional and allophonic behavior. The two rhotics – a trill and a tap – are contrastive in some environments and neutralize in others. The Spanish lateral is pronounced as a clear [l] in all environments, and neutralizes with rhotics in coda position in some dialects. An understanding of the articulatory nature of these three consonants, how they contrast and how they pattern together, is important when considering the phonetic and phonological properties of the class of liquids.

Spanish also provides an ideal test case for the central hypothesis being examined in this dissertation: that liquid consonants are characterized by a more global set of articulatory gestures than obstruents. Evidence from earlier studies was reviewed in Chapter 2 indicating that both of the liquids of English are produced with dorsal gestures. Yet because English uses a dark [ɫ] and an approximant rhotic, it is not surprising to find that these consonants are articulated with a dorsal component. It remains to be seen whether the clear lateral and the trill and tap of Spanish are also produced with a dorsal gesture.

In this chapter, an overview of the sound structure of Spanish will first be presented. The phonological behavior of the Spanish liquids will be compared to the behavior of other consonants, and the role of liquids in the phonological organization of the Spanish syllable will be considered. Building on the findings of previous studies, the goals of a new phonetic study of Spanish liquids will be set out, before these experiments are presented in Chapter 4.

3.1 Spanish Consonantal Phonology

Most varieties of Spanish distinguish 16 consonants and five vowels. Stress can be phonologically contrastive, but unstressed vowels are not significantly reduced. The phonemic inventory used by most standard varieties of American Spanish is illustrated in Table 3.1. Castilian Spanish uses an additional fricative /θ/ which contrasts with the alveolar fricative /s/ in pairs such as *cima* [ˈθi.ma] ‘summit’ / *sima* [ˈsi.ma] ‘abyss’. [1]

	LAB	LD	DEN	ALV	PA	PAL	VEL	
Stop	p		t̪				k	
	b		d̪				g	
Nasal	m		n̪			ɲ		
Affricate					tʃ			
Fricative		f		s̺			x	
						(ʝ)		
Rhotic				r				
				ɾ				
Lateral			l̪					
Vowel						i		u
						e		o
							a	

TABLE 3.1: **Phonemic inventory of standard Latin American Spanish** (adapted from Hualde 2005).

The phonemic status of /ʝ/ is controversial, but in general, all non-nasal palatal consonants which occur in unstressed prevocalic and syllable-initial positions – [j], [ʝ], [ʒ], [ɟ] – can be treated as allophones of the high front vowel /i̯/ (Hualde 2005).[2] Similarly, the high back glide (/w/ according to Harris 1969), found in words such as *dueño* [ˈdu̯e.ɲo] ‘owner’, can be treated as a vocoid /u̯/ because there are no minimal pairs which constrast the high back vowel with a labio-velar approximant. The major implication of this analysis is that the liquids are the only non-obstruent oral consonants in Spanish.

1 These phonemes have merged into a single dental fricative in *ceceo* dialects of southern Andalusia (/θ/,/s/ → [θ]), and into a single alveolar fricative in the *seseo* varieties spoken in Cordoba, the Canary Islands, and most parts of Latin America (/θ/,/s/ → [s]).

2 In some varieties (Buenos Aires), there is a distinct palatal consonant which contrasts with the high-front vowel: *yerba* [ˈʒer.βa] ‘mate leaves’ / *hierba* [ˈi̯er.βa] ‘grass’; however, for most Spanish speakers, these words would be homophonous ([ˈjer.βa]).

3.1.1 Liquid Inventory

Most Spanish speakers distinguish three liquid consonants: two apical rhotics /r/ and /ɾ/, and the lateral /l/. *Lleísta* dialects (Paraguay and some Andean Spanishes) distinguish a second lateral (*polo* [ˈpo.lo] 'polo' / *pollo* [ˈpo.ʎo] 'chicken'). In these varities, the palatal lateral contrasts also with a palatal approximant (*poyo* [ˈpo.jo] 'stone bench') and the lateral-vowel sequence /li/ (*polio* [ˈpo.li̯o] 'polio'). In most areas, however, the palatal lateral has merged with the palatal approximant – typically through the process of *yeísmo* (/ʎ/,/j/ → [j]) – but *žeísmo* (/ʎ/,/j/ → [ʒ]) and *šeísmo* (/ʎ/,/j/ → [ʃ]) mergers are also found in Argentina. As a result of these changes, most modern varieties of Spanish use only a single lateral consonant (Hualde 2005).

Martínez-Celdrán et al. (2003) assert that Castilian Spanish distinguishes two lateral phonemes (*luz* [luθ] 'light' / *alli* [aʎi] 'there') as well as a palatal affricate (*yate* [ɟ͡ʝate] 'yacht'), which supposes a four-liquid system. However, because they give no minimal pairs which contrast the palatal approximant and the two laterals in the same phonological environment, we can conclude that the Spanish variety which they are describing is not a *lleísta* dialect, but rather a *yeísta* variety in which either the merged palatal approximant is lateralized or the alveolar lateral is palatalized before high front vowels.

Spanish /l/ is produced as a clear lateral in all environments – no [ɫ] allophone appears in coda position, or as a result of back vowel coloring: *lata* [ˈla.ta] 'can' cf. *tal* [tal] 'such'. Hualde (2005) claims that the place of coronal articulation of the lateral assimilates to a following non-labial consonant: *alto* [ˈal̪.t̪o] 'tall', *colcha* [ˈkolʲ.tʃa] 'bedspread', cf. *balsa* [ˈbal.sa] 'raft'. There is no restriction on the distribution of /l/, which appears in onsets, codas, word-initially, and word-finally. In *lleísta* dialects, the palatal lateral merges with the alveolar lateral in word-final position: *élla* [eʎa] 'she' but *él* [el] 'he' (Harris 1969).[3]

3.1.2 Distribution of Rhotics

Spanish rhotics have a limited distribution: the trill and the tap are contrastive only in intervocalic contexts: *coro* [ˈko.ɾo] 'choir' / *corro* [ˈko.ro] 'circle'; *quería* [ke.ˈɾi.a] 'I wanted' / *querría* [ke.ˈri.a] 'I would want'. In phonological environments other than intervocalic, the trill and tap do not contrast, and different rhotic allophones are used depending on dialect, speaker and register.

Most commonly, the trill is found word-initially (*rata* [ˈra.ta] 'rat') and in medial

[3] Palatal nasals are also prohibited word-finally in all Spanish varieties.

onsets following consonantal codas (*honra* ['on.ra] 'honour'). Martínez-Celdrán et al. (2003) claim that in Castillian Spanish, the trill appears in medial onsets only after [l], [n] and [s].[4]

The tap is the prototypical rhotic found in onset clusters (*broma* ['bɾo.ma] 'joke', *abre* ['a.bɾe] 'he opens'), and in medial pre-consonantal codas (*carta* ['kaɾ.ta] 'letter'). Importantly, the tap also appears in word-final codas before another vowel – a position in which the rhotic would be resyllabified as an onset in *andante* and *presto* speech (*mar ancho* ['ma.ɾan.tʃo] 'wide sea'). Hualde (2005) observes that the tap is the only consonant in the phonology which is contrastive word-medially, but excluded from word-intial position.

The distribution of Spanish rhotics is summarized in Table 3.2. It is important to note that these are the allophones which prototypically appear in the environments indicated in most standard varieties of Spanish. According to Harris (1969), the type of rhotic which occurs in *all* environments can vary stylistically and idiolectally.

RHOTIC	ENVIRONMENT	EXAMPLE
Trill:	# _	['ro.ka]
	C $[_\sigma$ _	['en.re.do]
Tap:	$[_\sigma$C _ V	['gɾa.mo]
	V _ #V	['se.ɾa.mi.gos]
Contrastive:	V _ V	['ka.ɾo] / ['ka.ro]
Variable:	V _ $]_\sigma$C	['paɾ.te] ∼ ['par.te]
	V _ #C	['seɾ.po.'e.ta] ∼ ['ser.po.'e.ta]
	V _ ##	['seɾ o 'no 'seɾ] ∼ ['ser o 'no 'ser]

TABLE 3.2: **Distribution of Spanish rhotics** (adapted from Hualde 2005).

Because the trill and the tap occur in complementary distribution in all but one context, numerous analyses have been proposed under which these consonants are analysed as allophones of a single rhotic phoneme (Harris 1969, 1983; Mascaró 1976; Wheeler 1979). Under these approaches, the trill is typically treated as the surface realization of a geminate tap: /ɾɾ/ → [r] (Bonet & Mascaró 1997, Lloret 1997). This analysis is consistent with a *diachronic* account of Spanish trills, which developed from geminate rhotics in Latin (Penny 2002). The geminate origin of Spanish trills also explains their limited distribution in intervocalic position.

Nevertheless, as Hualde (2005) observes, the way in which trills syllabify in mod-

[4] *La Real Academia Española* prescribes the use of the trill after these consonants alone.

ern Spanish argues against their synchronic analysis as underlying geminates. Unlike in Italian, where long intervocalic rhotics syllabify across both coda and onset ([kar.ro] *'cart'* cf. [ka.ro] *'dear'*), Spanish intervocalic trills are syllabified in the same manner as taps – entirely in the onset: [ka.rro] *'cart'* cf. [ka.ro] *'expensive'*. Furthermore, if trilled rhotics were underlyingly geminates in modern Spanish then we would expect to find taps word-initially; instead we find trills in this environment, which Hualde (ibid.) suggests is the result of word-initial fortition of the rhotic.

In conclusion, the distributional behavior of Spanish rhotics suggests that there are two underlying phonemes which contrast in medial non-resyllabified onsets, and neutralize elsewhere. A fundamental goal of the phonetic study will therefore be to characterize the production of these two sounds in intervocalic environments, and to compare their production in other environments where they neutralize.

3.2 The Phonology of Spanish Liquids

Evidence for a class of liquids may be found in a variety of distributional phenemona, allophony, and other phonological processes in Spanish. The most important phonological characteristics of the Spanish liquids will briefly be reviewed in this section.

3.2.1 Spanish Syllable Phonotactics

Spanish syllable structure conforms to the template $(C_1(C_2))V(C_3(C_4))$, but shows a strong preference for open syllables with simple onsets (Table 3.3). Only vowels can fill a syllabic nucleus; there are no syllabic consonants.[5] Liquids play a special role in the phonotactics of the Spanish syllable as they are essential in the formation of onset clusters, and because they feature in a disproportionate number of codas.

Onset Structure

Spanish syllable onsets can be filled by a single consonant or one of a restricted set of clusters. Onset clusters are limited to a two-consonant sequence /C_1C_2-/ in which C_1 can only be the fricative /f/ or a stop, and C_2 either of the liquids /l/ or

[5] See discussion in Section 3.1 on the phonemic status of glides and the structure of the nucleus.

SYLLABLE TYPE	FREQUENCY
CV	55.81%
CVC	21.61%
V	9.91%
VC	8.39%
CCV	3.14%
CCVC	0.98%
VCC	0.13%
CVCC	0.02%
CCVCC	0.01%

TABLE 3.3: **Frequencies of occurance of Spanish syllable types** (Guerra 1983).

/ɾ/. Examples of each of these clusters are given in Table 3.4. The distribution and felicity of coronal-lateral clusters varies between dialects.[6]

RHOTIC-FINAL		LATERAL-FINAL	
/prado/	*'field'*	/plaka/	*'sheet'*
/brava/	*'fierce'*	/blanka/	*'white'*
/trampa/	*'trick'*	(/atlas/)	*'atlas'*
/drama/	*'drama'*	—	
/krasa/	*'crass'*	/klara/	*'egg white'*
/gramo/	*'gram'*	/glasea/	*'he glazes'*
/franka/	*'sincere'*	/flaka/	*'skinny'*

TABLE 3.4: Examples of possible **Spanish onset clusters**.

Coda Structure

Complex codas are rare in Spanish (Table 3.3).[7] Although most consonants are licensed in coda position, few post-nuclear consonants commonly occur in Spanish

6 Word-initial /tl-/ onsets are found in words of Nahuatl origin in Mexican Spanish: *tlapalería* 'paint store', *tlecuil* 'hearth'. Word internal /-tl-/ sequences which are broken across syllables in most varieties of Peninsular Spanish are syllabified as onsets in all Latin American varieties: [a.tlas] *'altlas'*, [a.ˈtlan.ti.co] *'atlantic'* (Hualde 2005).

7 All coda clusters in native words take the form /-Cs/, where C is one of a limited set of consonants, e.g. *biceps*, *ads.cri.bir*, *trans.por.te*. In Peninsular Spanish, some family names end with the cluster /-nθ/: *Sanz*, *Sainz* (Hualde 2005). Other types of clusters are found only in loan words, eg. *Nueva York*, *thorax*. All complex codas are prone to simplification through deletion: eg. [to.ras], [tras.por.te], [nu̯e.va.jor] (Colina 2006).

syllables. Colina (2006) and Hualde (2005) observe that simple codas most frequently consist of one of the coronals {/d/,/s/,/n/,/ɾ/,/l/}, as well as the fricative /θ/ in Peninsular Spanish, yet they do not support the claim with any lexicostatistical data.

In order to examine the structure of Spanish codas more thoroughly, an electronic corpus was automatically syllabified and searched to provide an estimate of the distribution and frequency of coda consonants. The corpus consisted of a dictionary of 68,415 of the most common roots of Mexican Spanish (Free Software Foundation 1994). Of the 250,213 syllables occurring in the corpus, 177,176 (71%) were found to be coda-less. The most commonly occurring coda consonants were /-n/ (33%), /-ɾ/ (29%), /-s/ (18%) and /-l/ (6%). Less than 3% of all syllables ended other than with a nasal, liquid, /-s/ or no coda (Table 3.5).[8]

CODA	COUNT	% SYLLABLES	% CODAS
No coda	177,176	70.8%	
Nasal	27,435	11.0%	37.6%
Liquid	25,597	10.2%	35.0%
/-s/	12,866	5.1%	17.6%
Other	7,139	2.9%	9.8%
Total	250,213	100.0%	100.0%

TABLE 3.5: **Representative frequencies of Spanish coda consonants**.

These data are consistent with those of Guerra (1983), who estimated 68.9% of Spanish syllables to be coda-less (Table 3.3). While the data in Table 3.5 do not support the claim that /d/ ranks amongst the most frequent coda consonants (/-d/ accounts for only 0.6% of codas in this corpus), it does demonstrate that the great majority of Spanish coda consonants are coronals (86%), sonorants (73%) or both (68%). 35% of all codas in the corpus were liquids.

Harris-Northall (1990: 40) suggests that liquids appear in a disproportionate number of codas in (Castillian) Spanish because they "have always shown themselves to be more resistant to erosion than other consonantal segments". He demonstrates that throughout the history of the language, coda obstruents and nasals have often been deleted or moved out of post-nuclear postions through the application of metathesis or epenthesis; liquids, on the other hand, have proven to be more diachronically stable in syllable-final and word-final positions.

8 Because the data source is a dictionary of base wordforms, some consonants which commonly occur in inflectional suffixing codas, especially /s/ and /n/ will be under-represented in this frequency analysis. It is also likely that the liquid /ɾ/ will be over-represented because of the disproportionate number of infinitive verb forms in the corpus.

For example, a major force in the development of Old Spanish, was [-e] apocope. At the peak of the application of this process in the 12th and 13th Centuries, word-final consonants of all types were found in Spanish words (Table 3.6). Most of the word-final consonants attested in Old Spanish are no longer found in absolute word-final position in Modern Spanish – as the data in Table 3.6 illustrates, [-e] epenthesis has generally been used to repair dispreferred word-final closed syllables. However, liquids, as well as /s/ and /n/, were tolerated in word-final position in many words, and have survived into the modern language.

LATIN	OLD SPANISH	MODERN SPANISH	GLOSS
PRINCIPE	princip	principe	‘prince’
PONTE	puent	puente	‘bridge’
NOCTE	noch	noche	‘night’
NOVE	nuef	nueve	‘nine’
DICIT	diz	dice	‘say’-3SG.PRES
CRUDELE	cruel	cruel	‘cruel’
MARE	mar	mar	‘sea’

TABLE 3.6: **Diachronic stability of Spanish word-final liquids** (Harris-Northall 1990).

Coda Preferences in Loanword Phonology

Is is not only in ancestral forms that coda liquids have proven to be more diachonically stable than other types of consonant. Harris-Northall (1990) notes that final liquids were also maintained in many Arabic loanwords, yet he provides only two examples, and does not describe the sound changes which affected other consonants in the transfer from Arabic.[9] Versteegh (1997) estimates that Modern Spanish uses more than 4000 words of Arabic origin. Because both the Classical and Hispaño-Arabic from which these words were sourced were languages with rich sets of coda consonants, examination of the phonological changes which have shaped Arabic loanwords in Spanish can offer further insights into the role of liquids in the phonotactics of the Spanish syllable.

To better consider the diachronic stability of coda consonants in Spanish, a corpus of 1,250 Arabic loanwords was examined (wordlist obtained from Batzarov 2004; etymons taken from Real Academia Española 2009). The survey reveals that words which were originally consonant-final in Arabic have typically undergone

[9] One of the examples of final lateral ‘preservation’ cited by Harris-Northall (1990) has a unclear etymology, but appears to be the result of the lateralization of a final stop in the Hispaño-Arabic (originally Persian) loanword: *azúl* < [laːzaward] ‘blue’ (Real Academia Española 2009).

paragoge so as to conform with the prefered open syllable structure of Spanish: *aladroque* < [alħatˤruk] ‘anchovy’; *alcrebite* < [kibriːt] ‘sulphur’; *jarabe* < [ʃaraːb] ‘syrup’. Only 6.7% of Arabic loanwords listed by Batzarov (2004), for example, were found to be obstruent-final, while 18.9% ended with an obstruent-vowel sequence.

Lateral- and rhotic-final words of Arabic origin, on the other hand, abound in Modern Spanish: *alcázar* < [qasˤr] ‘fortress’; *azúcar* < [sukkar] ‘sugar’; *mandil* < [mandiːl] ‘apron’; *zagal* < [zuggluːl] ‘lad’, *alcohol* < [kuħl] ‘alcohol’; *abismal* < [mismaːr] ‘abysmal’. Some words which originally ended with a liquid-vowel sequence in Arabic are liquid-final in Modern Spanish, e.g. *albur* < [buːriː] ‘word game’. 13.2% of the Arabic loanwords listed by Batzarov were found to be liquid-final – twice as many as were obstruent-final, despite the greater frequency of obstruent consonants.

It is not only final obstruents which have been affected in the phonological transfer: although some words of Arabic origin have maintained their final nasal (*algodón* < [qutˤn] ‘cotton’; *almacén* < [maxzan] ‘warehouse’), many other nasal-final words have also been altered through epenthesis of a final vowel (*aduana* < [diːwaːn] ‘customs’; *mezquino* < [miskiːn] ‘mean, stingy’; *fulano* < [fulaːn] ‘so-and-so’), which suggests that liquids might be more felicitous absolute final coda consonants in Spanish than the other sonorants. A more rigourous examination of the historical development of Arabic loanwords would be necessary to justify such claims; however, it is apparent from even a small survey of such wordforms that liquids have a special status as coda consonants in Modern Spanish.

3.2.2 Phonological Processes Involving Liquids

As well as their shared phonotactic distribution, Spanish rhotics and laterals pattern together in a range of phonological processes which suggest that they form a class.

Liquid Dissimilation

Liquids have dissimilated in many Spanish words which originally contained two similar liquids in Latin: ARBOR > *arbol* ‘tree’; REBUR > *roble* ‘oak’. Colantoni & Steele (2005) observe that this change occurred only in those Romance varieties in which the rhotic was realized as a tap.

Synchronic liquid dissimilation is also observed in both Peninsula and Caribbean Spanish dialects, in words such as *peregrino* → [pelegrino] ‘wanderer’, *glándula* →

[ˈgrandula] 'gland', *delantales* → [delantares] 'aprons' (Lloret 1997; Hualde 2005). Lloret (1997) identifies a wide range of sonorant dissimilation phenomena in Iberian languages, but notes that dissimilation within the class of liquids is more common than changes between nasals and liquids.

Metathesis

As in other languages, liquids feature in a high proportion of the metathesis phenomena which are attested in Spanish. Mutual metathesis of liquids has occurred in the development of some words from their Latin etymons: PERICULUM > *peligro* 'danger'; MIRACULUM > *milagro* 'miracle', as well as synchronically in variants such as *fraile* → [flaire] 'monk' (Quilis 1999).

More common than mutual metathesis is CV metathesis, which is attested in many varieties of Spanish, and most commonly involves liquids and nasals. The most common pattern in examples cited by Russell Webb & Bradley (2009) involves the metathesis of coda rhotics into complex onsets: *garbanzo* → [grabanzo] 'chickpea', *permiso* → [premiso] 'permission', *porfiar* → [profiar] 'to insist'. Quilis (1999) cites an example demonstrating the opposite pattern for a lateral, which is metathesized out of an onset and into coda position: *clueca* → [kuleka] 'broody'. Liquid metatheses which result in the same patterns of resyllabification – laterals moving into codas, and rhotics into onsets – are ubiquitous in Judeo Spanish, e.g. *dadlo* → [daldo] 'give it'; *tarde* → [tadre] 'late'; *sordo* → [sodro] 'deaf' (examples from Bradley 2006).

Coda Liquid Neutralization

In Andalusian, Extremaduran and Caribbean Spanish varieties in particular, the tap/lateral contrast tends to be neutralized in coda position. As a result of this process, pairs such as *mar* 'sea'/*mal* 'evil' and *harto* 'full'/*alto* 'tall' have become homophonous for some speakers in the Dominican Republic and Cuba (Lipski 1994).

Neutralization results from a number of different processes which affect liquids in coda position. In Puerto Rican Spanish, for example, the neutralized consonant can be realized either as a type of a lateralized rhotic: *puerta* → [ˈpue^{r}l.ta] 'door'; *por favor* → [po^{r}l.fa.ˈβol] 'please' (Hualde 2005); while in Cuban Spanish, pre-consonantal liquids tend to assimilate to varying degrees to the following consonant, sometimes resulting in an intervocalic geminate (Quilis 1999): *el golpe* → [eg.ˈgob.pe] 'the blow'; *el verde* → [eb.ˈbed.de] 'the green one'; *pulga* 'flea', *purga* 'purgative' > [ˈpug.ga] (Hualde 2005).

Many other phonological processes which affect coda liquids have been reported in both Peninsular and American Spanish varieties, some of which result in liquid neutralization, and some of which only affect the rhotic or lateral. The most important of these processes are summarized below.

Rhotacism and Lambdacism

Rhoticization of final laterals is a feature of the Spanish spoken in the Bahía Honda, Havana and Cárdenas regions of Cuba, e.g. *delantal* → [delantar] 'apron'; *multa* → [murta] 'fine'; *pulso* → [purso] 'I press' (Quilis 1999). Coda laterals are also described as partially or completely rhotized in some varieties in Venezuela (D'Introno et al. 1979), Andalusia (Quilis-Sanz 1998) and the Canary Islands (Marrero 1988).

Rhoticization is not limited to laterals in coda position, but also occurs in tautosyllabic onset clusters in Leónese and Murcian Spanish, e.g. *planta* → [pranta] 'plant'; *flor* → [fror] 'flower'; *iglesia* → [igresia] 'church'; *clavel* → [kraβel] 'carnation' (Quilis 1999).

Lateralization of coda rhotics is reported in regions of Cuba, Panama and Puerto Rico (López-Morales 1983). Willis (2006) illustrates the phenomenon in Dominican Spanish: *ver̠dad* → [bel̠.da] 'truth', *comprar̠* → [kom.pral̠] 'to buy', and Quilis (1999) gives numerous examples from the Cuban Spanish spoken in Santigo de Cuba: *abrir* → [abril] 'open'; *tambor* → [tambol] 'drum'; *secarse* → [secalse] 'dry oneself'. [10]

Liquid Vocalization

In some Spanish varieties spoken in Colombia, Andalusia, the Canary Islands, and most famously in the Cibao region of the Dominican Republic, coda liquids are prone to vocalization pre-consonantally, and word-finally in words with final stress (Hualde 2005). For both laterals and rhotics, the segment which results from this process is a high front vowel or a palatal glide: *algo* [ˈai̯.ɣo] 'something', *cuerpo* [ˈkwei̯.po] 'body', *mujer* [mu.ˈhei̯] 'woman', *baul* [ba.ˈui̯] 'trunk' (Jiménez Sabater 1975). Quilis (1999) observes that liquids can also vocalise to a schwa in unstressed codas.

[10] Quilis (1999) notes that lateralization rarely affects coda rhotics which appear before nasals.

Spirantization and Nasalization of Liquids

Other phonological processes which affect both coda laterals and rhotics in some Spanish varieties include spirantization (Guane, Cuba): *alpargata* → [ahpar'gata] 'espadrille', *perla* → ['peh.la] 'pearl'; and nasalization (Cuba and the Dominican Republic): *piel* → [pjen] 'skin', *calamar* → [kala'mãn] 'squid' (Quilis 1999).

3.2.3 Phonological Acquisition of Spanish Liquids

Studies of phonological development show that the lateral and rhotics are acquired later than other consonants by Spanish speaking children (Stoel 1973, Jimenez 1987, Vihman 1996), despite their high frequency (Section 3.2). Before mastery, alternations are observed between all the liquids and /d/ (Stoel 1973). The data points to an earlier development of the lateral over the rhotics, however, once /l/ is established it provides a substitute for both rhotics until they have been mastered (Yavaş 2004, Barlow 2005).

Liquids are also acquired late, and often imperfectly, by second language learners of Spanish (Berkowitz 1986; Elliot 1997; Zuengler 1988). Non-native productions of all three liquids serve as a strong sociolinguistic marker of second language speakers (Face & Menke 2008), who often substitute their native rhotic for both target rhotics (Face 2006; Major 1986), and fail to acquire a clear lateral in coda postition (Segalowitz et al. 2004).

3.2.4 Summary – The Class of Liquids in Spanish

In this section, a wide range of phonological phenomena involving liquid consonants in Spanish have been identified. The trill and the tap neutralize in most phonological environments, where they are realized as different types of rhotics by different speakers. Phonotactically, both laterals and rhotics appear in a disproportionate number of codas, and the liquids are the unique class of sounds which facilitate complex onsets in Spanish.

Diachronically, synchronically, and during acquisition, laterals and rhotics participate in a variety of mutual and shared phonological processes, including substitution, dissimilation, metathesis with each other and with adjacent vowels, neutralization and vocalization. Spanish liquids have been shown to be especially susceptible to phonological processes in coda environments, where they tend to neutralize with each other.

Collectively, this represents a convincing body of evidence that the consonants {/l/,/ɾ/,/r/} constitute a phonological class. We can gain some insights into the properties of this class by considering some of these phenomena more closely. The fact that liquids are acquired later than other consonsants suggests that they are more phonetically complex in some respect, which is consistent with the hypothesis that liquid production involves a greater degree of global lingual coordination than obstruents.

The widespread occurance of phonological processes in Spanish which involve substitution of one liquid for the other (dissimilation, rhoticism, lambdacism), or neutralization of different liquids into a common realization, suggests that the liquids might share some common phonetic properties. It is also noteworthy that the liquids tend to pattern more with each other than with the other the other sonorants in all of these phenomena, as this indicates that the common property which liquids share might be more specific than merely sonority. Likewise, although the liquids pattern with the other coronals in some aspects of Spanish phonology (distribution in codas), in general the other coronals neither share the same distributional properties (cluster phonotactics) nor participate in the same processes as the liquids (dissimilation, vocalization, etc.), which suggests that the liquids might be characterized by some shared phonetic properties which distinguishes them from the other coronals.

The goal of the experimental component of this part of the dissertation will be to investigate potential phonetic bases for some of this class-like behavior. Before outlining the specific aims of these experiments, the phonetic literature on Spanish liquids will briefly be reviewed to consider what is already known about the production of rhotics and laterals.

3.3 Phonetic Characterization of Spanish Liquids

Phonetic studies of the Spanish liquids have primarily focused on the acoustic properties of these sounds (e.g. Massone & Gurlekian 1981, Quilis 1999, Simonet et al. 2008). Articulatory data on these consonants are limited, and often address only coronal activity. Partly due to the difficulty of obtaining data, and partly due to a lack of appreciation of the importance of studying the whole vocal tract, the dynamics of articulation of Spanish liquids have not been studied extensively, and are not well understood.

Liquid production has been more thoroughly examined in Catalan than in Spanish (Barnils 1933; Recasens 1986, 1991, 2007; Solé 2004, etc.). Because of the phonological similarities between the languages, the results of these studies are of interest;

however, the first goal of the present study is to address this deficit by examining the phonetics of the Spanish liquids in much greater detail, using modern experimental techniques.

3.3.1 Phonetic Properties of Spanish Laterals

The primary goals of production of the Spanish lateral /l/ are described by Ladefoged & Maddieson (1996): an apical coronal closure is formed in the dental-alveolar region while the body of the tongue is elongated, allowing airflow around the sides of the tongue, rather than through a central channel. Comparison of data from palatographic studies (Navarro Tomás 1970, Recasens 2004, Ladefoged & Maddieson 1996) reveals considerable variation in the place of articulation and extent of contact of the coronal constriction; unsurprisingly, less variation in the coronal articulation of [l] is observed in *lleísta* varieties which contrast a palatal lateral.

The behavior of the tongue dorsum during the production of Spanish laterals is less well understood. Articulatory studies of Spanish and Catalan laterals have either used palatography (Recasens et al. 1995, 1996, Martínez-Celdrán & Fernández-Planas 2007) – which provides no information about regions of the tongue which do not come into contact with the roof of the mouth – or else have inferred details about dorsal articulation from the acoustic analysis of coarticulation (Recasens 1987). Some static articulatory data is available from X-ray studies of single speakers of Castilian Spanish (Quilis 1963, Straka 1965, Martínez Celdrán 1984). Mid-sagittal X-rays captured during mid-consonantal production in these studies show that the back of the tongue assumes a lower posture than that observed during lateral production in English and Russian.

Acoustically, Spanish [l] is characterized by a relatively high second formant frequency. Cross-linguistically, it has been observed that the frequencies of the first two formants – especially F2 – are correlated with the degree of velarization or pharyngealization of /l/: laterals with F2 $>$ 1200Hz generally being perceived as clear, and those with F2 $<$ 1200Hz perceived as dark (Fant 1960, Recasens 2005). Acoustic studies of laterals produced by male speakers of a variety of different Spanish varieties report second formant frequencies above 1800Hz in the context [ala], and greater than 1400Hz in the context [ulu] (Chafcouloff 1972, Quilis et al. 1979, Hualde 2005). These values are consistent with the lower/more advanced dorsal postures observed in the X-ray studies cited earlier, and the characterization of Spanish [l] as a clear lateral.[11]

[11] An important difference between Spanish and Catalan is that Catalan uses a dark lateral, which is also observed in the Spanish spoken in Cataluña. Recasens et al. (1995) charaterize Castilian and Argentinian Spanish laterals as clearer than French, but darker than German [l].

3.3.2 Phonetic Properties of Spanish Rhotics

The production of the Spanish tap (*vibrante simple*),[12] is described as involving the rapid vertical movement of the tongue tip, resulting in a single contact in the post-dental region (Ladefoged & Maddieson 1996), while the trill (*vibrante múltiple*) typically involves two or three contacts in the same region (Hualde 2005). Spectrograms provided by Martínez-Celdrán (1984) show trills produced with four coronal contacts, however the consonant /r/ is often produced by Spanish speakers with a single contact, which raises the question of how a short trill differs from a tap.

The fundamental phonetic distinction between the two rhotics is the mechanism by which the tongue tip is moved: the tap being articulated by lingual muscular activity – the same as a coronal stop – while the coronal articulation in a trill results primarily from aerodynamic factors (once the tongue tip and blade have been actively approximated to the passive articulators). Studies of trill production in Catalan and other languages (Catford 1977, McGowan 1992, Solé 2002) have identified the complex set of articulatory and aerodynamic conditions which are necessary to initiate tongue-tip trilling: positioning and relaxation of the tongue tip, contraction of the tongue body to achieve the right shape and elasticity requirements, creation of a sufficiently narrow aperture to create a Bernoulli effect, and the maintenance of sufficient pressure difference across the lingual constriction. However; once trilling is initiated, tongue-tip vibration is maintained as a self-sustaining vibratory system.

Although the *mechanics* of trill production have been described in detail, the broader phonetic characterization of trilled rhotics, and the way in which the trill is differentiated from the tap in Spanish is less well understood. Recasens (1991) has investigated the rhotic contrast in Catalan,[13] and concluded that "the tongue body is subject to a higher degree of constraint during the production of the trill than the tap", based on their differing degrees of resistance to coarticulation from adjacent vowels. These results built on an earlier study of VCV sequences in Catalan and Spanish, in which Recasens (1987) concluded that the trill and the Catalan dark lateral [ɫ] were more resistant to coarticulation because these consonants involve "a velarization gesture", unlike the tap and the clear [l].

[12] Harris (1969), Ladefoged (1975) and others use the terms *tap* and *flap* interchangably. As Ladefoged (2005) later observes, it is useful to distinguish between a rhotic articulated primarily through lingual movement perpendicular to the passive articulator (*tap*), and one in which tongue tip movement is first away from and then towards the passive place of articulation (*flap*). This distinction is important when characterising the liquid systems of some Dravidian and Australian languages. It will be shown in Chap. 4 that Spanish rhotics are prototypically articulated as taps, rather than flaps.

[13] Catalan, like Spanish, also uses a trill and a tap, contrastive only in intervocalic enviroments.

If trills are characterized phonetically by the use of a dorsal gesture which is not present in the production of a tap, this raises the question of whether the taps differ phonetically from the coronal obstruents, which presumably only involve a specification for a coronal gesture. Likewise, if the 'clear' laterals of Spanish are inherently different from laterals in English, Russian and Catalan, in that they also lack a dorsal gesture, they might also be expected to display similar phonetic properties to the coronal obstruents which are not observed in the production of the trill.

Evidence from previous phonetic studies suggests that taps differ from coronal obstruents in at least two respects. Monnot & Freeman (1992) found that the Spanish tap differs from flapped allophones of American English /t/ and /d/ in that it does not involve any anticipatory articulation. In a study of Castilian coronal consonant clusters, Romero (1996) concluded that [ɾd] clusters consisted of two different segments, which is consistent with the hypothesis that the tap involves a different type of articulation from alveolar obstruents. While these results are suggestive, in neither study was the full set of Spanish liquids examined and compared with the stops. It remains to be seen exactly how the production of coronal consonants in each class might be characterized with respect to lingual control, and whether they differ in terms of dorsal articulation.

The conclusion to be drawn from a survey of the phonetic literature is that much more (and more specific) data is required to fully understand the articulatory nature of the Spanish rhotics and the way that they differ; however there is evidence that both rhotics seem to require a type and precision of lingual control which differs from that involved in the coronal stops.

Svarabhakti in Spanish Rhotics

It has long been observed that medial rhotic-initial clusters appear to be pronounced differently to other heterosyllabic clusters in some Spanish varieties (Lenz 1892, Gili Gaya 1921). Navarro Tomás (1918) has hypothesized that this effect results from epenthesis of a vowel fragment ("el elemento esvarabático") between the coda tap and the following consonant.[14] Malmberg (1965) illustrates the phenomenon in his transcription of the (Southern) Peninsular Spanish pronunciation of four words containing medial rhotic clusters (Table 3.7).

[14] The original reference to *svarabhakti* in Spanish rhotics is attributed to Lenz (1892): "he oído a españoles y peruanos ... pronunciarla (la *r*) con sonoridad muy completa, como en *arte*, *trabajar*, *cuerpo*, donde entre el golpe de lengua de la *r* y las consonantes vecinas puede percibirse un perfecto sonido glótico (*svarabhakti*)." (Quilis 1999: 338). In the Romance phonetics literature, the term has come to refer specifically to the "short, vowel-like fragments found between a tap /ɾ/ and its adjacent consonant" (Schmeiser 2009).

árboles	[ar^{ə}.βo.les]	*'trees'*
verdes	[ver^{ə}.ð̞es]	*'green'*
cargar	[kar^{ə}.ɣar]	*'to load'*
fuerzes	[fu̯er^{ə}.ses]	*'force'*

TABLE 3.7: **Rhotic svarabhakti** in Peninsular Spanish - ɾC- clusters (Malmberg 1965).

Quilis (1999) observes that svarabhakti also occur in tautosyllabic rhotic-final onset clusters. In the spectra in Figure 3.1, a resonant fragment is evident between the stop interval and the tap closure in the obstruent-rhotic clusters which begin each word. Quilis transcribes this fragment as *e*, noting its "considerable duration": *prado* [perado] 'field', *trece* [terese] 'thirteen', *fresa* [feresa] 'strawberry', *droga* [deroga] 'drug'.

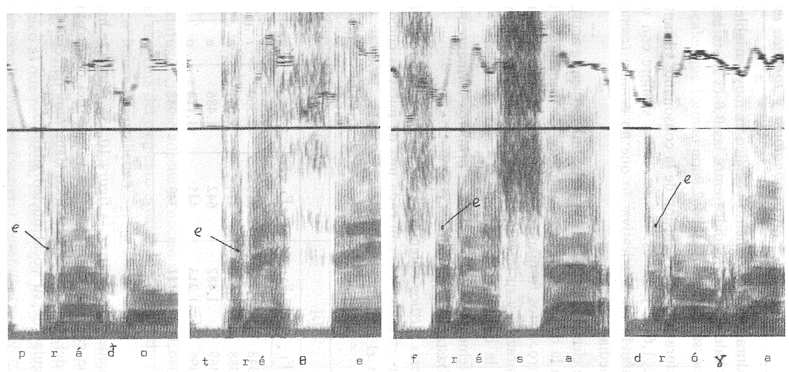

FIGURE 3.1: Spectra of **cluster-initial Spanish words showing svarabhakti** (Quilis 1999: 339).

Observations of svarabhakti – all based exclusively on acoustic data – have been made in many other other descriptions of Spanish rhotic clusters (Massone 1988; Almeida & Dorta 1994; Blecua 1996, etc.). The intermediary fragment is not always realized as a resonant element: in an acoustic study of five speakers of Highland Equadoran Spanish, Bradley (2004) found that coda rhotics are separated from following consonant either by a short vowel or a fricative burst resulting from assibilation. Martínez Celdrán (2007) describes the element which precedes the final syllable in the word *neutro* as having schwa-like formant qualities, and transcribes this pronunciation accordingly: [neut^{ə}ro].

The common assumption in all of these descriptions is that the resonant fragment is intrusive: an epenthetic element which is introduced between a rhotic and its adjacent consonant to break up the cluster. Considering the overwhelming preference for open syllables and simple onsets in Spanish syllable structure (Section 3.2.1), the interpretation of Spanish cluster svarabhakti as epenthetic vowels is understandable, as similar processes occur in many languages, including Lenakel (Kager 1999), Italian (Maiden & Parry 1997), and Morocan Colloquial Arabic (Gafos 2002), as well as in loanword phonology in Japanese and many other languages.

Under an Optimality Theoretic approach (Prince & Smolensky 1993), for example, the presence of svarabhakti in both onset (Table 3.8) and coda clusters (Table 3.9) could be explained by a common constraint hierarchy in which a prohibition on complex onsets outranks both a coda prohibition and input faithfulness constraints: *COMPLEX ≫ NO-CODA ≫ LIN-IO ≫ DEP-IO.

/prado/	*COMPLEX	NO-CODA	LIN-IO	DEP-IO
pra.do	*!			
par.do		*!	*	
☞ pə.ra.do				*

TABLE 3.8: **Svarabhakti in Spanish rhotic onset clusters**: an OT account.

/arboles/	*COMPLEX	NO-CODA	LIN-IO	DEP-IO
ar.bol.es		***!		
ar.bo.les		**!		
a.rbo.les	*!			
raboles		*	*!	
☞ a.rə.bo.les		*		*

TABLE 3.9: **Svarabhakti in Spanish rhotic medial clusters**: an OT account.

An alternative explanation offered by Bradley (2004) is that that the resonant fragments which appear in rhotic clusters are the result of timing differences in the accompanying coronal segments. Under this account, coda svarabhakti are not epenthetic, but appear when gaps arise between the otherwise contiguous tongue tip gestures of the coda rhotic and the following onset consonant (Fig. 3.2).

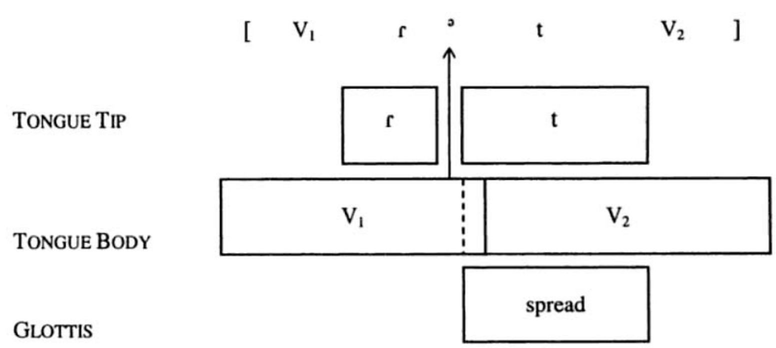

FIGURE 3.2: A gestural account of intrusive **svarabhakti vowels** in Spanish medial rhotic-final clusters (taken from Bradley 2004: 206).

If Bradley's account is correct, then we should expect the svarabhakti which appear in Spanish medial rhotic-initial clusters to have the same properties as the vowels which precede them. On the other hand, if svarabhakti are essentially epenthetic, as Quilis, Martínez Celdrán and Malmberg's descriptions suggest, then these resonant fragments might be expected to have the phonetic properties of a schwa. Acoustic data on the formant properties of svarabhakti (Quilis 1970) is inconclusive: when plotted in an F1-F2 plane, these vowel fragments cluster around schwa, but distribute in the directions of the acoustic targets of the adjacent context vowel.

Another possibility, which has not been properly explored in the literature, is that the svarabhakti observed in Spanish clusters are neither epenthetic nor reflexes of adjacent vowels, but an intrinsic part of the rhotic. If taps share with trills the property of having a controlled dorsum, then we would expect to see some phonetic reflexes of this dorsal articulation in the acoustic signal. Martínez Celdrán (2007) has alluded to this commonality: based on her comparisons of svarabhakti in intervocalic and coda rhotics, she has proposed that there might be a "vocalic element" common to all Spanish rhotics, which is sometimes masked by a following vowel.

Svarabhakti phenomena in Spanish rhotic clusters remain poorly understood. Studies have largely relied on acoustic data alone; the few articulatory studies which have examined rhotic production in cluster environments have generally used EPG data (e.g. Martínez Celdrán 2007) which offers limited insights into dorsal articulation. A broader phonetic study, including articulatory and acoustic data of rhotics produced in both coda and non-coda environments, will be necessary to come to a more complete understanding of the nature of svarabhakti, and the extent to which they might arise from an articulatory component intrinsic to the rhotic.

3.4 Summary

In this chapter, the phonological properties of the Spanish liquid consonants have been examined. Their behavior as a class has been demonstrated in their phonotactic, allophonic and other shared phonological properties. The tendency for Spanish liquids to alternate and neutralize suggests that they might share some common phonetic properties. Their unique distribution in onset clusters demonstrates that Spanish liquids are characterized by an affinity for the nucleus in the organization of the syllable.

A survey of the phonetic literature has revealed a lack of adequate articulatory data on Spanish liquids. In Chapter 4, an experiment designed to shed more light on the phonetic characterization of the class of Spanish liquids will be described. Specifically, the goals of this study are to:

i. examine the *dynamic* articulation of the three Spanish liquids
ii. compare the production of the liquids with the production of coronal obstruents, focusing in particular on the differences in dorsal articulation
iii. characterize the articulation of the tap, and how it differs from the trill and the coronal stop
iv. examine the articulation of rhotics in medial clusters in order to come to a better understanding of the origins of svarabhakti