1. Introduction

Consonant assimilation occurs when a consonant becomes more similar to a nearby or adjacent segment, be it consonantal or vocalic. Take, for example, the data in (1), which exemplifies nasal place assimilation in Spanish (Navarro Tomás 1918; Quilis 1993). The syllable-final nasal in the preposition ‘en’ in, realized as an alveolar nasal [n] in isolation or before a vowel (1a), is pronounced as bilabial [m] before a bilabial consonant (1b), and as velar [ŋ] before a velar consonant (1c). In addition, the word-internal codas in ‘Andalucía’ and ‘Valencia’, which occur before a dental and interdental consonant, respectively, are realized with the same place of articulation as the following consonant (1a, b).

(1) a. en Andalucía /en andaluθia/ [e.naŋ.da.lu.ˈθi.a] in Andalucia
   c. en Cataluña /en kataluŋa/ [eŋ.ka.ta.ˈluŋa] in Catalonia

All transcriptions in this chapter are given the International Phonetic Alphabet (IPA). Note that /d, t/ are dental in Spanish. Unless noted, examples are conveyed in Castilian (North-Central Peninsular) Spanish (for transcription conventions, see Martínez-Celdrán et al. 2003; Campos-Astorkiza 2012; Hualde 2014). In (1a) resyllabification applies across words (see Colina, this volume, and Hualde, this volume).

Consonant assimilation in Spanish is local, within and across word boundaries, since the target of assimilation and its trigger are immediately adjacent. Nonlocal, or ‘at-a-distance’, assimilation, where the trigger and the target are phonetically separated by one or more segments, is, however, attested for vowels in Spanish (Jiménez and Lloret, this volume).

Nasal place assimilation is anticipatory (regressive), since the ‘target’ (the segment undergoing assimilation) becomes more similar to the following segment (the ‘trigger’). Anticipatory assimilation is more prevalent in Spanish than perseveratory (progressive) assimilation, where the trigger precedes the target. This is also the case cross-linguistically (Gordon 2017: 124). Spirantization, which involves assimilation of the feature [continuant], is the main example of perseveratory consonant assimilation in Spanish. Compare, for example, ‘vino’ [ˈbi.no] wine vs. ‘el vino’ [el.ˈbi.no] the wine. In the second example, ‘v’ is realized as an approximant because the
Consonant assimilation

preceding sound is [+continuant] (see also Martínez-Gil, this volume). When both anticipatory and perseverative assimilation apply, mutual or reciprocal assimilation arises, as in ‘un vino’ [um. ’bi.no] a (glass of) wine. In this case, the nasal assimilates in place to the following consonant, which agrees in continuity with the preceding nasal.

Consonant assimilation in Spanish can be partial, as in (1), or total, depending on whether some or all segmental characteristics are assimilated. Total assimilation is also known as gemination. One example is ‘mismo’ /ˈmis.mo/ same, realized in some Spanish dialects as [ˈmim.mo] (D’Introno et al. 1995: 291). While total assimilation in Spanish is anticipatory and can be triggered only by an adjacent consonant, partial assimilation can be perseverative and may be triggered by consonants (as in 1), vocoids, or both. For example, /k ɡ x/ are palatalized before front vocoids in Chilean Spanish (cf. ‘reloj’ [re.ˈlox] watch with ‘relojes’ [re.ˈlo.ɾes] watches; Silva-Fuenzalida 1953: 161; see also section 1.3). In addition, spirantization is triggered by both vowels and consonants (Martínez-Gil, this volume).

Section 2 previews the main types of consonant assimilation in Spanish. Section 3 examines some critical issues arising from the consideration of assimilatory processes in Spanish. Section 4 provides a case study of velar palatalization in Chilean Spanish, and section 5 summarizes the main points of this chapter and provides some directions for further investigation.

2. Main types of consonant assimilation in Spanish

Four main types of consonant assimilation can be considered for Spanish: (i) place assimilation, (ii) voice assimilation, (iii) manner assimilation, and (iv) gemination. The first three types involve partial assimilation, while the last entails total assimilation.

Place assimilation is the most commonly attested type of assimilation in Spanish, and cross-linguistically as well (Gordon 2017: 127, 128). Place assimilation targeting sonorants, such as nasal place assimilation, and lateral place assimilation, whereby a coda lateral assimilates in place to the following onset, appear to be common across Spanish dialects. On the other hand, place assimilation phenomena targeting obstruents are associated with specific dialects. This is the case for velar palatalization in Chilean Spanish, whereby velar obstruents /k ɡ x/ are realized as palatal before a front vocoid, and for coda interdentalization of /p t k/., as in ‘actor’ [aθ.ˈtoɾ], reported in North-Central Peninsular Spanish. Place assimilation is described in detail in section 2.1.

Voicing assimilation, second only to place assimilation in frequency cross-linguistically (Gordon 2017: 127, 128), refers to a change in consonantal voicing due to the influence of a nearby segment. One example is the word ‘isla’ island, pronounced in many Spanish dialects as [ˈiz. la]. Voicing assimilation in Spanish can be triggered by voiced consonants and vowels. A more detailed description of voicing assimilation in Spanish is provided in section 2.2.

Typologically, gemination and manner assimilation appear to be relatively rare, particularly the latter (Gordon 2017). The main type of manner assimilation in Spanish is spirantization, which is perseverative and involves the feature [continuant], as already mentioned. Martínez-Gil (this volume) provides a detailed examination of spirantization in Spanish. We indicate additional examples of manner assimilation phenomena reported for Spanish in the literature in section 2.3.

Last but not least, gemination, or the total assimilation of a coda consonant to the following onset, as in ‘carne’ [ˈkan.ne] meat, is widespread in several dialectal areas, including Caribbean and Andalusian Spanish. Gemination has aroused much interest in Spanish phonology and has recently been documented in detail for additional dialectal areas, including Murcian Spanish. More information on gemination in Spanish dialects is given in section 2.4.
2.1. Place assimilation

Place assimilation in Spanish can target both sonorants and obstruents. Within the first group we have nasal place assimilation (previewed in (1)) and lateral place assimilation. The examples in (2, 3) illustrate nasal place assimilation across all places of articulation, across and within words, respectively. As mentioned earlier, nasal place assimilation interacts with spirantization (Navarro Tomás 1996: 110; Harris 1969; Hooper 1972; Cressey 1978, among others).

(2) a. en Andalucía /en andaluθia/ [e.naŋ.da.lu.ˈθi.a] in Andalucia
b. en Bilbao /en bilbao/ [em.bil.ˈθaŋ] in Bilbao
c. en Finisterre /en finistere/ [em.ˈfi.nis.ˈte.re] in Finisterre
d. en Zaragoza /en ˈθaragəθa/ [eŋ.ˈθa.ta.ˈθo.a] in Saragossa
e. en Toledo /en tole.do/ [em.to.ˈle.θo] in Toledo
f. en Sevilla /en sebi.ja/ [en.se.ˈθi.ja] in Seville
g. en Lleida /en ˈle.ida/ [en.ˈθe.ja.θa] in Lleida
h. en Cataluña /en kataluˈɲa/ [eŋ.ˈθa.ta.ˈθu.ɲa] in Catalonia

Note that before a palatal consonant, as in (2g), /n/ tends to be realized as a palatalized nasal [ɲ] rather than as a fully palatal nasal [ɲ], unless it precedes a palatal nasal, as in ‘un ñame’ (Quilis 1993: 229–230; Hualde 2014: 173).

(3) a. mana /mana/ [ˈma.na] it flows
b. envidia /enbidia/ [em.ˈbi.θja] jealousy
c. menfis /menfis/ [ˈmenθ.fis] Memphis
d. manzana /manθana/ [maŋ.ˈθa.na] apple
e. manta /manta/ [ˈmaŋ.ta] blanket
f. mansa /mansa/ [ˈman.sa] docile-FEM.
g. mancha /mantʃa/ [ˈmanθ.ʃa] stain
h. manga /manga/ [ˈmaŋ.ɡa] sleeve

An exception to nasal place assimilation within words is when /m/ immediately precedes /n/, as in ‘alumno’ [a.ˈlum.no] student (Hualde 2014: 172).

Kochetov and Colantoni (2011) find that nasal place assimilation in Argentinian and Cuban Spanish is categorical except before fricatives, and that it goes hand in hand with stricture (manner) assimilation (see also section 2.3; cf. Honorof 1999 for Peninsular Spanish).

Coda laterals assimilate in place of articulation to a following coronal consonant (i.e. interdental, dental, or (pre)palatal; 4, 5) (Navarro Tomás 1996; Alarcos Llorach 1950; Quilis 1981, among others). Lateral place assimilation blocks spirantization before /d/ (cf. 5e with 5b).

(4) a. ala /ala/ [ˈa.la] wing
b. alma /alma/ [ˈa.lma] soul
c. elfa /elfa/ [ˈel.fə] elf-FEM.
d. falsa /falsa/ [ˈfal.sa] fake
e. alza /alθa/ [ˈa.lθa] raise!
f. alta /alta/ [ˈa.ɫta] tall-FEM.
g. colcha /kolθa/ [ˈkoŋθ.θa] quilt
h. alcohol /alkool/ [a.lˈθoŋ] alcohol
Consonant assimilation

(5) a. el amor /el amor/ [e.ˈla.mor] the love
b. el valor /el balor/ [e.ˈla.ˈloɾ] the courage
c. el furor /el furor/ [e.ˈlu.ˈroɾ] the fury
d. el celo /el thecelo/ [e.ˈθe.ˈloɾ] the zeal
e. el dolor /el dolor/ [e.ˈdo.ˈloɾ] the pain
f. el sabor /el sabor/ [e.ˈsa.ˈboɾ] the taste
g. el llanto /el llanto/ [e.ˈla.na.to] the weeping
h. el calor /el kaloɾ/ [e.ˈka.ˈloɾ] the heat

Note that before a palatal consonant, as in (4g, 5g), /l/ tends to be realized as palatalized [ʎ] rather than as a fully palatal [ʎ] (Quilis 1993: 310–311; cf. Hualde 2014: 178).

As mentioned in the introduction, velar obstruents /k ɡ kʃ/ in Chilean Spanish are palatalized before front vocoids (6) (Lenz 1940; Silva-Fuenzalida 1953; Oroz 1966). For /ɡ/, palatalization interacts with spirantization, resulting in [ʝ] after nasal or pause and [j] elsewhere (Morales Pettorino 2003: 52). Velar palatalization is reportedly attested in areas of Colombia, Peru, Mexico, and Spain as well (Zamora Vicente 1967: 389; Greet Cotton and Sharp 1988: 286; RAE 2011). Unusually in Spanish, velar palatalization involves onset targets and vocalic triggers. For details, see section 4.

(6) a. quiso /kiso/ [ˈki.so] (s)he wanted
b. corto /koro/ [ˈko.ro] short
c. higuera /iɡera/ [i.ˈxe.ɾa] fig tree
d. gafa /ɡafa/ [ˈɡa.fa] glasses
e. gente /xente/ [ˈxe.nte] people
f. jota /xota/ [ˈxo.ta] jay

Palatalization of onset nasals is found in Asturias and Castilla-León Spanish. In Puerto Rico, Ecuador, Chile, Argentina, Colombia, the Philippines, and areas of Mexico, nasal palatalization appears to be assimilatory since it is triggered by diphthongs beginning with [i], as in ‘néphew’ [ˈɲe. to] nephew, ‘Antonio’ [a.ɲeto] (Quilis 1993: 242–243; Córdova 1996; RAE 2011: 243, among others). A similar phenomenon is attested for the sequence [li] followed by vowel in various Spanish dialects, including Judeo Spanish and dialects spoken in areas of Mexico and in Equatorial Guinea (Quilis 1993: 325 and references therein).

Interdentalization of /p t k/ in North-Central Peninsular Spanish might also be assimilatory. These obstruents, especially /k/, are realized by some speakers as [θ] before all voiceless stops (7) (Navarro Tomás 1996; D’Introno et al. 1995: 264; Quilis 1964). Some authors suggest that hypercorrection or orthographic influence are behind interdentalization (Lapesa 1981; Hualde 2014). However, González (2008) argues that place assimilation is involved, concurrently with manner dissimilation (cf. Antón 1994; Martínez-Gil 1999 for nonassimilatory approaches). Word-internally, coda /p t k/ can only be followed by coronal consonants /θ t s n/. Evidence from online misspelling shows that interdentalization of /k/ is more frequent before /t/, and rare before /s/, where deletion tends to take place. In addition, word-final /k/ tends to be either pronounced faithfully or deleted.

(7) a. óptico /optiko/ [ˈoθtiko] optical
b. ético /ethiko/ [ˈeθi.ko] ethnic
c. adicto /adikto/ [a.ˈdik.to] addict
Interdentalization appears to be more pervasive in some areas of North-Central Spain (Asturias, Burgos) than in the Basque country (Martínez Martín 1983; Antón 1994, 1998; Barbero and González 2015). Ongoing research suggests that in Basque-speaking areas, total assimilation (gemination) is a more frequent outcome, at least for coda /k/ (section 2.4).

Finally, in Bolivian Spanish /s/ becomes labiodental before /f/ in words such as ‘resbaloso’ slippery or ‘desvelo’ sleeplessness (Coello Vila 1996). In addition, labialization of /f/ to [ɸ] appears to be assimilatory in Caribbean Spanish, since it occurs more frequently before [u̯], as in ‘fue’ s/he went or ‘fuego’ fire (Vaquero 1996; RAE 2011: 187). Similarly, dorsalization of /f/, resulting in [h], [x], or [h], appears to be assimilatory in Venezuelan Spanish and other dialects, since it occurs before /u/ and/or all back vowels: ‘perfumar’ [peɾ.hu.ˈmar] to perfume (Quilis 1993: 282–283; RAE 2011: 189).

2.2. Voicing assimilation

As already mentioned, voicing assimilation in Spanish can be triggered by both voiced consonants and vowels. We will discuss each case in turn.

In some dialects maintaining /s/ in the coda, as in Mexico and parts of Spain, coda fricatives /θ/ s x/ assimilate in voicing to a following voiced consonant, within and across words (8, 9) (Navarro Tomás 1996; see also Harris 1969; Hooper 1972; Hualde 1989b; cf. Torreblanca 1978; Martínez-Gil 1991, 2003; Campos-Astorkiza 2014, in press, among others).

(8) a. afgana /afɡana/ [av.ˈɣa.na] Afghan-FEM.
b. jazmín /xaθmin/ [xað.ˈmin] jasmine
c. muesli /muesli/ [ˈmwez.li] muesli
d. musgo /musɡo/ [ˈmuz.yo] moss

(9) a. las gardenias /las ɡaɾデンias/ [laz.ˈɡaɾ.ˈde.njas] the gardenias
b. las rosas /las rosas/ [laz.ˈro.sas] the roses

Voicing assimilation is extremely rare for coda /θ/ (8a), because few Spanish words have /θ/ in this position. In addition, it does not apply to coda /x/, also relatively rare in Spanish (Hualde 2014: 156; see also section 2.2). Note that voicing assimilation interacts with spirantization in (8a, d).

Voicing assimilation can target noncontinuant obstruents as well. In some Spanish dialects, coda stops optionally assimilate in voicing to the following onset (Hualde 1989a; Martínez-Gil 1991, 1999; Morris 2002a; RAE 2011: 148). In Castilian Spanish, coda stop voicing assimilation interacts with spirantization (10a, c) and, in some cases, with coda fricativization (cf. 10b, d) (for more details, see Martínez-Gil 1991, 1999, 2003; González 2002).

(10) a. admirar /admiɾar/ [að.mi.ˈɾar] to admire
b. adquirir /adkiɾir/ [að.ki.ˈɾiɾ] to acquire
c. acne /akne/ [aɣ.ˈne] acne
d. actor /aktor/ [ak.ˈtɔɾ] actor

A similar voicing assimilation process is attested in Venezuelan Spanish, where voicing assimilation interacts with velarization: ‘absoluto’ [ak.so.ˈlu.to] absolute; ‘étnico’ [ˈeq.mi.ko] ethnic (RAE 2011: 143).
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As mentioned earlier, voicing assimilation can also be triggered by vowels in Spanish. Word-final /s/ assimilates in voicing to a following vowel in Ecuadorian Spanish (Lipski 1994: 248; Bradley 2005; Colina 2009a; Chappell 2011). In Istanbul Judeo-Spanish, both /s/ and /ʃ/ undergo this type of assimilation (Bradley 2007; Hualde and Saul 2011, among others). In Catalan Spanish, /s/ is typically voiced between vowels (García Mouton 1994), and in Canary Islands and Puerto Rican Spanish, /s/ and /ʃ/ undergo voicing in this context (Torreblanca 1986; Torreira and Ernestus 2012).

Note that unlike for fricatives, which are phonologically voiceless in Spanish, voicing assimilation targets both voiced and voiceless stops in this language and can result in voiced/voiceless outcomes.

Onset voiceless stops are realized as voiced in several Spanish dialects (Torreblanca 1976; Marrero Aguiar 1988; Quilis 1993: 222–223; Vaquero 1996; RAE 2011: 138–139, among others). This is generally understood as consonantal weakening rather than assimilation.

2.3. Manner assimilation

Aside from spirantization (Martínez-Gil, this volume), manner assimilation is rather infrequent in Spanish. One example is the realization of coda /s/ as the fricative rhotic [ɹ̝] before a trill (11) (Navarro Tomás 1996: 107, 156; D’Introno et al. 1995: 290).

(11) a. Israel /israel/ [ɪɾ.ˈra.ˈel] Israel
b. las reinas /las reinas/ [laɾ.ˈrej.nas] the queens

As discussed in section 2.2, coda fricatives can assimilate in voicing to a following voiced consonant. Before a trill, however, voicing assimilation goes in tandem with /s/ rhoticization.

/s/ can alternatively be realized as a trill: [ir.ˈra.ˈel], [lar.ˈrej.nas] (D’Introno et al. 1995: 290), which would be an instance of total assimilation (section 2.4). Deletion of /s/ in this context is also common (Hualde 2014: 155).

As noted in section 2.1, Kochetov and Colantoni (2011) report that nasal place assimilation in Cuban and Argentinian Spanish is accompanied by stricture (‘manner’) assimilation. This raises the question of whether manner/stricture assimilation is involved, and underreported, in other place assimilation phenomena in Spanish.

2.4. Gemination

Phonological geminates do not exist in Spanish, except for a few learned words such as ‘perenne’ perennial or ‘obvio’ obvious (Hualde 2014; cf. Baker 2004). However, they can arise via complete assimilation of a coda to the following onset. For example, in Murcian Spanish all codas except for /m n/ assimilate to the following onset, within and across words (12, 13) (Monroy and Hernández-Campoy 2015: 230, 231).

(12) a. aptitud [at.ti.ˈtuð] aptitude
b. atmosfera [at.mɔs.ˈfe.ɾa] atmosphere
c. absurdo [as.ˈsur.ðo] absurd

(13) a. los pies [lop.ˈpje] the feet
b. las manos [laɾ.mˈnɔ] the hands
c. los vasos [loɾ.ˈbəs.o] the glasses
In Murcian Spanish, /a e o/ are reportedly realized as open [æ ɛ ɔ] when the coda is not pronounced (12b, 13a–c) (Monroy and Hernández-Campoy 2015: 233, 235). It is unclear from the source whether this is categorical; in (13a) the last vowel is transcribed as closed [e]. In addition, vowel harmony takes place when coda /s/ indicates person or plurality, as in (13c) (Monroy and Hernández-Campoy 2015: 235 and references therein).

In many dialects, including Caribbean, Andalusian, and New Mexican Spanish, gemination targets /s/ before a consonant (see, for example, RAE 2011: 200). Focusing on Andalusian Spanish, complete assimilation of /s/ to the following onset may arise regardless of the following consonant (14). In addition, if the following onset is a voiceless stop, complete assimilation with preaspiration may result (14a). If the onset is a sonorant, partial devoicing can take place (14b). Finally, if the onset is a voiced obstruent, a geminated voiceless fricative results (14c) (Alarcos 1958; Hualde 1989a, 1989b; Gerfen 2001, 2002; among others).

(14) a. visto [ˈbit.to] [ˈbit.t.to] seen
   b. abismo [a.ˈʃim.mo] [a.ʃim.mo] abyss
   c. rasgo [ˈraʃ.go] [ˈrax.xo] feature

Postaspiration is also attested in some Andalusian varieties. For details, see Torreira (2012).

Gemination also targets liquids in coda position in Caribbean Spanish (Guitart 1976, 1980; Harris 1985; Núñez-Cedeño 1994; Martínez-Gil 2012) and in parts of Panama, Colombia, and Chile (RAE 2011: 230). Gemination of coda /ɾ/ is also attested in Chilean Spanish and other dialectal areas, particularly with a coda nasal or stop: ‘actor’ [at. ’tor] actor, ‘un médico’ [um. ’me.ɾi.co] a doctor (Oroz 1966; Quilis 1993; D’Introno et al. 1995; RAE 2011: 256). In addition, total assimilation might be more pervasive than previously thought in some variants of North-Central Peninsular Spanish (Martínez-Gil 2017, p.c.). In an ongoing acoustic study on coda /k/ in Basque Spanish, González (2015) reports geminated outcomes in 23% of tokens analyzed for eight speakers of this dialect; most occur before [t] (cf. 23% deletion, 11% interdentalization, 30% [k], and 13% other realizations).

3. Critical issues

As shown in the previous section, consonant assimilation is pervasive and multifaceted in Spanish, with a number of voicing, place, and manner assimilation phenomena attested in several dialects. This section discusses a number of empirical and theoretical issues that stand out regarding these phenomena.

3.1. Empirical issues

One issue that arises when we examine consonant assimilation in Spanish is the extent to which it is categorical. This is important for descriptive reasons, and also has implications for its theoretical analysis.

Like other phonological phenomena—such as weakening or strengthening—consonant assimilation is grounded in phonetics, with articulatory, perceptual, and aerodynamic factors leading or contributing to it (Jun 1995, 2004). Articulatory factors are prevalent; speech segments are typically coarticulated in running speech, frequently resulting in or causing assimilation to nearby sounds. Coarticulation is obvious when we isolate the first gesture of ‘curo’ /ˈkuɾo/ I heal, which has lip rounding. Compare with ‘quita’ /ˈkita/ take off (imp.), where /k/ is
pronounced with lip spreading. This shows that /k/ is typically coarticulated with the following vowel (expressed in narrow transcription with /k/ labialization in ‘curo’ [ˈkʰu.ro] and fronting in ‘quita’ [ˈkʰi.ta]). Coarticulation underpins various types of consonantal assimilatory phenomena in Spanish, most notably velar palatalization. But coarticulation is by nature phonetic and gradient, whereas velar palatalization and other assimilatory phenomena are phonological and (quasi-)categorical.

Perception is another important factor leading to or contributing to consonant assimilation, particularly when directionality asymmetries are observed (Gordon 2017: 123). It is well known that velars are likely to be perceived as palatals before front vowels and glides, which contributes to palatalization phenomena across languages (Guion 1998; see also Zampaulo, this volume). Perception also plays a role in assimilatory processes that have codas as targets, since it is harder to accurately perceive voicing and place cues in this position (Quilis 1993: 363). Assimilation to the following onset is one possible outcome, together with neutralization, deletion, or weakening. Last but not least, aerodynamics is relevant in cases such as voicing assimilation, which affects all coda fricatives except for /x/. Aerodynamic reasons can explain this apparent exception: voicing is least conducive for velar obstruents cross-linguistically, since their constriction is too close to the larynx to allow for sustained voicing. Aerodynamics can also impact whether a phenomenon is categorical or gradient, as shown by Kochetov and Colantoni (2011) for nasal place assimilation.

One case of assimilation that appears to be partial and/or gradient is fricative voicing assimilation (Harris 1969; see also section 2.2). Navarro Tomás (1996: 95, 108) observed that a slow, strong, or emphatic articulation blocks voicing for coda /sθ/. More recently, Campos-Astorkiza (2014) provides acoustic evidence that in North-Central Peninsular Spanish, voicing assimilation is gradient and sensitive to prosody, since it is more likely within words than in higher prosodic domains.

It is also important to note which assimilatory phenomena are optional rather than obligatory, and which are relatively more prevalent. Practically all types of consonant assimilation discussed in this chapter appear to be optional, excepting perhaps gemination in Andalusian or Caribbean Spanish. This issue is particularly relevant when several types of assimilation can apply in the same context, as with coda stops in Peninsular Spanish, which optionally interdentals, assimilates in voicing, or completely assimilates to the following onset.

Gradience and optionality need to be investigated further in many of the phenomena previewed in section 1. Another, more specific empirical issue to investigate further is whether fricatives and stops do indeed undergo voicing assimilation in similar dialectal areas. Whereas coda fricatives undergo voicing assimilation, which is gradient (or gemination in certain dialects, such as Caribbean or Andalucian Spanish), several assimilatory outcomes are possible for coda stops, including not only voicing assimilation but also interdentilation and gemination. Voicing assimilation can also interact with coda devoicing and spirantization, which ‘conspire’ to realize coda voiced stops as voiceless fricatives in Castilian Spanish (Martínez-Gil 1999; González 2002; Morris 2002a). Detailed acoustic investigation of both coda fricatives and voiced and voiceless stops in a given dialectal area is needed to clarify whether voicing assimilation targets both types of obstruents in similar ways, and how voicing assimilation interacts with other phenomena.

Interdentilation of coda voiceless stops and gemination also remain to be explored in more detail. Ongoing research by the present author suggests that interdentilation might not be as common in Basque-speaking areas as in other areas of Northern and Central Spain. Gemination also appears to be more extended than otherwise thought; more acoustic and articulatory evidence is needed, especially in dialects other than Andalusian or Caribbean Spanish.
3.2. Theoretical issues

Modeling assimilation proved challenging under rule-based, linear generative approaches, particularly for nasal place assimilation (Harris 1969; Cressey 1978; Núñez Cedeño 1980), since the Sound Pattern of English (SPE) formalism could not capture it simply (see, for example, Hooper 1972). Autosegmental approaches could capture assimilation more effectively through the delinking and spreading of different nodes comprising isolated features (e.g. ‘voice’) or feature nodes (such as ‘place’) (Hualde 1989b; Martínez-Gil 1991; Núñez Cedeño 2014). They could also capture partial assimilation outcomes, via double linked specifications such as [+voice], [−voice] for partial (de)voicing.

The most influential phonological framework since the 1990s, Optimality Theory (OT; McCarthy and Prince 1993a, 1993b; Prince and Smolensky 1993), is based on language-specific rankings of universal constraints. The prevailing way to capture assimilation in OT revolves around the interaction of faithfulness constraints (typically Identity; McCarthy and Prince 1995) with Agreement (AGREE) constraints (Lombardi 1999, 2001). The latter enforce similar feature specifications between segments. In consonant assimilation, AGREE outranks Identity (IDENT). Because AGREE constraints are nondirectional, IDENT constraints relevant to the trigger outrank AGREE (see Piñeros 2006 and section 4 for examples).

One example is provided in (15), focusing on voicing assimilation. The ranking IDENT-Onset [voice] >> AGREE [voice] >> IDENT [voice] selects candidate (b) as the winner, since it violates only the lower-ranked IDENT [voice]. Faithful candidate (a) fails because [s] disagrees in voicing with the adjacent consonant, leading to a violation of higher-ranked AGREE [voice]. Candidate (c) achieves voicing agreement by changing the onset input specification, violating top-ranked IDENT-Onset [voice].

\[(15) /isla/ \rightarrow [ˈiz.la] ‘island’\]

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</table>

AGREE constraints are not phonetically grounded. They can be understood as expressing a coarticulation imperative (González 2014), but since assimilation can also be grounded in perception and aerodynamics, their lack of phonetic grounding might be an advantage. They are nondirectional and generally ‘blind’ to feature binarity (but see section 4). However, assimilation is asymmetrical cross-linguistically, and certain assimilations are seldom attested (Bateman 2007; Zsiga 2011). Future work should explore whether AGREE constraints are ideal to capture assimilation.

One of the most important issues in the theoretical analysis of assimilation is how to best account for variation—and whether both grammatical and nongrammatical variation should be incorporated in phonological models (Coetzee 2016). One way in which variation can be accounted for in OT is having two (or more) constraints ranked similarly. This can result in a ‘tie’ between optimal candidates. Another option is constraint reranking in related grammars, which may correlate with different degrees of formality, tempo, or other factors that underlie different phonological realizations. Examples of both will feature in the case study in the next section. In addition, during the past two decades there has been an increase in empirical studies of consonant assimilation, and an improved understanding of the typology of assimilatory phenomena. From approaches with Lazy constraints (Kirchner 1998; Baker 2004) and gestural
Consonant assimilation

OT (Bradley 2014a, 2014b) to stochastic OT (Boersma 1997; Boersma and Hayes 2001), Max-Ent models (Hayes and Wilson 2008), and (noisy) Harmonic Grammar (Pater 2009; Coetzee 2016), OT continues to provide promising avenues of investigation to incorporate variation in consonant assimilation.

In Harmonic Grammar, constraint weighting replaces constraint ranking, with a Harmony score calculated for each candidate according to its constraint violations and the weights of those constraints. See Pater (2009) and Coetzee (2016) for details.

4. Case study: velar palatalization in Chilean Spanish

This section will focus on the analysis of velar palatalization in Chilean Spanish, introduced in section 2.1. Velar palatalization is common cross-linguistically (Bateman 2007; Gordon 2017). In Spanish, velar obstruents are slightly fronted before front vocoids across dialects (Navarro Tomás 1996), as in the word ‘quita’ [kɪ.ɪ.ta] take off mentioned in section 3.1. We will refer to this general coarticulatory tendency as ‘velar fronting’. In contrast, however, velar obstruents /k ɡ x/ are (pre) palatal before front vocoids in Chilean Spanish (Lenz 1940; Oroz 1966). We will refer to this phenomenon as ‘velar palatalization’. For /ɡ/, the allophone [ʝ] occurs after a nasal or pause, and the allophone [ʝ] elsewhere.

(16) a. quiso /ˈkiso/ [ˈci.so] wanted (3rd person sg.)
    page usted /ˈpa.ɡe usˈted/ [ˈpa.je.ɡu.ˈte] you (formal) pay
    gente /ˈɡente/ [ˈɡe.ɡente] people

Available studies on this phenomenon from the past forty years suggest that velar palatalization in Chilean Spanish can be considered (quasi-)categorical. Rabanales (1980: 447, 448) lists palatalization of velar obstruents as a phenomenon common in all areas of Chile, regardless of formality or educational level; Tapia and Valdieso (1997: 136) also consider it a general phenomenon in Chile. On the other hand, while Wagner (1996: 227) states that velar palatalization is almost categorical at lower sociocultural levels, but optional otherwise, Flores (2016) reports that velar palatalization is prevalent across the upper and middle classes and concludes that velar palatalization has gained ground and acquired overt prestige in Chile since the 1990s.

A theoretical account of this phenomenon, couched in OT, is given in González (2014), which compares synchronic velar palatalization in Chilean Spanish with diachronic palatalization (for more information on the latter, see Baker and Holt, this volume, and Zampaulo, this volume). The remainder of this section draws from this analysis. It shows that a general, coarticulatory tendency to front back consonants, and a (quasi-)categorical assimilatory phenomenon to fully palatalize them, can be captured in a related manner with Agree constraints in OT.

The analysis assumes that vowels are dorsal (Sagey 1986), therefore specified as [±back], as are velar and palatal consonants. It also proposes that vowels and dorsal consonants are specified for [±front]. Thus, /a, o, u/ are [−front, +back], and /e, i/ are [+front, −back]. Fronted and palatal consonants articulated in the hard palate are [−back], with the former being [−front] and the latter [+front]. On the other hand, velars are [+back, −front].

Following Calabrese (2005), velar fronting is captured through the involvement of [−back]. It is proposed that velar palatalization involves the feature [+front]. Both fronting and palatalization can be captured through the interaction of Ident and Agree. Because vocoids are triggers and consonants are targets, two types of Ident constraints are proposed, based on Telfer (2006).

(17) IDENT-C: ‘Preserve the feature values of consonants.’

Corresponding [+consonantal] input and output segments have the same features.
Carolina González

(18) **IDENT-V**: ‘Preserve the feature values of vocoids.’

Corresponding [−consonantal] input and output segments have the same features.

These constraints interact with **AGREE [−back]** and **AGREE [+front]**. The formulation of these constraints singles out ± feature specifications, which captures velar palatalization in Spanish and avoids generating consonant retraction of palatals.

(19) **AGREE [−back]**: ‘If a segment is [−back], adjacent segments are [−back].’

That is, *[−back] [+back], *[+back] [−back]

(20) **AGREE [+front]**: ‘If a segment is [+front], adjacent segments are [+front].’

The ranking **IDENT-V >> AGREE [−back] >> IDENT-C >> AGREE [+front]** captures velar fronting, common in most Spanish dialects, as shown in (21). Note that candidate (b), with a fronted velar, is optimal since it violates low-ranked constraints, unlike candidates (a), (c), and (d). Note that (d) achieves agreement through a double violation of **IDENT-V** (since the vowel has changed its input specification in backness and fronting).

(21) /xente/ → [ˈxeŋ.te] people

<table>
<thead>
<tr>
<th>Candidates</th>
<th>IDENT-V</th>
<th>AGREE [−back]</th>
<th>IDENT-C</th>
<th>AGREE [+front]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. xeŋ.te</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>❌ b. xeŋ.te</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. çeŋ.te</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>❌ d. xoŋ.te</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

If **IDENT-C** is demoted below **AGREE [+front]**, and there is no crucial ranking between both agreement constraints, velar palatalization arises, as shown in (22). The winning candidate (c) is realized with full palatalization of the input velar, violating **IDENT-C**. In comparison, candidates (a, b) violate higher-ranked agreement constraints, while (d) loses on a double violation of **IDENT-V**. The tableau in (23) shows the evaluation for the word /gala/, where palatalization does not apply. In this case, faithful candidate (a) is selected as the winner; unlike its competitors, it does not violate any constraints in the evaluation.

(22) /xente/ → [ˈceŋ.te] people

<table>
<thead>
<tr>
<th>Candidates</th>
<th>IDENT-V</th>
<th>AGREE [−back]</th>
<th>AGREE [+front]</th>
<th>IDENT-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. xeŋ.te</td>
<td>*(!)</td>
<td>*(!)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>❌ b. xeŋ.te</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. çeŋ.te</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>❌ d. xoŋ.te</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

(23) /gala/ → [ˈga.la] gala

<table>
<thead>
<tr>
<th>Candidates</th>
<th>IDENT-V</th>
<th>AGREE [−back]</th>
<th>AGREE [+front]</th>
<th>IDENT-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ga.la</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>❌ b. g’ala</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. ja.la</td>
<td>*(!)</td>
<td>*(!)</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>❌ d. go.la</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Finally, the ranking $\text{Ident-V, Ident-C} > \text{Agree [+front], Agree [−back]}$ would capture instances of velar faithfulness, since both faithfulness constraints would rank over both agreement constraints. It is an empirical question whether there are Spanish dialects where velars display no fronting whatsoever before fronted vowels.

The related rankings in (21, 22) represent similar, but nonidentical grammars in various Spanish dialects. With some additions, these basic rankings can account for the development of palatals diachronically in Hispano-Romance, which went through a fronting phase before fully palatalizing (for details, see González 2014).

This approach involves specification of features in the formulation of $\text{Agree}$ constraints, which accounts for some of the asymmetrical nature of this type of assimilation; more investigation is needed on whether specification is needed to account for other phenomena. In addition, it depends on specifying dorsal consonants, and vowels, with $[±\text{front}]$. More investigation is needed on the relevance of $[±\text{front}]$ in other areas of Spanish phonology.

One possible alternative analysis without recurring to the feature $[\text{front}]$, suggested by Martínez-Gil (p.c.), considers palatalized velars as having both a consonantal and a vocalic place of articulation. The latter would correspond to a secondary, fronted place of articulation. The ranking $\text{Agree [back]} > \text{Def-V-Place} > \text{Ident [back]}$ would capture fully palatalized outcomes in Chilean Spanish in this analysis.

5. Conclusion

The goal of this chapter was to provide a comprehensive overview of consonant assimilation in Spanish. The preview offered in section 1 shows that consonant assimilation in Spanish is generally anticipatory and tends to involve coda targets and onset triggers. This is not surprising since a large body of research shows that codas are weaker in many ways than onsets and more prone to undergoing phonological changes. Consonant assimilation in Spanish targets both sonorants and obstruents, albeit in different ways. Most cases of consonant assimilation in Spanish involve place, followed by voicing, the most common features that assimilate between adjacent consonants cross-linguistically. Spirantization (see Martínez-Gil, this volume) is also unusual in that it involves assimilation of manner (more specifically, continuancy). Finally, while some types of assimilatory phenomena are pervasive across Spanish dialects (such as nasal and lateral place assimilation), some appear to be specific to certain dialects (such as interdentalization).

Although much work has been conducted on certain types of consonantal assimilatory phenomena in Spanish, such as voicing or nasal place assimilation, more research is needed regarding less investigated cases, such as interdentalization or gemination. In addition, a better understanding of gradience and optionality in Spanish consonant assimilation phenomena will contribute greatly to the refinement and/or development of current theoretical models in phonology.

References


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